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**Studies on the Helminth Fauna of Alaska. XXXV.
On the Identity of Certain Cestodes (Taeniidae) from Foxes**

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Some species of the genus *Taenia* Linnaeus, 1758, are morphologically so similar in the adult stage that their separation is very difficult. Complicating this problem is the questionable validity of certain of these species which have been insufficiently characterized. There are two species, however, the adults of which possess well defined morphological differences but which have been repeatedly confused despite their having been adequately described by early investigators. These cestodes, *Taenia crassiceps* (Zeder, 1800) and *T. polyacantha* Leuckart, 1856, have for many years been recognized solely by their larval characteristics under the misconception that the adults were indistinguishable.

It is the purpose of this paper to redefine the morphological characteristics of these two species, and to review the status of *Taenia hyperborea* von Linstow, 1905, also a parasite of foxes.

DIFFERENTIATION OF *T. crassiceps* and *T. polyacantha*

Although *T. crassiceps* was described by Zeder in 1800, the name frequently has been attributed to Rudolphi, who later published a synoptic description of the adult (Rudolphi, 1810; p. 172). Its larval stage—cysticerci from the thoracic cavity of *Mus arvalis* [= *Microtus arvalis* (Pallas)]—was described by Rudolphi (1819; p. 547) under the name *Cysticercus longicollis*. Leuckart (1856; p. 32) reported having established through feeding experiments the relationship of the larval and adult stages, pointing out that the close agreement in form of the rostellar hooks had convinced him previously of their identity. Leuckart (1856) also published a diagnosis of *T. crassiceps*.

T. polyacantha was adequately described by Leuckart (1856), but unfortunately, as will be seen, an error was made in the measurements of the rostellar hooks, the lengths of which were given as 53 and 34 microns for the large and small hooks, respectively. Leuckart illustrated the hooks of both *T. crassiceps* and *T. polyacantha*, demonstrating the differences in their shapes, but the large hooks of the two species were shown as being of the same length, and small hooks nearly so.

Baer (1925) studied "un facon de Cestodes" obtained from a fox in Switzerland and identified a single species, *T. crassiceps*. Since his material did not correspond entirely with the description of *T. crassiceps* as given by Leuckart (1856), Baer undertook a redescription of the species. From his description, with the accompanying figures, it is evident that Baer's material consisted of strobilae of both *T. crassiceps* and *T. polyacantha*, but with scolices of only *T. polyacantha*. Baer's figure 1 (p. 78), "Le scolex de *T. crassiceps*," shows the typical hooks of *T. polyacantha*; his figure 2, "A" and "B," shows the details of the genital pores of both species (the differences being attributed to differences in the state of contraction of the strobilae); figure 3 (p. 79) portrays, as stated, the gravid segment of *T. crassiceps*.

Baer was aware that the number of rostellar hooks observed in his material (60 to 62) agreed with the number given by Leuckart (62) for *T. polyacantha*, but was misled by the erroneous measurements given by Leuckart for the rostellar hooks of this species. Baer (p. 78) suspected that an error had been made:

"Nous nous demandons s'il n'y a pas eu erreur, car, dans la planche II, les crochets de *T. crassiceps* et de *T. polyacantha*, dessinés à la même échelle, ont même forme et même longueur!" However, from the material that he studied, Baer concluded (p. 79), "Les deux espèces ont le même nombre de branches utérines et les dimensions des oeufs sont identiques. Nous en concluons que ces deux espèces sont identiques malgré la grande différence dans le nombre des crochets. Un exemple semblable nous est fourni par *T. taeniæformis* (Batsch), où le nombre des crochets varie de 26 à 52. Nous adoptons le nom de *T. crassiceps* Rud., qui a priorité, et lui décrivons 32 à 62 crochets, dont les grands ont 186 à 207 μ de long et les petits 129 à 135 μ . L'utérus a huit à dix branches latérales, et les oeufs 25 à 28 μ de diamètre." Baer attached no significance to the differences in the shape of the hooks of the two species, as portrayed by Leuckart.

The first description of the larval *T. polyacantha* was that of Baer (1932), who made the determination on the basis of the number, form, and size of the rostellar hooks. He referred to his earlier conclusions regarding the validity of this species as follows (p. 13), "Il y a quelques années (1925a), nous proposons de réunir *T. crassiceps* Rud. à *T. polyacantha* Leuck. vu l'identité des anatomies et des hôtes, et la très grande ressemblance des crochets; cependant lorsqu'on compare les formes larvaires, on constate qu'elles sont nettement différentes." Baer and Scheidegger (1946) also studied *T. crassiceps*, remarking about the strobilar stage (p. 63), "Par la forme et la taille, ces crochets ressemblent beaucoup à ceux d'une autre espèce de Ténia du Renard,

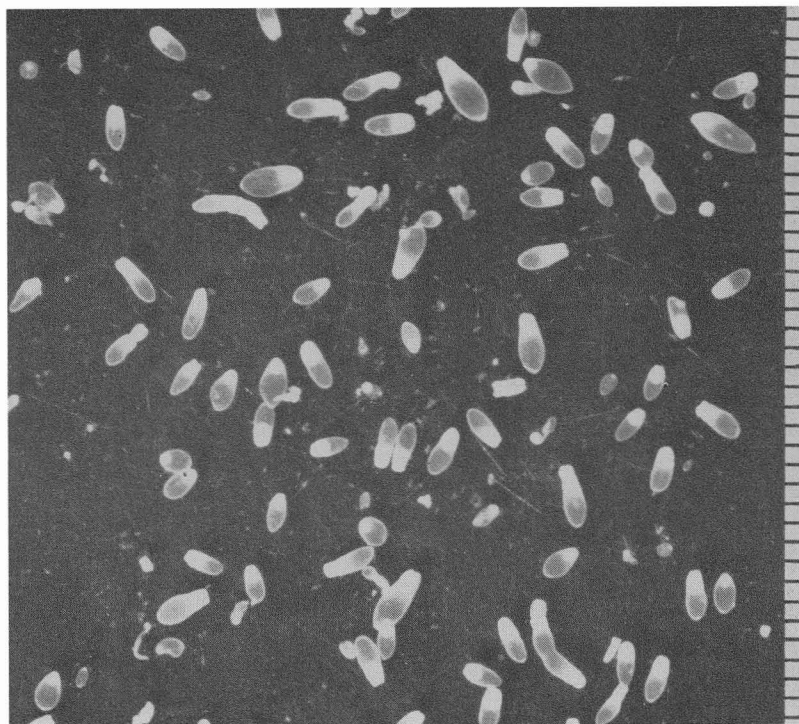


Figure 1. Larvae of *T. crassiceps* from *Lemmus*, Point Barrow, Alaska. Each space of scale has the value of 1 mm.

T. polyacantha Leuck., mais chez laquelle le nombre des crochets est presque deux fois plus élevé (60). Ces deux espèces de Cestodes sont très voisines par leur anatomie, mais se distinguent cependant facilement par leurs formes larvaires . . ." The hooks figured by Baer and Scheidegger (p. 64, fig. 3) for *T. crassiceps* clearly include those of both species.

T. crassiceps and *T. polyacantha* have been little studied since the work of Baer and Scheidegger (1946). The former, with a description of the adult, was first recorded from North America by Rausch (1952). *T. polyacantha* had not been recorded in North America at the time, and the problem of distinguishing the two species consequently was not considered. The first North American record of *T. polyacantha*, based on larvae from *Microtus*, was that of Schiller (1953). Wardle (1952; pp. 417 and 418) listed both species under *species inquirenda*.

In the course of surveys carried on in Alaska, large numbers of cestodes of both species have been collected from foxes, and the larvae of both have been found in various species of microtine rodents. A description of *T. polyacantha*, based upon this material, is presented below. Since a description of *T. crassiceps* has been recently published (Rausch, 1952), duplication is not necessary here. The larvae of the two species are shown in figs. 1 and 2.

Taenia polyacantha Leuckart, 1856 (Figs. 3-5)

DIAGNOSIS: Strobila 140 to 235 mm long; maximum width, up to 4 mm, attained in gravid segments. Length/width ratio of segments increases with



Figure 2. Larvae of *T. polyacantha* from *Lemmus*, Point Barrow, Alaska. Each space of scale has the value of 1 mm.

age; immature segments are wider than long, mature segments are about as long as wide, and gravid segments may be two times longer than wide. Margins of strobila serrate. Scolex relatively small, measuring about 1.2 mm in diameter; well developed suckers about 450 microns in length. Rostellum armed with 44 to 50 hooks, arranged in 2 rows. Large hooks have handle and blade of nearly equal length, and measure 200 to 214 microns (av. 210 microns); small hooks, having handle only slightly developed, measure 142 to 157 microns (av. 147 microns). Genital pores irregularly alternate, situated at middle of segmental margin. Genital papillae not prominent. Subspherical cirrus sac, overlapping ventral longitudinal excretory canal, measures 140 to 215 microns long by 140 to 180 microns wide. Cirrus aspinose, measuring about 65 microns in diameter and 140 microns long when everted. Vas deferens much coiled at proximal end of cirrus sac. Testes, numbering at least 220 per segment, measure about 70 microns in diameter; they are arranged in 2 lateral fields which are confluent in anterior portion of segment. Testes not extending posterior to posterior limits of vitelline gland and not overlapping ventral longitudinal excretory canals. Vagina, opening in genital atrium posterior to cirrus sac, measures about 15 microns in diameter; it is diverted abruptly posteriad by cirrus sac, after which it takes direct course mediad and forms large seminal receptacle at mid-line of segment. Ovary consists of 2 reniform lobes, of which aporal lobe is larger. Transversely, ovary comprises about $\frac{1}{3}$ of segment. Vitelline gland, about 8 times as wide as long, lies posterior to ovary near posterior margin of segment; its ends usually extend somewhat beyond limits of ovarian lobes. Mehlis' gland spherical, about 150 microns in diameter. Gravid uterus with 12 to 16 lateral branches on each side; these subdivide, nearly filling gravid segments within limits of ventral longitudinal excretory canals. In moderately relaxed strobilae, gravid uterus usually has well defined rectangular outline. Eggs measure 32 to 40 microns long by 30 to 35 microns wide (av. 36 by 32.5 microns).

HOSTS: *Alopex lagopus* Linnaeus (arctic fox) and *Vulpes vulpes* Linnaeus (red fox). Also occurs rarely in dogs in Alaska.

HABITAT: Small intestine of host.

DISTRIBUTION: Holarctic, but in North America known only from high-boreal regions (Alaska).

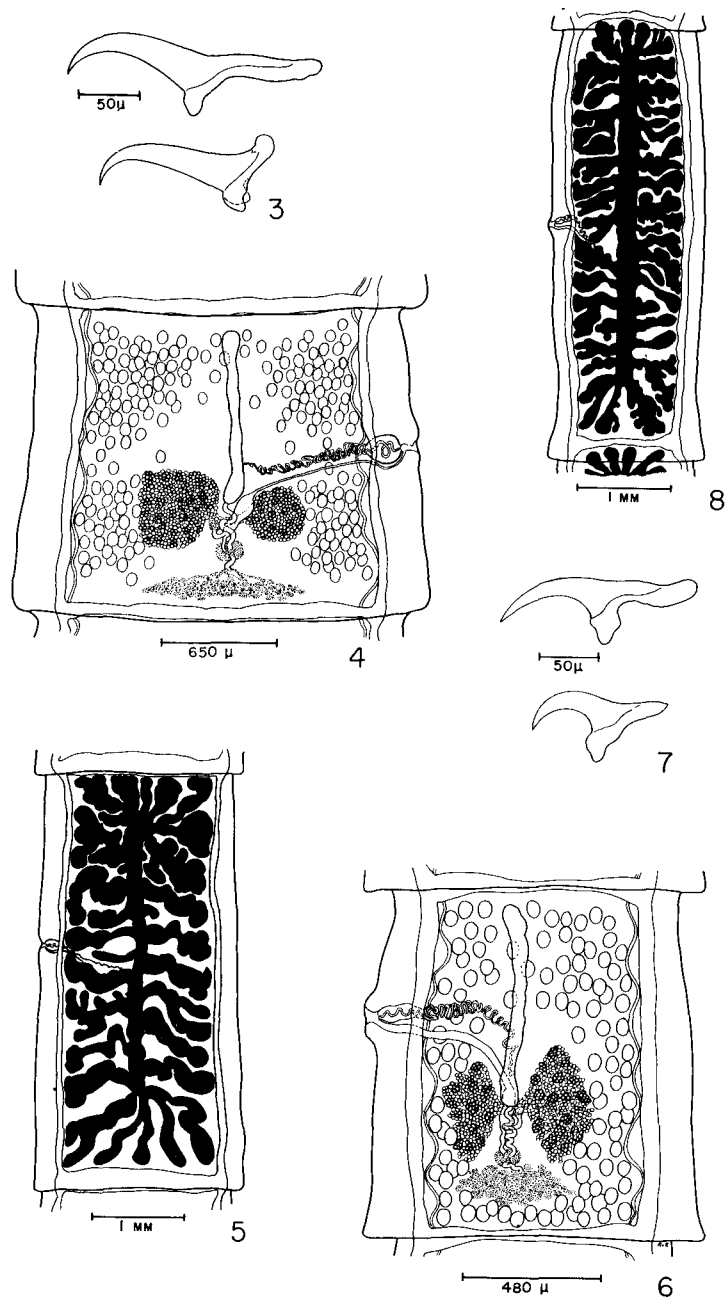
Slides containing an entire strobila of *T. polyacantha* have been deposited in the Helminthological Collection of the U. S. National Museum, No. 38398.

The specimens of *T. polyacantha* from Alaskan foxes possess a smaller number of rostellar hooks than do those from Europe (44 to 50 as compared with 60 to 62). However, I do not consider this difference sufficiently great to justify formal recognition of the Alaskan cestode at a subspecific level, particularly since the limits of normal variation in the number of rostellar hooks of *T. polyacantha* have not been determined in Eurasia, there having been no studies made on material collected east of Europe.

For comparative purposes the more important morphological details of *T. crassiceps* are shown in Figs. 6-8, and the differential characteristics of the two species are listed in Table 1.

THE IDENTITY OF *Taenia hyperborea* VON LINSTOW, 1905

T. hyperborea was described from material collected from an arctic fox on the east coast of Greenland. Although von Linstow's (1905) diagnosis was adequately detailed, the status of the species has never been finally determined. The form of the rostellar hooks led Railliet and Henry (1915) to



Figures: 3. Rostellar hooks of *T. polyacantha*; 4. Mature segment of *T. polyacantha*; 5. Gravid segment of *T. polyacantha*; 6. Mature segment of *T. crassiceps*; 7. Rostellar hooks of *T. crassiceps*; 8. Gravid segment of *T. crassiceps*.

Table 1. Differential characteristics of *T. polyacantha* and *T. crassiceps*, from Alaskan material

	<i>T. polyacantha</i>	<i>T. crassiceps</i>
Length of strobila	140 to 235 mm	70 to 140 mm
Number of rostellar hooks	44 to 50	28 to 32
Size of rostellar hooks	Large hooks: 200 to 214 microns Small hooks: 142 to 157 microns	Large hooks: 172 to 178 microns Small hooks: 121 to 136 microns
Position of genital pore	At middle of segmental margin.	Anterior to middle of segmental margin.
Characteristics of cirrus sac	Subspherical, usually overlapping ventral longitudinal excretory canal. 140 to 215 microns long by 140 to 180 microns wide.	Elongate, usually not overlapping ventral longitudinal excretory canal. 160 to 215 microns long by 50 to 70 microns wide.
Number of uterine branches	12 to 16 on each side.	16 to 20 on each side.
Size of egg	32 to 40 microns long by 30 to 35 microns wide.	25 to 32 microns long by 22 to 27 microns wide.
Distribution of testes	Two lateral fields, confluent only in anterior half of segment.	Two lateral fields, confluent both in anterior half of segment and posterior to ovary.

conclude that *T. hyperborea* is one of the *Multiceps*-group, and most subsequent workers have accepted this opinion (cf. Meggitt, 1924, p. 89); Sprehn, 1932, p. 495). More recently, from two arctic foxes killed on the Iamal Peninsula, western Siberia, Kolmakov (1937) identified *T. hyperborea*, describing the morphological characteristics and comparing this material with von Linstow's original description.

Since both *T. crassiceps* and *T. polyacantha* have a holarctic distribution in the same species of hosts, it might be suspected that *T. hyperborea* is identical with one or the other. Now that the aforementioned species have been distinguished, it is practicable to re-examine the status of *T. hyperborea*.

It is evident from von Linstow's (1905) description and figures that *T. hyperborea* in some details resembles both *T. polyacantha* and *T. crassiceps*. However, it has several important characteristics in common with *T. crassiceps*. Comparing von Linstow's figure of the mature segment with that of *T. crassiceps*, it is seen that the testes apparently have the same distribution, being confluent across the posterior margin of the segment. However, in von Linstow's figure, the testes extend across between the ovary and vitelline gland; an error may have been made in the drawing, but it is assumed that the testes are confluent in the posterior portion of the segment. According to von Linstow, the genital pore is situated at the middle of the segmental margin, as is the case in *T. polyacantha*. This may have resulted from the contracted state of the material studied, since the relationship of the cirrus sac and vagina is the same as for *T. crassiceps*, and the shape of the cirrus sac also is typical of the latter. In von Linstow's material, the eggs measured 29 by 23 microns, corresponding in size to the eggs of *T. crassiceps*.

The rostellar hooks figured by von Linstow for *T. hyperborea* correspond in shape to those of *T. crassiceps*; they number from 30 to 32, and measure

170 and 120 microns for the large and small hooks, respectively. Kolmakov (1937) found that the hooks on his material ranged from 28 to 34 in number, and measured 172 to 188 microns and 132 to 154 microns for the large and small hooks, respectively. According to Leuckart (1856; p. 67), the specimens of *T. crassiceps* studied by him had usually 32 hooks, less commonly 34; the large hooks measured 186 microns and the small ones 135 microns. It is of interest that Leuckart (1856; p. 67) remarked that "Der Wurzelfortsatz der kleinen Haken besitzt ein sehr schwächliche Bildung, fast wie bei *T. coenurus*." This characteristic presumably led Railliet and Henry (1915) to assign *T. hyperborea* to the *Multiceps*-group. Alaskan specimens of *T. crassiceps* possess from 28 to 32 rostellar hooks, the large ones measuring 172 to 178 microns long and the small ones measuring 121 to 136 microns long.

The close agreement in morphological details between *T. crassiceps* and *T. hyperborea* seems sufficient to indicate that they are conspecific, a conclusion supported also by ecological and zoogeographic considerations. Consequently, *T. hyperborea* von Linstow, 1905, is regarded as a synonym of *T. crassiceps* (Zeder, 1800). Therefore, it appears that there are but two species of *Taenia* which commonly parasitize foxes in northern regions; these are *T. crassiceps* and *T. polyacantha*, both of which have holarctic distribution.

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