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***Taenia pencei* n. sp. from the Ringtail, *Bassariscus astutus* (Carnivora: Procyonidae), in Texas, U.S.A.**

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ABSTRACT: *Taenia pencei* n. sp. is described from the ringtail, *Bassariscus astutus* (Carnivora: Procyonidae), in western Texas, U.S.A., and its metacestode is characterized on the basis of specimens from *Peromyscus* cf. *maniculatus* in southern Oregon. *Taenia pencei* n. sp. apparently occurs exclusively in the ringtail, and it is the first cestode of the genus *Taenia* known from a member of the family Procyonidae. It is morphologically most similar to species of *Taenia* from mammals of the family Mustelidae in subclade 2 of the recently constructed phylogeny of that genus. *Taenia pencei* is distinguished from the nearctic *Taenia taxidiensis* in the badger *Taxidea taxus*; from the palaearctic *Taenia martis* occurring in members of the genus *Martes* and other mustelids in Europe; from the holarctic *Taenia twitchelli* in the wolverine *Gulo gulo*; and from the nominal species of small-hooked cestodes in mustelids (not including *Taenia mustelae*, in a different subclade), of which all but one have been described from members of the genus *Martes*. According to the concept presented in this study, those cestodes represent a single, holarctic species, *Taenia* cf. *intermedia*, synonyms of which, on grounds of priority, are *Taenia sibirica* and *Taenia skrjabini*, both described from *Martes zibellina* in Eurasia, and *Tae. martis americana* from *Martes* spp. in North America. *Taenia melesi*, from the Eurasian badger *Meles meles*, remains species inquirenda. *Taenia pencei* n. sp. is distinguished from all the aforementioned species by form and dimensions of rostellar hooks and by the arrangement and characteristics of genital organs. The holarctic occurrence of *Taenia* cf. *intermedia* appears to be a consequence of dispersals of mammals via Beringia during the late Pleistocene.

KEY WORDS: Cestoda, Taeniidae, *Taenia pencei* n. sp., *Taenia* spp. from Mustelidae, ringtail, *Bassariscus astutus*, Procyonidae.

Pence and Willis (1978) reported the occurrence of a cestode of the genus *Taenia* in ringtails, *Bassariscus astutus* (Lichtenstein, 1830), trapped in 5 counties of western Texas. Their finding was the first record of a member of the genus *Taenia* from the family Procyonidae. They noted that the cestode was most similar to taeniids from mustelids. The cestode was tentatively identified as *Taenia martis* (Zeder, 1803), without allocation to subspecies because it was not morphologically compatible either with *Tae. m. martis* (Zeder, 1803), occurring mainly in mustelids of the genus *Martes* in Europe, or with *Tae. m. americana* Wahl, 1967, occurring in mustelids of the same genus in North America.

In view of the uncertainty about the identity of that cestode, Dr. Danny B. Pence kindly made specimens available for further study. They represent an unknown species, which is described in this study. In addition, the cestode that was previously named *Tae. m. americana* is shown to be an independent species, probably identical with taxa reported from mustelids of the genus *Martes* in Eurasia; in the present study, it is designated *Taenia* cf. *intermedia* Rudolphi, 1809.

In this study only those species of *Taenia* that are from carnivores of the family Mustelidae in subclade 2 of the phylogenetic arrangement by Hoberg et al. (2000) are considered. Two additional species in that subclade occur in members of the family Canidae, but morphologically they differ markedly from those in mustelids in both the strobilar stage and the metacestode.

MATERIALS AND METHODS

The cestode from *B. astutus* was represented by portions of 10 specimens that were stained with celestine blue and mounted permanently on slides, each slide containing a rostellum and a series of mature proglottids and of early gravid proglottids. In all cases, pressure had been applied to the cover glass to cause hooks, if any, to lie flat. The material consisted of 93 mature proglottids, 43 early gravid proglottids, 5 large rostellar hooks, and 24 small hooks. The metacestodes identified as that of the same species provided further data including numbers of rostellar hooks.

Relative lengths of blade and handle of hooks were measured from a vertical line parallel with the posterior margin of the guard. Arcs of blades of some hooks were compared by the method of Feduccia (1993). Illustrations of hooks were prepared from enlarged photographs taken at x400.

Of the cestodes studied (all mounted permanently), specimens of *Tae. m. martis* were stained with lactic

acid carmine solution, whereas others were stained with acetic carmine. Species compared were as follows—*Taenia martis martis*: 2 complete specimens and rostellar hooks only from 2, from *Martes foina* (Erxleben, 1777), southern Germany, leg. B. Loos-Frank. *Taenia martis americana*, herein designated *Taenia* cf. *intermedia* Rudolphi, 1809, all from *Martes americana* (Turton, 1806): 1 from Mayo Lake, Yukon Territory, Canada, leg. P. Youngman; 2, Nos. 73275 and 80019, United States National Parasite Collection, Beltsville, Maryland, U.S.A., and 1, Washington State, leg. E. P. Hoberg; 3 from Alaska, leg. RLR; and metacestodes from a vole, *Microtus xanthognathus* (Leach, 1815), northern Yukon Territory, leg. P. Youngman. *Taenia taxidiensis* Skinner, 1935, from the nearctic badger, *Taxidea taxus* (Schreber, 1778): 2 from Malheur County, Oregon, leg. C. Maser; 4 from Madison County, Montana, leg. J. Rozdilsky; 2 from Dane and Sauk Counties, Wisconsin, leg. RLR. *Taenia twitchelli* Schwartz, 1924, from the wolverine, *Gulo gulo* (Linnaeus, 1758): 10 from various localities in Alaska, leg. RLR. Metacestode of *Taenia pencei* n. sp.: 3 individuals from *Peromyscus* cf. *maniculatus* (Wagner, 1845), 6 km south of Bandon, Curry County, Oregon, leg. C. Maser.

All measurements reported in this study are in micrometers unless otherwise stated.

***Taenia pencei* n. sp. Rausch, 2003 Adult (Figs. 1–4)**

Description

Length of strobila not precisely determined but less than 100 mm (Pence, personal communication). Margins of strobila slightly serrate. Mature proglottids 0.88 to 1.04 mm wide at anterior margin, 1.05 to 1.4 mm at posterior margin, and 0.9 to 1.0 mm in length; mean length of mature proglottids 74% of mean width at posterior margin. Complete scoleces not available. Rostellum armed with 34 hooks in 2 rows (based on metacestode). Large hooks 166 to 176 in length (average = 169), blade 46%–54% (average 49%) of length; small hooks 138 to 153 (average = 139), blade 38%–45% (average 42%); arc of blade of large hook 99°. In general form, rostellar hooks typical of those of most *Taenia* spp. in mustelids (excluding *Tae. taxidiensis*). Genital pores irregularly alternate, situated anteriorly on lateral margin of proglottid, 27%–31% (average = 29%) posterior to its anterior margin. Genital papilla little developed. Opening of genital atrium 70 to 90 in diameter. Ventral longitudinal excretory canals 36 to 73 in diameter; transverse canals 15 to 51; dorsal canal 10 to 12. Genital ducts passing either dorsally or ventrally across excretory canals (e.g., in sequence of 8 mature proglottids: 5 dorsal, 3 ven-

tral; in 1 proglottid, male genital duct was dorsal to ventral canal, and female genital duct was ventral). Cirrus sac clavate, 122 to 244 in length (average 21 = 188), 52 to 73 (average 21 = 61) in maximal diameter at about 25% of length from proximal end. Cirrus sac opening anterior to vagina into genital atrium and in mature segments extending 49 to 90 beyond medial margin of ventral excretory canal. Wall of cirrus sac 10–13 in thickness; extruded cirrus 109 to 132 in length, diameter at base 27 to 36, and 15 at distal end. Vas deferens with numerous loops medial to proximal end of cirrus sac, extending posteromedial to slightly beyond midline of proglottid, there turning posteriad. Testes subspherical, 34 to 48 in greater diameter by 32 to 43 (average 45 × 37); arranged in 2 major layers over most of field between longitudinal excretory canals. In 7 mature segments, number of testes ranging from 261 to 330 (average = 282). Testes confluent across anterior of proglottid, with usually at least 1 row extending across posterior margin, posterior to vitelline gland. Testes overlapping margins of ovarian lobes dorsally and extending between medial margins of ovarian lobes and vitelline gland. Vagina enlarging distally, opening posterior to orifice of male duct and extending medial parallel with vas deferens to lateral margin of testicular field, there turning posteromedial and extending to seminal receptacle situated posteriorly at midline. Vagina 50 to 60 in diameter near genital atrium, thereafter often narrowing to 24 to 30; lumen of vagina lined with minute, cilia-like structures, except in narrow, straight portion just anterior to seminal receptacle. Ovary consisting of 2 lobes of which aporal lobe is larger. Aporal lobe 190 to 450 in length by 110 to 250 (average 292 × 189); poral lobe 160 to 310 in length by 100 to 210 (average 256 × 163). Long axes of lobes somewhat convergent anteriorly toward midline. Vitelline gland lobulate, situated on midline posterior to ovarian lobes, 105 to 180 in length by 146 to 255 (average 149 × 204). Uterus arising dorsally as tubular structure on midline, extending to anterior margin of mature proglottid. Early gravid proglottids 2.0 to 4.5 mm in length (average 3.2), with maximal width 1.4 to 1.8 mm (average 1.6) at posterior margin or occasionally near middle. Early gravid uterus filling area between longitudinal excretory canals; lateral uterine branches little developed. Immature eggs, 20 to 26 in greater diameter, consisting of oncosphere en-

closed by embryonic membrane. Oncosphere 13 to 14 in length by 8 to 10.

Taxonomic summary

Type host: Ringtail, *Bassariscus astutus* (Lichtenstein, 1830).

Type locality: Jeff Davis County, Texas, U.S.A.

Site of infection: Small intestine.

Type specimens: Holotype, United States National Parasite Collection, Beltsville, Maryland, USNPC No. 92283; Paratypes (2): United States National Parasite Collection, USNPC No. 92284; Paratypes (2): Harold W. Monter Laboratory, University of Nebraska State Museum, Lincoln, Nebraska, HWML 16730, 16731.

Etymology: The cestode is named in honor of Danny B. Pence, who has contributed significantly to the knowledge of the helminths of carnivores.

Metacestode (Figs. 5, 6)

Description

Metacestode (3 studied) consisting of sub-spherical vesicle, 4 to 6 mm in greater diameter, each with 5 pseudosegmented forebodies projecting from vesicular surface (forebodies 1.2 to 2 mm in length). Scoleces invaginated, near distal end of forebodies, 637 to 860 in diameter; suckers 200 to 300 in diameter. Rostellum with 34 hooks in 2 rows, forming circle 280 to 310 in diameter en face. In each metacestode, rostellar hooks differing somewhat in size, indicating asynchronous development. Large hooks 158 to 171 in length (average 165), blade 47%–50% (average 45.5%) of length; small hooks 132 to 144 (average 140), blade 42%–55% (average 47.5%); arc of blade of large hook 96°.

Taxonomic summary

Type intermediate host: Deer mouse, *Peromyscus* cf. *maniculatus* (Wagner, 1845).

Type locality: Six kilometers south of Bandon, Coos County, Oregon, U.S.A.

Site of infection: Skeletal musculature, dorsal, between scapulae and in axial areas.

Voucher specimens: United States National Parasite Collection, Beltsville, Maryland, U.S.A. USNPC No. 92285 (2 specimens).

Remarks

Taxonomic and nomenclatural status: To provide a basis for defining the differential characters of *Tae. pencei*, the synonymies, host occurrence, and geographic ranges of *Taenia* spp. in mammals of the family Mustelidae (excluding *Taenia mustelae* Gmelin, 1790) are reviewed. Six nominal taxa have been recognized in Eurasia and 3 in North America. The former consist of *Tae. martis*, *Tae. intermedia* Rudolphi, 1809, *Tae. twitchelli* Schwartz, 1924; *Tae. sibirica* Dubnitskii, 1952; *Tae. skrjabini* Romanov, 1952; and *Tae. melesi* Petrov et Sadykhov, 1956. The taxa from North America are: *Tae. twitchelli*; *Tae. taxidiensis*; and *Tae. m. americana*. In addition, cestodes, apparently of an undescribed species of *Taenia*, have been found once, in a marten, *M. americana*, in Alaska (under investigation).

Uncertainties about the identity of cestodes occurring primarily in carnivores of the genus *Martes* have prevailed for about 2 centuries as a result of the inadequacies of original descriptions and, after about 1950, of mistaken synonymies. The cestode at present designated *Tae. m. martis*, characterized in part by its large rostellar hooks, occurs commonly in martens, *M. foina* and *Martes martes*, and occasionally or rarely in mustelids of other species in Europe. At northern latitudes, the range of *M. foina* extends eastward to the Caucasus and that of *M. martes* to the Ural Mountains (Stubbe, 1993), but *Tae. m. martis* evidently has not been reliably identified beyond eastern Europe. The record given by Loos-Frank (1994) (citing Shuteev, 1977) of its metacestode from a muskrat, *Ondatra zibethicus* (Linnaeus, 1766), in the region of the upper Ob' River is in error; on the upper Ob', Shuteev (1977) obtained only the metacestode of *Echinococcus multilocularis* Leuckart, 1863. The distributional records of *Tae. m. martis* elsewhere within the limits of the former Soviet Union (Kozlov, 1977) involved mistaken synonyms. Small rodents of the genera *Apodemus* and *Clethrionomys* often serve as intermediate hosts, but rodents of various other species become infected. Again, because of uncertain synonymies, records of the metacestode of *Tae. m. martis* are unreliable (Ryzhikov et al., 1978).

Because *Halysis martis* Zeder, 1803 (= *Tae. martis*) was distinguished on the basis of its oc-

currence in the intestine of “*mustela martis*” (sic) by Zeder (1803, p. 372), its identity has been questioned (see Abuladze, 1964, for discussion). For a time it was designated *Tae. intermedia* (Joyeux and Baer, 1934, 1936; Abuladze, 1964; Prokopič, 1965; Schmidt, 1986; and others), although Sprehn (1959) applied the name *Tae. martis* with adequate characterization. Much of the uncertainty arose after Thienemann (1906) restudied Rudolphi’s material of *Taenia* spp. from mustelids in the collection of the Berlin Zoological Museum. He found that vial no. 3, labeled “*Taenia intermedia*,” from *Mustela foina* (= *M. foina*), contained a single cestode, 98 mm in length, with 131 proglottids, but details of the reproductive organs were obscured by calcareous corpuscles. Most important, however, was the presence of some (“*einige*”) rostellar hooks. Referring to the measurements of a large hook (“*Die Massen eines grossen Hakens . . .*”), Thienemann (1906) reported a length of 0.145 mm and remarked that all dimensions corresponded to those given for *Tae. intermedia* by Leuckart (1856). The 7–8 cestodes in vial no. 4 were dried; hence only the dimensions of the embryophores could be determined. Thienemann (1906) considered the specimens in vial no. 4 to have been the types of *Tae. intermedia*.

Joyeux and Baer (1934) studied cestodes that they designated *Tae. intermedia* from *M. foina* from the vicinity of Nancy, France. Their specimens were contracted, and some details were not discernible. They determined that the scolex had a double row of rostellar hooks, 34 in total, of which the larger measured 210–220 in length and the smaller 150–160. The cirrus sac measured 210–230 by 70–80. The gravid uterus had 10–13 lateral branches. They noted the significant differences in comparison with hooks of *Tae. hydatigena* Pallas, 1766, and remarked that martens could hardly become infected by metacestodes in ruminants. Referring to Thienemann’s work (1906), they believed that he had measured only a small hook of *Tae. intermedia*. However, that Thienemann’s examination of Rudolphi’s cestodes was thorough cannot be doubted, and he certainly would have distinguished large and small hooks. The characteristics of both *Tae. intermedia* and *Tae. hydatigena* were later more adequately defined by Joyeux and Baer (1936). Freeman (1956) considered the work of Joyeux and Baer (1934, 1936), and not-

ing the large size of rostellar hooks they reported for *Tae. intermedia* and noting as well that Dubnitskii (1952) had listed *Tae. hydatigena* as occurring in mustelids in Eurasia, he suggested that Joyeux and Baer had studied *Tae. hydatigena* rather than *Tae. intermedia*. It is improbable that Joyeux and Baer could have misidentified a common and well-known helminth in view of their knowledge of the Cestoda; as well, they had discussed *Tae. hydatigena*, whose cycle typically involves large carnivores and ruminants. Kozlov (1977) also included *Tae. hydatigena* in his list of cestodes of the stone marten, but its occurrence in mustelids must be very rare.

In his study, Freeman (1956) identified as *Tae. martis* an immature cestode from the nearctic marten, *M. americana*, from Ontario, Canada, on the basis of the form and dimensions of the rostellar hooks, of which large and small measured 146 and 133, respectively. He was aware of the similar hook-dimensions of *Tae. sibirica* (large 150–153, small 128–130) and of *Tae. skrjabini* (153–155 and 120–129). Sizes of hooks of those 2 cestodes (see below) from sables, *Martes zibellina* (Linnaeus, 1758), are much like those of Freeman’s specimen. Relying on the similarities in the size and form of rostellar hooks, Freeman (1956) placed *Tae. intermedia*, *Tae. sibirica*, and *Tae. skrjabini* in synonymy with *Tae. martis*, notwithstanding the much larger dimensions of hooks reported for *Tae. martis* in Europe (cf. Joyeux and Baer, 1934, 1936). Freeman (1956, footnote) identified small, monocephalic cysticerci from the pleural cavities of *Clethrionomys gapperi* (Vigors, 1830) as the metacestode of *Tae. martis* on the basis of characteristics of the hooks.

Wahl (1967), who studied cestodes having large rostellar hooks from *M. foina* in the val de l’Allondon, Switzerland, as well as Freeman’s specimen from *M. americana*, noted (p. 166) that the large hooks of the cestode from Canada coincided in size and form with those of *Tae. sibirica* and *Tae. skrjabini*. On grounds of priority, over Romanov’s (1952) description, the latter had been placed in synonymy with *Tae. sibirica* by Abuladze (1964), who suggested that Freeman’s cestode represented a North American record of *Tae. sibirica*. Wahl (1967) did not identify the cestode from *M. americana* as *Tae. sibirica* but proposed the designation *Tae. m.*

americana for the nearctic cestode. The nominate species thereby became bitypic.

Taenia sibirica was described from the "Barguzinsk sable" (= *M. zibellina princeps* Birula, 1916) in the Barguzinsk region east of Lake Baikal (Geptner et al., 1967). *Taenia skrjabini* also was described from *M. zibellina*, from the Krasnoyarsk Krai. *Taenia sibirica* has been reported from sables from various localities in Siberia. The cestode now designated *Tae. m. americana* is common in martens in North America. Cestodes apparently of that species from 25 of 162 fishers, *Martes pennanti* (Erxleben, 1777), in Manitoba were identified as *Tae. sibirica* by Dick and Leonard (1979), but cestodes from 16 of 139 martens also in Manitoba were identified as *Taenia* cf. *martis martis* by Poole et al. (1983).

Concerning the recognition of subspecies of *Tae. martis*, Verster (1969) accepted Freeman's (1956) concept along with that of Wahl (1967). Verster listed *Tae. intermedia*, *Tae. skrjabini*, and *Tae. sibirica* as synonyms of *Tae. martis* sensu Zeder, 1803; *Tae. intermedia* as a synonym of *Tae. m. martis*; and *Tae. sibirica* and *Tae. skrjabini* as synonyms of *Tae. m. americana* sensu Wahl, 1967. She did not mention the striking dissimilarity in form of the respective metacestodes. Loos-Frank (1994) also retained the subspecific designations (i.e., the subspecies *martis* and *americana*) but stated (p. 155) that "... there are morphological differences which, together with the different size and shape of the hooks suggest both to be true species." Loos-Frank also studied *Tae. sibirica* from *M. foina* in Germany and noted that the rostellar hooks of *Tae. sibirica*, *Tae. m. americana*, and *Tae. melesi* never overlapped those of *Tae. m. martis* in size, but the available material was considered to be insufficient to determine the relationship of *Tae. sibirica* and *Tae. m. americana*.

Differences in the metacestodes of *Tae. m. martis* and *Tae. m. americana* alone clearly show that they represent independent species. That of subspecies *martis*, first identified by Schmidt (1961) (designated by him as *Tae. intermedia*), is a large, monocephalic, fimbriated structure (Schaerer, 1987; Loos-Frank, 1994). Loos-Frank found that specimens from the pleural cavities of small rodents (*Apodemus* spp. and *Clethrionomys glareolus* (Schreber, 1780)) attained a length of 80 mm, with a mean of 34 mm; mean length of those from the peritoneal

cavity was 63 mm. Metacestodes in muskrats were larger (maximal recorded length 180 mm). The metacestode of *Tae. m. americana* is a small, monocephalic cysticercus (Freeman, 1956; Rausch, 1977). A metacestode from the "lungs" (=pleural cavities?) of a red-backed vole, *C. glareolus*, in Austria was identified as that of *Tae. sibirica* by Pfaller and Tenora (1972) on the basis of the rostellar hooks; a detailed description was not given.

The morphological characters of *Tae. m. americana* (cf. Rausch, 1977) suffice to establish its specific independence from *Tae. martis* sensu Zeder (1803) and to indicate its affinity with *Tae. intermedia*. As characterized by Joyeux and Baer (1934, 1936), Wahl (1967), and Loos-Frank (1994), *Tae. martis* is the common species found in martens in Europe. The cestode now designated *Tae. sibirica* occurs in sables and martens over most of northern Eurasia, from Europe to northeastern Siberia. The size (0.145 mm) of the large hook reported by Thienemann (1906) places *Tae. intermedia* with the small-hooked species, with which it agrees also in relatively small size of strobila. On grounds of priority, *Tae. sibirica* Dubnitskii, 1952 would become a synonym of *Tae. intermedia* Rudolphi, 1809. Thienemann's data (1906) concerning *Tae. intermedia* are considered to be accurate; if he had measured a small rostellar hook the cestode even so could not have been *Tae. martis*, whose small hooks range from 167 to 198 μ m, with a mean (for 70 hooks) of 181 μ m (Loos-Frank, 1994). In the present study, because Eurasian specimens designated *Tae. sibirica* have not been available for direct comparison with the cestode from nearctic martens, the question of conspecificity could not be determined with certainty. Thus, provisionally, the North American species (host: *M. americana*) is here designated *Taenia* cf. *intermedia*.

With respect to *Taenia* cf. *intermedia* in the Nearctic, the distributional history of its usual host, *M. americana*, indicates a late Pleistocene dispersal eastward via Beringia (Kurtén and Anderson, 1980). An earlier invasion during Wisconsin Time led to its spread into the southeastern region of North America after which it became isolated by the continental ice. A later dispersal into western North America then occurred. Consequently, the populations of *M. americana* consist of 2 morphologically distinct groups of subspecies (Clark et al., 1987). The

western subspecies (the *caurina*-group) are in cranial and dental characters more similar to the Eurasian *M. zibellina* than are the eastern subspecies (the *americana*-group) (Kurtén and Anderson, 1980). *Taenia* cf. *intermedia* conceivably reached the Nearctic with either or both invasions of martens.

The status of *Tae. melesi*, described from a Eurasian badger, *Meles meles* (Linnaeus, 1758), in the former Azerbaidzhan SSR, in Russia, remains uncertain. The lengths of the rostellar hooks (148–154 and 130–136) are similar to those of the other small-hooked cestodes in mustelids. According to the original description, reproduced in Abuladze (1964), *Tae. melesi* had a much longer strobila, up to 162 mm, and was quite wide (4–4.6 mm); numbers of testes ranged from 120 to 150, with none situated posterior to the ovarian lobes and vitelline gland. The metacestode is unknown. Verster (1969) listed it as species inquirenda but stated that it appeared to be identical to *Tae. m. americana*. It was included, along with *Tae. intermedia*, *Tae. sibirica*, and *Tae. skrjabini*, as a synonym of *Tae. martis* by Kozlov (1977). However, *Tae. melesi* is evidently morphologically distinctive; it is perhaps a host-specific cestode of the badger.

The holarctic species *Tae. twitchelli* occurs in the wolverine, *G. gulo*. It was thought to be limited to the Nearctic until Domnich and Obushenkov (1983) identified it in 7 of 8 wolverines from the vicinity of Markovo and in 14 of 16 in the basin of the Omolon River, both in northeastern Siberia. It is the most common helminth in wolverines in North America, found in 102 of 134 examined in Alaska (Rausch, 1977). There, the metacestode developed in the pleural cavities of the intermediate hosts, usually marmots, *Marmota* spp. (cf. Rausch, 1959, 1977). Cestodes reported from wolverines in Siberia before the findings of Domnich and Obushenkov (1983), identified as *Tae. martis*, were possibly *Tae. twitchelli* (cf. Loos-Frank, 1994). Because the rostellar hooks of *Tae. twitchelli* are very similar to those of *Tae. martis*, the 2 taxa were believed to be conspecific by Wahl (1967) and Prokopič (1970). That *Tae. twitchelli* is an independent species has been confirmed by Verster (1969) and Loos-Frank (1994), in part on the basis of the unusual form of its metacestode (cf. Rausch, 1977, fig. 1). The metacestode resembles only that of *Tae. endothoracica* Kirshen-

blat, 1948 (cf. Shul'ts and Gvozdev, 1970, fig. 117), from which it differs not only in size and form of the rostellar hooks but also in the process of morphogenesis (Rausch, 1959; Hulínská, 1975). The metacestode of *Tae. endothoracica* occurs in the pleural cavities of gerbils of various species; foxes (*Vulpes* spp.) are the final host.

Taenia taxidiensis (syn. *Fossor angertrudae* Honess, 1937, and *Monordotaenia taxidiensis* (Little, 1967)) occurs only in the nearctic badger, *Tax. taxus*. The metacestode, a simple cysticercus, was first obtained experimentally by Pederson and Leiby (1969) in ground squirrels, *Spermophilus* spp. (designated *Citellus* spp. in Europe), which are the major prey of the badger. Naturally infected ground squirrels were reported by Jenkins and Grundmann (1973), in Utah, and by McGee (1980) in Saskatchewan. *Taenia taxidiensis* is distinguished in part by the presence of a single row of rostellar hooks of unique form.

Comparisons with taxonomically allied taxa: *Taenia pencei* is distinguished from the following species by direct comparisons:

From *Tae. martis* (southwestern Germany), it differs in lengths of rostellar hooks (cf. Fig. 4), in size of strobila, and in dimensions and proportions of proglottids. The cirrus sac of *Tae. pencei* is relatively much longer, extending well beyond the medial margin of the ventral longitudinal excretory canal. Testes are arranged in 2–3 layers and closely apposed. The ovarian lobes are much smaller and of different shape. The vitelline gland is much smaller. The metacestode is diagnostic. *Taenia pencei* is known only from *B. astutus*. (*Tae. martis*: large hooks, avg 227, small hooks, 181; strobila up to 315 mm in length; cirrus sac extending medially to or just beyond lateral margin of ventral canal; testes widely spaced, usually in a single layer; ovarian lobes fan-shaped, lobules usually well developed laterally; vitelline gland, average length 134, width 452. The metacestode is a monocephalic, fimbriated cysticercus.)

From nearctic specimens of *Taenia* cf. *intermedia*, it differs in having larger rostellar hooks (Fig. 4), and hooks are more numerous. The strobila is more robust and wider. The cirrus sac is larger, extending well beyond the medial margin of the ventral longitudinal excretory canal. Testes are more numerous. Ovarian lobes and vitelline gland are not closely apposed. The

Figures 1–5. *Taenia pencei* sp. n. 1. Rostellar hooks. 2. Mature segment, dorsal view. 3. Details of female genital ducts, ventral view. 4. Comparison of some large rostellar hooks: *Taenia martis* (and *Taenia twitchelli*) (top); *Taenia pencei* (middle); and *Taenia* cf. *intermedia*, from nearctic marten (bottom). 5. Rostellar hooks of *Taenia pencei*, metacystode. V, vagina; Ut, uterus; Ov, ovary; Sr, seminal receptacle; Ovd, oviduct; Utd, uterine duct; Mg, Mehlis' gland; Vd, vitelline duct; Vg, vitelline gland.

metacystode is distinctive. (Nearctic *Taenia* cf. *intermedia*: large hooks, average 143, small hooks, 123; usually 28 hooks; maximal strobilar width 0.832 to 1.2 mm; cirrus sac, average 149 × 60, not reaching medial margin of ventral canal; testes, average 110 per proglottid, in 1 layer. The metacystode is a simple, monocephalic cysticercus.) *Taenia* cf. *intermedia* occurs in *Martes* spp. in North America and in mustelids of various species in Eurasia.

From *Tae. twitchelli*, it is immediately distinguished by its smaller rostellar hooks. The strobila is smaller, with margins less serrate. Distribution of the testes is more extensive. The cirrus sac is less slender and relatively longer. The metacystode is diagnostic. (*Tae. twitchelli*: hooks closely resemble those of *Tae. martis*;

large hooks 200–212, small hooks 156–168; mature segments are trapezoidal; testes usually are confined to lateral fields and not confluent anteriorly; cirrus sac does not reach the medial margin of the ventral canal. The metacystode consists of numerous, elongate, monocephalic vesicles attached to a vestigial bladder.)

From *Tae. taxidiensis*, *Tae. pencei* is distinguished by its much smaller strobila; in having 2 rows of “mustelid-type” rostellar hooks; and in arrangement and proportions of the genital organs. The metacystode is diagnostic. (*Tae. taxidiensis*: strobila up to 480 mm in length. Scolex has a single row of hooks of unique shape. The metacystode is a simple, monocephalic cysticercus.) *Taenia taxidiensis* is a nearctic species in the North American badger.

Figure 6. *Taenia pencei* sp. n., metacestode from *Peromyscus* cf. *maniculatus*. (One scolex was removed for study of rostellar hooks.)

DISCUSSION

Taenia pencei was found in 3 (20%) of the 15 ringtails examined for helminths in Texas (Pence and Willis, 1978). Its prevalence suggests that it is host-specific in that carnivore. Another procyonid, the raccoon, *Procyon lotor* (Linnaeus, 1758), has an extensive distribution in North America. Its helminth fauna, relatively well known, so far includes no species of *Taenia*. That none of 10 cestodes from the ringtail had fully developed eggs seemed unusual, but a similar condition was noted in *Tae. taxidiensis*, of which only 1 of 28 cestodes obtained from 3 badgers (in Wisconsin) had gravid segments (Rausch, 1947).

My identification of the metacestode of *Tae. pencei* was based, first, on characteristics of the rostellar hooks (dimensions of the hooks varied slightly in each of the 3 metacestodes examined). Hooks of the scolex found to be the most advanced in development (large hooks, 168 to 171 in length; small hooks, 137 to 144) were similar in size to those of the strobilar stage. The arcs of the blades of large hooks of the strobilar stage and of the metacestode also were nearly identical, 99 and 96°, respectively. Other evidence as well supports the identification of the metacestode. First, it differs morphologically (Fig. 6) from all other known metacestodes of *Taenia* spp. Second, it is evidently unique in locus in the host—in skeletal muscle of a small mammal (Cricetidae). Among others that occur in arviculids, the proliferative metacestode of *Tae. crassiceps* (Zeder, 1800) typically produces aggregations subcutaneously or in the pleural and in the peritoneal cavities of its hosts. The

metacestode of *Tae. taxidiensis* occurs in skeletal and smooth muscles of ground squirrels, family Sciuridae. Finally, there is a distributional component. The deer mouse infected by the metacestode was collected in southern Oregon, within the geographic range of the ringtail. (No cestode was present in 2 ringtails that I examined from the same area.)

Like other procyonids, the ringtail is omnivorous. Rodents (with carrion) reportedly make up about 24% of its diet (Davis, 1978). The infected deer mouse was identified as *P. maniculatus*, but its standard measurements somewhat exceeded those of that species. According to Hall (1981), *P. maniculatus* does not have an extensive range in Texas, occurring in the far southwest and in the east-central regions, but 2 other species of *Peromyscus* occur more widely in the state; 2 subspecies of *Peromyscus leucopus* (Rafinesque, 1818) have extensive ranges, and *Peromyscus truei* (Shufeldt, 1885) is present in the north. That other indigenous rodents may serve as intermediate host of *Tae. pencei* is conceivable and could be determined experimentally.

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