

PROCEEDINGS OF THE UNITED STATES NATIONAL MUSEUM



SMITHSONIAN INSTITUTION
U.S. NATIONAL MUSEUM

Vol. 83

Washington : 1935

No. 2980

TWO NEW SPECIES OF TAPEWORMS FROM CARNIVORES
AND A REDESCRIPTION OF *TAENIA LATICOLLIS*
RUDOLPHI, 1819

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IN STUDYING a collection of cestodes from carnivores in North America, I found two species with characters sufficiently distinctive to necessitate considering them new.

A review of specific characters develops the fact that hook sizes as given in the literature are not necessarily comparable things. No scheme for measuring hooks appears to be generally accepted by the various writers on cestodes, but in this paper I assume, where no scheme such as Meggitt's (1927, p. 420) is presented, that the length of the entire hook is the distance, in a straight line, from tip to tip; that the length of the blade is the distance, in a straight line, from the tip of the blade to the tip of the guard; and that the length of the handle is the distance, in a straight line, from the tip of the handle to the tip of the guard. The length of the guard is perhaps usually considered the distance from the tip of the guard to the dorsal edge of the hook. In this paper the different types of hooks have made it advisable to use more than one scheme for measurement. The scheme used for *Taenia lynx* is represented in plate 19, figure 4. AB represents length of hook, DB length of blade, AC length of handle, and EF length of guard. This scheme is also followed in measuring the hooks of *T. taxidiensis*. The hooks

of *T. laticollis* are measured according to the scheme referred to above as the one believed to be in general use. All these terms used in discussions of hooks invite criticism, especially such a name as "dorsal edge", for hooks cannot accurately be said to have a "dorsal" edge, but these terms are retained in preference to introducing a new terminology.

TAENIA LYNCIS, new species

PLATE 19, FIGURES 2-5; PLATE 20, FIGURES 1-4

Specific diagnosis.—Length up to about 64 cm, maximum width 11 mm. Genital papillae inconspicuous, located approximately in middle of lateral margin of segment. Overlapping of segments not pronounced. Mature segments comparatively few, usually 10 to 15; gravid segments constituting more than half of length of strobila. Neck usually short; segmentation usually beginning 540μ to 1.4 mm posterior to suckers. Scolex usually wider than first segments, 620μ to 1 mm wide; suckers conspicuous, round, or slightly oblong with greater diameter in anteroposterior direction, 165μ to 205μ in diameter; rostellum 250μ to 400μ in diameter, armed with double crown of 36 to 46 hooks, rostellum sometimes protruding to an extent one and a half times as long as remainder of scolex. Large hooks 220μ to 258μ long (pl. 19, fig. 5); handle 110μ to 151μ long, widest portion at distal end; guard conspicuous, 55μ to 70μ long; blade 79μ to 85μ long. Small hooks 159μ to 208μ long; guard distinctly bifid (pl. 19, fig. 3), 43μ to 63μ long; handle 79μ to 122μ long; blade 61μ to 73μ long. Nerve cord about 600μ from lateral margin of segment; ventral longitudinal canal 700μ to 800μ from lateral margin of segment; posterior transverse canal conspicuous. Calcareous corpuscles spherical or ovoid, about 22μ in greater diameter.

Type specimen 23 cm long; maximum width 4.5 mm; about 236 segments; all segments wider than long; terminal gravid segments about 2.75 mm long, 3.5 mm wide. Segmentation apparent 750μ to 1 mm posterior to suckers; genital primordia visible in about fifteenth segment. The strobilae of various specimens vary widely in general appearance; in the type and a paratype (U.S.N.M. no. 28482) the strobila is thin; in some other paratypes (U.S.N.M. no. 26886) it is uniformly much wider and thicker, and would thus suggest that it is a distinct species, but the hooks and the anatomy of the mature segment check satisfactorily with the type specimen. The mature segments illustrated in plate 20, figure 3, are from a worm about 60 cm long from *Felis concolor hippolestes* and are quite unlike those of the type specimen in other ways than in the size of the strobilae (that is, in the shape and size of the ovary and vitel-

larium and in the number of testes), but the hooks are sufficiently like those of the type specimen to leave no doubt concerning the specific determination of this worm. Other strobilae collected from the same host show in some of the mature segments much greater similarity to the type specimen than do those that were photographed, but the condition of the material did not provide segments suitable for photographing. The strobila of this larger worm appears to have been stretched in fixation, and this probably accounts for the distance between the vitellarium and the posterior margin of the segment as contrasted with the position of the vitellarium in the type specimen.

Male reproductive system.—Testes usually¹ spherical, sometimes slightly elongated, 30μ to 50μ in greater diameter in typical segments, 200 to 500 in number, with usual distribution between longitudinal canals, not closely crowded in typical segment; usually a few testes in space between ovaries and vitellarium; testes usually overlap lateral portions of vitellarium; usually several testes posterior to vitellarium, only rarely a few posterior to ovary. In plate 20, figure 2, are shown segments of a strobila in which testes are 60μ to 95μ in diameter and somewhat more crowded together. Seminal vesicle not observed. Coiled mass of vas deferens passing in an approximately straight line from cirrus pouch toward center of segment. Cirrus pouch 200μ to 375μ long, 70μ to 110μ wide, rarely extending mediad to ventral longitudinal excretory canal.

Female reproductive system.—Ovaries varying somewhat in shape, depending on state of contraction; typical shape of ovary is that shown in plate 20, figure 2; each lobe wider (measured along transverse axis of strobila) than long. Vitellarium usually of shape shown in plate 20, figure 2, occasionally triangular, usually not extending laterad beyond lobes of ovary, about 1.5 mm wide as measured along transverse axis of strobila and about 120μ long as meas-

¹The description of this species is based on the study of specimens collected over a period of many years and therefore represents a far more extensive consideration of variation than is commonly included in the original description of a species. To one not wholly familiar with the usual variations found in cestodes, such a study has its disadvantages, for when one recognizes and tabulates variations resulting from different stages of contraction and expansion (due usually to methods and media of fixation), from the age of the specimens, from the size and state of nutrition of the host animal, or from the multitude of undetermined factors (possibly the hereditary composite due to the genes) that are accepted as playing a part in determining the physical characteristics of any organism, it becomes difficult to set down concise statements concerning characters that may be found in all specimens; as a result the description lacks a pleasing exactness that might be given to it if no note were made of these variations or if several additional species were made on the basis of such variation. My study of cestodes has led me to take the position that in many descriptions what has been designated as specific differences is no more than these individual variations, and with the resulting latitude given to my conception of a species the frequent use of limiting adverbs such as "usually" becomes unavoidable.

ured along longitudinal axis of strobila. Vagina posterior to cirrus pouch, lined with ciliated cells; seminal receptacle variable in size, 125μ to 170μ long and 50μ to 61μ wide. The structure considered herein as the so-called shell gland is relatively inconspicuous, 30μ to 60μ in diameter. Uterus at first an approximately straight tube, later developing wide outpocketings, these becoming reduced to more delicate lateral branches, 4 to 10 (frequently 8) in number on each side; uterine branches sometimes (pl. 19, fig. 2) taking on the appearance of "drooping" branches. Eggs about 25μ by 28μ to 35μ .

Larva with large terminal bulblike bladder about 8 mm long and 6.5 mm wide, transversely striated (pl. 20, fig. 4); body of larva about 11 mm long and 2.5 mm in maximum width.

Hosts.—Definitive: *Lynx rufus rufus*, *L. r. californicus*, *L. r. fasciatus*, *L. r. vinta*, *Felis concolor azteca*, *F. c. hippolestes*, *F. c. oregonensis*; intermediate: *Odocoileus columbianus scaphiatus*, *O. hemionus hemionus*, and *O. virginianus macrourus*.

Location.—Small intestines of definitive host; lungs and pericardium of intermediate host.

Distribution.—United States (Arizona, California, Colorado, Idaho, Minnesota, Montana, New Mexico, North Carolina, Oregon, Utah, Virginia, and Washington).

Life history.—The hooks of larval forms found in *Odocoileus columbianus scaphiatus*, *O. hemionus*, and *O. virginianus* are similar to those of the adult cestode. While experimental evidence as to the life history is lacking, the shape and size of these hooks appear to constitute a specific character, and this morphological character suggests that these larvae found in the deer develop to an adult form in the carnivores listed as definitive hosts when infested deer are eaten by these carnivores. The deer presumably become infested by ingesting the eggs in contaminated food or water.

Cysticerci attached to the liver of *Peromyscus maniculatus nubriterrae* from Sevier County, Tenn., show hooks similar to those of *Taenia lyncis* in shape and size. Both the host and the location of these cysticerci indicate that evidence based upon successful experiments with the life history of this worm is needed before a specific determination can be made. These specimens were collected by E. V. Komarek, of Thomasville, Ga.

The hooks, especially the small ones, which are unlike those of other carnivore cestodes known to me, on account of their long tapering handle and long bifid guard serve as the best character for specific determination. This species has frequently been found in the same host with *Taenia macrocystis*.

Type specimen.—U.S.N.M. no. 39801, collected from *Lynx rufus* in Alleghany County, Va., by Dr. E. W. Price, of the U. S. Bureau of Animal Industry; paratypes (no. 28482) also collected by Dr. Price.

TAENIA TAXIDIENSIS, new species

PLATE 19. FIGURES 9-12; PLATE 21

Specific diagnosis.—Type specimen about 10 cm long; maximum width about 2 mm; about 150 segments (100 immature, 30 mature, 20 gravid). Neck relatively long; first segmentation apparent about 3 mm posterior to suckers; genital primordia visible in about twentieth segment. Genital papillae usually in middle of lateral margin of segment or slightly anterior to middle, sometimes quite prominent and occupying one-fourth length of segment margin. Scolex (pl. 19, fig. 12) only slightly wider than anterior portion of neck, about 450μ in greatest diameter; suckers prominent, cuplike, about 140μ in diameter; rostellum about 170μ in diameter. Hooks (pl. 19, fig. 9) incompletely known; only one type (presumably large hooks) present on available material; length of hooks 90μ to 93μ ; handle about 56μ long; guard 44μ to 47μ long; width of guard about 16μ . Hooks appeared to be easily lost; the one hook found on the type specimen was lost during the mounting process. Longitudinal excretory canals inconspicuous, difficult to trace even in cross sections. Calcareous corpuscles round or ovoid, up to 15μ in greater diameter.

One complete (?) specimen and several fragments comprise the type and paratype material.

Male reproductive system.—Testes 150 to 250 in number, in one layer dorsoventrally, usually spherical, sometimes ovoid, about 31μ in greater diameter, with the usual distribution between longitudinal canals. No testes observed posterior to vitellarium and none between lobes of ovary. Coiled mass of vas deferens conspicuous, usually curving somewhat toward posterior margin of segment in its course toward median region of segment. Cirrus pouch extending mediad to inner margin of ventral excretory vessel.

Female reproductive system.—Ovaries and vitellarium vary widely in shape and size, as shown by camera lucida diagrams, all drawn to same scale, in plate 21. Vitellarium relatively conspicuous, not extending laterally beyond ovary, usually close to posterior margin of segment. Shell gland not demonstrable. Gravid uterus (pl. 19, fig. 11) with 11 to 19 lateral branches on each side. Eggs not observed.

Hosts.—Definitive: *Taxidea taxus taxus*; intermediate: Unknown.

Location.—Intestine of definitive host.

Distribution.—United States (Granite County, Mont.).

Life history.—Unknown.

Type specimen.—U.S.N.M. no. 39803; paratypes, no. 32840; all collected by W. L. Jellison, of the University of Montana.

The condition of the type specimen and of the few additional paratype fragments available makes adequate description of a number of details impossible, but the size and shape of the hooks, especially the conspicuously long guard, constitute a character adequate for specific determination.

TAENIA LATICOLLIS Rudolphi, 1819

PLATE 19, FIGURES 1, 6-8

Specific diagnosis.—Length up to 14 cm, maximum width 3.2 mm. Immature segments usually wider than long; mature segments usually approximately square; gravid segments usually longer than wide. Neck usually distinct, sometimes obscured by contraction, usually slightly narrower than greatest diameter of scolex. Genital papillae only moderately prominent, located approximately in middle of segment margin. Suckers usually prominent, rostellum usually prominent, about 700μ in diameter, with double circlet of 38 to 42 hooks; large hooks 390μ to 415μ long; hook 400μ long with handle 195μ long, blade 146μ long, guard 73μ long; small hooks 214μ to 238μ long, handle 122μ to 134μ long, blade 134μ to 140μ long; guard only slightly bifid. Ventral longitudinal excretory canals only moderately prominent, varying widely in shape and size, up to 125μ in diameter when circular in cross sections; no other longitudinal canals demonstrable. Transverse excretory canal conspicuous, up to 230μ in diameter.

One specimen examined was 83 mm long and 2.5 mm in maximum width; about 90 segments (62 immature, 10 mature, 18 gravid); first segmentation apparent about 1.4 mm posterior to suckers; genital primordia visible in twentieth to twenty-fifth segments. Scolex 1.5 mm in diameter; suckers 390μ in diameter, rostellum 714μ in diameter.

Male reproductive system.—Testes approximately globular, 37μ to 49μ in diameter, 180 to 250 in number, with usual distribution between longitudinal canals. No testes observed posterior to vitellarium or between lobes of ovary. Vas deferens (pl. 19, fig. 7) usually loosely coiled, conspicuous, sometimes occupying entire medullary parenchyma from cirrus pouch to median field of segment, usually curved somewhat anteriorly in median field of segment, usually extending to center of segment. Cirrus pouch 275μ to 293μ long by 66μ to 131μ wide, extending to longitudinal canals.

Female reproductive system.—Ovaries with aporal lobe usually larger, about 360μ long by 180μ wide, poral lobe about 295μ long by 180μ wide. Vitellarium wedge-shaped, 595μ to 655μ wide (measured along transverse axis of strobila) by 60μ to 120μ long, usually extend-

ing laterad beyond ovaries. Uterus with 10 to 15 lateral branches on each side. Eggs 40μ by 28μ to 32μ .

Hosts.—Definitive: *Lynx fasciatus*, *L. f. fasciatus*, *L. rufus*, *L. r. californicus*, *Lynx lynx* (syn. *Felis lynx*), *Canis lestes*; intermediate: Unknown.

Location.—Intestine of definitive host.

Distribution.—Europe and United States (Washington and California).

Life history.—Unknown.

Remarks.—This redescription is based upon U.S.N.M. no. 25317 and other specimens filed in the Zoological Division, Bureau of Animal Industry.

In several respects this species is similar to *T. taeniaeformis*, and the two species have undoubtedly been confused; in both species the rostellum is relatively heavy and conspicuous, sometimes extended to a length exceeding that of the scolex; the suckers also are relatively prominent and the hooks relatively large. Nevertheless, the two species are readily separated, by even casual examination, on the basis of the difference in the shape of the large hooks and the striking difference in the size of the strobila in mature specimens; the guard of the hooks of *T. taeniaeformis* is much more prominent than the guard of the large hooks of *T. laticollis*; the strobila of *T. taeniaeformis* is usually much longer and wider than that of *T. laticollis*. It is also probable that *T. laticollis* has been confused with *T. macrocystis*; both species are relatively small cestodes and both have relatively large hooks, but the hooks of *T. macrocystis* are more numerous and the large hooks especially are quite unlike those of *T. laticollis* in shape and size; the maximum length of the large hooks of *T. macrocystis* is less than the minimum length recorded for those of *T. laticollis*.

The size and shape of the hooks and the conspicuous vas deferens, with its mass of coils usually extending to the median field of the segment and curving somewhat anteriorly, are the two most outstanding characters for differentiation of this species from other members of the genus.

Hall (1919) gave a compilation (see table 1) of the descriptions of *T. laticollis* from several authors, including Leuckart (1856). Hall's compilation gave the large hooks as "(?) 380 to 420μ long" and the small hooks as "150 (?) to 183μ long"; Leuckart figured them on the same scale as and in the same plate with *T. crassicollis* (= *T. taeniaeformis*) and described them as the same size as those of *Taenia crassicollis* but slenderer and somewhat more curved ("gerummt"). The large hooks of *T. laticollis* must then be considered recorded by Leuckart as 390μ (the length recorded by him

for the large hooks of *T. crassicollis*), but I find the length of the large hooks of *T. taeniaeformis* (syn., *T. crassicollis*) to be 380μ to 430μ ; therefore the large hooks of *T. laticollis* as estimated from Leuckart's description may be considered to be approximately 380μ to 430μ long. For the small hooks of *T. laticollis* Leuckart gave the length from the tip of the handle to the tip of the guard as 128μ and the distance from the tip of the blade to the tip of the guard as only slightly more than the length of the handle (or more than 128μ). This provides a basis for determining Leuckart's estimate of the length of the short hooks of *T. laticollis*, but they may also be compared with the small hooks of *T. taeniaeformis*, which I find to be 238μ to 260μ long, and these measurements may be taken to represent approximately the length of the small hooks of *T. laticollis* according to Leuckart's description. The length of the short hooks of *T. laticollis*, as estimated from Leuckart's description, is then somewhat more than that given by me, while the measurement I give for the large hooks agrees with that given by Leuckart. One other point of difference remains—the relative length of the blade and handle in the large hooks as described and figured by Leuckart and by me. From Leuckart's description and figures the distance from the tip of the guard to the tip of the handles is found to be 239μ and the distance from the tip of the guard to the tip of the blade to be slightly longer than 239μ . In the hooks described by me, the length of the blade, measured as Leuckart measured it, is found to be less than the length of the handle. This difference leaves grounds for contending that the two species are not identical. However, in spite of this difference and the slight difference in the length of the small hooks, I conclude that the specimens that I examined from lynxes in North America are *T. laticollis*.

TABLE 1.—*Descriptive data on Taenia laticollis Rudolphi, 1819*

Character	Hall's compilation (1919)	Leuckart's description (1856)	Skinker
Length.....	50 to 95 mm.....	95 mm.....	Up to 140 mm.
Maximum width.....	2 mm.....	2 mm.....	3.2 mm.
Neck.....	Absent.....	Absent.....	Present or absent according to state of contraction. ¹
Scolex (diameter).....	1 to 1.22 mm.....	.....	About 1.5 mm.
Rostellum (diameter).....	600 μ to 700 μ	700 μ	About 714 μ .
Suckers (diameter).....	340 μ to 400 μ.....	.....	About 390 μ .
Hooks (total number).....	38 to 60.....	60.....	38 to 42.
Small hooks (length).....	150 (?) to 183 μ	About 250 μ ²	214 μ to 238 μ .
Small hooks (distance from tip of handle to tip of guard).....	.....	128 μ	122 μ to 134 μ .
Small hooks (distance from tip of guard to tip of blade).....	.....	Slightly more than 128 μ	134 μ to 140 μ .
Large hooks (length).....	380 to 420 μ	About 390 ²	390 μ to 415 μ .
Large hooks (distance from tip of handle to tip of guard).....	.....	239 μ	195 μ to 244 μ .
Large hooks (distance from tip of guard to tip of blade).....	.....	Slightly more than 239 μ	146 μ to 177 μ . ²
Genital papillae.....	Prominent.....	.....	Only moderately prominent.
Longitudinal excretory canals.....	.....	.....	Not prominent.
Testes (number).....	.....	.....	About 180 to 250.
Testes (diameter).....	.....	.....	37 μ to 49 μ .
Eggs.....	.....	Not observed.....	28 μ to 32 μ by 40 μ .
Hosts (definitive).....	<i>Lynx lynx</i> (syn., <i>Felis lynx</i>), <i>L. canadensis</i> . ³	The lynx.....	<i>Lynx fasciatus</i> , <i>L. f. fasciatus</i> , <i>L. rufus</i> , <i>L. r. californicus</i> .
Locality.....	Europe and (?) U. S.....	Europe.....	North America (Wash. and Calif.)
Larva.....	Unknown.....	Unknown.....	Unknown.
Drawings.....	Small hooks, after Lühe (1910).	Large hooks and small hooks.	Hooks, mature segment, gravid segment.

¹ Observations made by me on many specimens of cestodes indicate that the presence or absence of the neck in any taenioid cestode is dependent upon the state of contraction of the strobila as a whole. In *T. taeniaeformis*, a species described by most authors as being without a neck, I find a distinct neck in all uncontracted specimens.

² See discussion of measurement of hooks given in the general discussion of this species (p. 217).

³ Hall (1919) included *Lynx canadensis* in the list of hosts of *T. laticollis*. This record is undoubtedly based on a record published by Stiles and Hassall (1894), but examination of this material by me reveals that the specimens, which were collected by Dr. A. I. Comfort, were incorrectly determined and are *T. macrocystis*; no other information concerning them is available. Therefore *Lynx canadensis* cannot at present be said to be known to serve as a host for *T. laticollis*, although several other members of the genus *Lynx* are known to serve as hosts, and it is therefore probable that *L. canadensis* will in time be found to harbor this cestode.

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<https://doi.org/10.5479/si.00963801.83-2980.211>.

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