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Canadian Journal of Zoology

Réimpression du

Journal canadien de zoologie

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Volume 53 • Number 11 • 1975

Pages 1537–1551

National Research Council Canada

Conseil national de recherches Canada

Cestodes of the genus *Hymenolepis* Weinland, 1858 (sensu lato) from bats in North America and Hawaii[1]

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Received April 1, 1975

RAUSCH, R. L. 1975. Cestodes of the genus *Hymenolepis* Weinland, 1858 (sensu lato) from bats in North America and Hawaii. Can. J. Zool. **53**: 1537–1551.

Hymenolepidid cestodes obtained through the examination of 539 vespertilionid bats representing 15 species and five genera, collected in three regions of North America and on the Island of Hawaii, were studied. Three species of the genus *Hymenolepis* Weinland, 1858 sensu lato, previously known from nearctic Chiroptera, are redescribed: *H. christensoni* Macy, 1931, *H. roudabushi* Macy and Rausch, 1946, and *H. gertschi* Macy, 1947. A fourth, ***H. lasionycteridis*** sp. nov., recorded from bats of eight species in North America and Hawaii, is described and distinguished morphologically from the other species of *Hymenolepis* s.l. characterized in part by the presence of an armed rostellum and occurring in bats. The presence of this cestode in the Hawaiian hoary bat, *Lasiurus cinereus semotus* (Allen), indicates that at least some of the progenitors of the population on the Island of Hawaii were migrants of western North American origin. The zoogeography of cestodes in bats is briefly discussed.

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On a étudié les cestodes (Hymenolepididae) obtenus à l'examen de 539 chauves-souris de 15 espèces et de cinq genres de la famille des Vespertilionidae, récoltées dans trois régions d'Amérique du Nord et sur l'île d'Hawaii. Les trois espèces (*H. christensoni* Macy, 1931, *H. roudabushi* Macy and Rausch, 1946 et *H. gertschi* Macy, 1947) du genre *Hymenolepis* Weinland, 1858 sensu lato, déjà connues comme parasites de Chiroptères néarctiques, sont redécrites. ***H. lasionycteridis*** sp. nov., enregistré de huit espèces de Chiroptères d'Amérique du Nord et d'Hawaii, est décrite ici; il se distingue morphologiquement des autres espèces d'*Hymenolepis* s.l. qui sont caractérisées en partie par la présence d'un rostre armé et qui se trouvent chez les Chiroptères. La présence d'*H. lasionycteridis* chez *Lasiurus cinereus semotus* (Allen) de l'île d'Hawaii indique que parmi les ancêtres de cette population insulaire se trouvaient au moins quelques individus originaires de l'ouest de l'Amérique du Nord. On discute de la zoogéographie des cestodes parasites des chauves-souris.

Cestodes representing three species of the genus *Hymenolepis* Weinland, 1858 sensu lato (= *Vampirolepis* Spasskii, 1954, *partim*) are known from bats in North America: *H. christensoni* Macy, 1931; *H. roudabushi* Macy and Rausch, 1946; *H. gertschi* Macy, 1947. Although these cestodes have been reported subsequently from bats in various regions of North America, their morphological characteristics are known only from the original descriptions, which are deficient in some details.

A preliminary examination of cestodes from the Hawaiian hoary bat, *Lasiurus cinereus semotus* (Allen), sent to me by Dr. P. Quentin Tomich, indicated that their identification would require detailed comparisons with the species occurring in North American bats. Since comparative material was inadequate, their further study was deferred. Recently, through the efforts of Mr. Chris O. Maser and his co-workers, numerous cestodes have been obtained from bats in Oregon, making possible the work reported here.

The purpose of this paper is to redescribe the three species of *Hymenolepis* known previously from North American bats, to describe another, and to discuss briefly the zoogeography of *Hymenolepis* spp. in these mammals. Since inadequacies in published descriptions of species and uncertainties about the limits of some of the nominal genera in Hymenolepididae make generic allocations unreliable on morphological

[1]In recognition of the contributions by Mr. C. O. Maser and his co-workers, this paper is in part a contribution from the Oregon Coast Ecological Survey, Puget Sound Museum of Natural History, and from the Coniferous Forest Biome, U.S. Analysis of Ecosystems, International Biological Program.

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grounds alone, the cestodes considered here are placed in the genus *Hymenolepis* sensu lato.

Materials and Methods

Cestodes were obtained through examination of 539 vespertilionid bats representing 15 species and five genera from the following four geographic regions. *Midwestern United States* (Ohio, Michigan, and Wisconsin) (collected by me during 1943–1947): *Myotis lucifugus* (Le Conte), 12; *Eptesicus fuscus* (Palisot de Beauvois), 63; *Lasionycteris noctivagans* (Le Conte), 12; *Nycticeius humeralis* (Raffinesque), 13; and *Pipistrellus subflavus* (Cuvier), 1. *Alaska* (collected by me or submitted for virological examination during 1949–1974): *M. lucifugus*, 48. *Oregon* (collected by C. O. Maser and coworkers during 1971–1974): *M. lucifugus*, 99; *M. californicus* (Audubon and Bachman), 51; *M. evotis* (Allen), 30; *M. yumanensis* (Allen), 25; *M. volans* (Allen), 22; *M. thysanodes* Miller, 4; *M. leibi* (Audubon and Bachman), 3; *E. fuscus*, 34; *L. noctivagans*, 14; *Pipistrellus hesperus* (Allen), 16; *Plecotus townsendi* Cooper, 21; and *Antrozous pallidus* (Le Conte), 10. *Hawaii* (Honokaa) (collected by P. Q. Tomich during 1963–1965): *Lasiurus cinereus semotus* (Allen), 61. The total number of cestodes studied from these mammals was 140.

Routinely, the cestodes were isolated in water for a short time to permit relaxation, then fixed in hot 10% formalin solution. In the case of the bats collected in Oregon, the intestine was opened in water, and the cestodes were removed, allowed to relax, and fixed in formalin solution; the remaining intestinal contents were preserved for further examination by addition of formalin to make a 10% solution. Cestodes were stained in Semichon's acetic carmine or Ehrlich's acid hematoxylin, dehydrated in ethanol, cleared in xylene or terpineol, and mounted permanently. Cestodes collected during 1943–1947 were mounted entire; of those obtained subsequently, the rostellum was removed from selected specimens and mounted separately with the hooks flat. For study of eggs before possible distortion by the clearing reagent, wet mounts in formalin were prepared. The hooks were drawn with the aid of a camera lucida.

Results

Published records indicate that the three species of *Hymenolepis* known previously from bats in North America usually have been distinguishable, although Cain (1966) considered his identification of *H. gertschi* from *Tadarida brasiliensis* (G. St.-Hilaire) in New Mexico to be tentative. Since the types of *H. gertschi* and *H. christensoni* are not extant in the U.S. National Museum Helminthological Collection (Dr. J. Ralph Lichtenfels, personal communication), and to distinguish more adequately the species described herein, redescription of the three cestodes is appropriate. The figures of mature segments represent those in which reproductive organs had attained full development. All measurements are in millimetres.

Hymenolepis christensoni Macy, 1931

(Figs. 1–3)

Material studied (numbers of cestodes by species of host)—OREGON: *Myotis yumanensis*, 7; *M. lucifugus*, 24; *M. californicus*, 1; *M. evotis*, 1. ALASKA (Ketchikan): *M. lucifugus*, 2. WISCONSIN: *M. lucifugus*, 1. MINNESOTA (Lake Itasca): *M. keeni* (Merriam), 1 (cf. Macy and Rausch 1946).

Description

Strobila 54 to 65 long, with 295 to 323 segments; maximum width, attained in early gravid segments, 1.0. Strobilar margins not serrate; segmental margins usually convex. All segments wider than long. Length/width ratio of mature segments 1:5 to 1:4; relative length increasing posteriad, with ratio of 1:3 to 1:2 attained in last gravid segments. Scolex 0.340 to 0.434 wide, slightly set off from neck. Rostellum about 0.100 long when extended, with single row of 40 hooks 0.030 to 0.035 long (av. 0.033). Suckers 0.104 to 0.116 in greater diameter. Neck 0.930 to 1.2 long, and 0.372 to 0.403 wide. *Anlagen* of genital organs first discernible about 3.0 posterior to neck. Genital pores unilateral, dextral, situated just anterior to middle of segmental margin; genital atrium about 0.024 deep. Genital ducts passing dorsally across longitudinal excretory canals. Ventral canal 0.040 to 0.060 in diameter; dorsal canal 0.008 to 0.016. Cirrus sac 0.156 to 0.192 by 0.044 to 0.048 (av. 0.170 by 0.046), usually extending mediad from genital atrium, then anteriad, overlapping ventral excretory canal near anterior margin of segment. Internal seminal vesicle 0.084 to 0.126 long; poral end of cirrus sac with numerous glandular cells. Duct from cirrus wide, forming loop dorsal and posterior to aporal end of cirrus sac, then dilating just medial to longitudinal excretory canals, forming external seminal vesicle. External seminal vesicle 0.132 to 0.220 long by 0.060 to 0.088 in maximum diameter (av. 0.181 by 0.073), extending mediad anterior to poral testis and dorsal to seminal receptacle. Testes subspherical, 0.104 to 0.144 in transverse diameter by 0.080 to 0.120 (av. 0.125 by 0.105), forming transverse row dorsally along posterior margin of segment and extending through more than one-half of segmental length. Testes usually not in contact with longitudinal excretory canals laterally. Vagina opening in genital atrium ventral to orifice of male duct, extending mediad

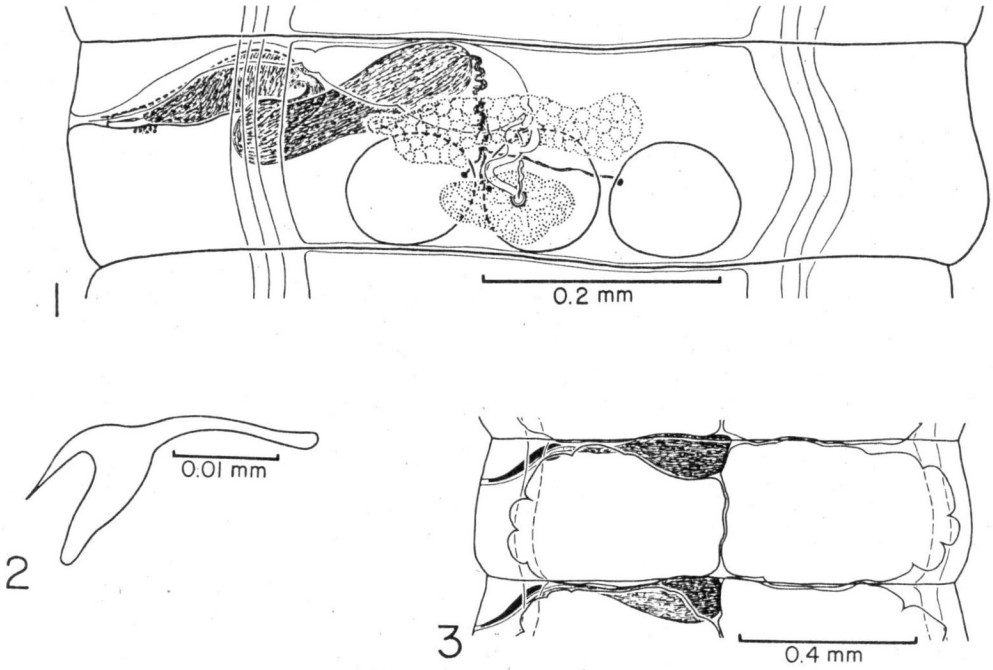

FIG. 1. Mature segment of *Hymenolepis christensoni*, ventral view. FIG. 2. Rostellar hook of *H. christensoni*. FIG. 3. Gravid segment of *H. christensoni*.

ventrally, often anterior or posterior to cirrus sac, then enlarging, forming large seminal receptacle. Seminal receptacle 0.160 to 0.252 long by 0.068 to 0.108 in maximum diameter, situated transversely anterior to testes, extending mediad to or slightly beyond midline of segment. Ovary transversely elongate, 0.220 to 0.288 wide by 0.060 to 0.116 in greatest length (av. 0.247 by 0.092), situated in middle of segment ventral to and mostly anterior to testes. Oviduct short and broad. Vitelline gland weakly lobed, 0.084 to 0.132 wide by 0.056 to 0.084 in greatest length (av. 0.099 by 0.069), situated posterior to ovary and ventral to medial testis. Uterus arising dorsal to ovary in posterior half of segment, forming bilateral lobes that enlarge and fill gravid segment, overlapping longitudinal excretory canals dorsally; lobes secondarily divided by trabeculae that break down in late gravid segments. Aporal uterine lobe larger and extending farther anteriad. Male and female genital ducts, including seminal receptacle, persisting in gravid segments. Eggs subspherical, 0.035 to 0.042 by 0.030 to 0.037 (av. 0.038 by 0.034). Embryo 0.025 to 0.032 by 0.020 to 0.025. Embryonic hooks about 0.015, 0.015, and 0.013 long; second pair thickest.

A specimen of *H. christensoni* from *Myotis lucifugus*, collected at the W. L. Findley National Wildlife Refuge, Benton County, Oregon, on 3 June 1974, has been deposited in the U.S. National Museum Helminthological Collection, No. 73837.

Remarks

H. christensoni was described on the basis of three somewhat fragmented specimens from *Myotis lucifugus*, collected at St. Paul, Minnesota (Macy 1931). In morphological characteristics, the series of specimens considered here showed substantial agreement with the original description. Discrepancies in dimensions of certain organs are probably attributable to differences in degree of development of the mature segments from which the respective measurements were obtained.

H. christensoni was stated originally to have about 35 rostellar hooks, and numbers of 35 to 41 were reported for specimens collected subsequently from *M. lucifugus* and *M. keeni* at Lake Itasca, Minnesota (Macy and Rausch 1946). In the present material, 40 hooks were observed in specimens judged to have the full complement, and none had a greater number.

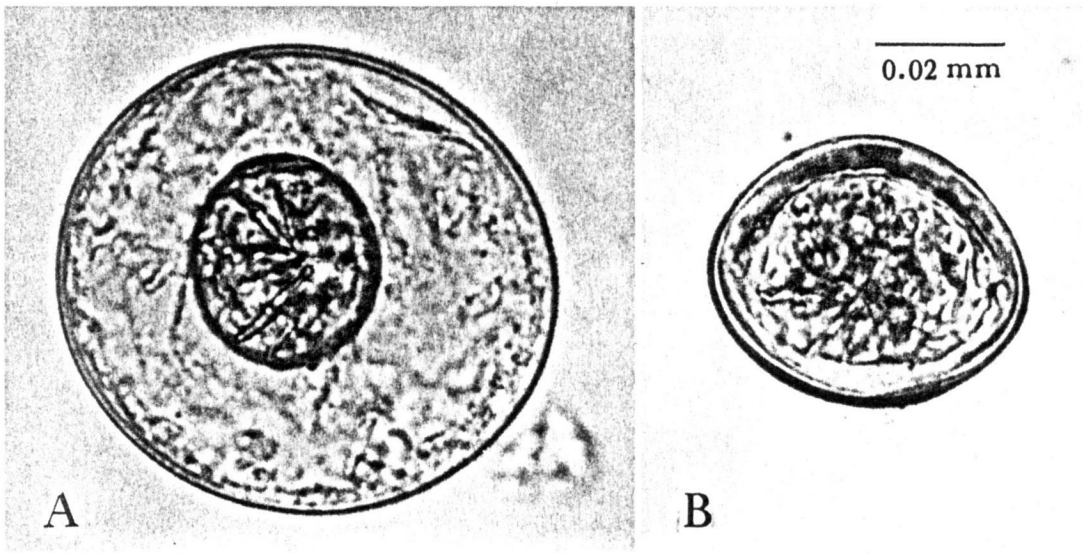

FIG. 4. Eggs of *Hymenolepis* spp. from bats. (A) *H. christensoni*, (B) *H. lasionycteridis* sp. nov.

Macy (1931) reported a length of about 0.033 for the rostellar hooks, and a range of 0.033 to 0.038 was later recorded (Macy and Rausch 1946). In the present material, separately mounted hooks from 12 specimens of *H. christensoni* ranged in length from 0.030 to 0.035 mm. In these, the handle varied from straight to slightly curved. This cestode has large, thin-walled eggs that are usually much distorted in strobilae mounted permanently, preventing accurate measurement. Macy (1931) reported the diameter of the egg to be about 0.050 mm. In the present study, eggs in mounted specimens had an average diameter of 0.038, but those liberated from gravid segments of cestodes preserved in formalin ranged from 0.072 to 0.087 by 0.067 to 0.080 (av. 0.080 by 0.072) (see also Fig. 4).

H. christensoni has been identified also from *Myotis grisescens* Howell in Kansas (Ubelaker 1966; Nickel and Hansen 1967) and thus is known in North America only from bats of the genus *Myotis*. This cestode has been reported from bats in western Eurasia and in South America, but these records seem to require confirmation by direct comparison of specimens. Several species of *Hymenolepis* s.l. occurring in bats are morphologically similar, and the conclusion by Spasskii (1954) that *H. roudabushi* is conspecific with *H. christensoni* would make difficult the discrimination of the latter species.

Ryšavý (1956) reported *Vampirolepis* (= *Hymenolepis*) *christensoni* from *Miniopterus schreibersi* Kuhl in Czechoslovakia and, more recently, specimens obtained from bats of four species (genera *Vespertilio*, *Myotis*, and *Barbastella*) in Slovakia were listed among the helminths in the collections of the Helminthological Institute of the Slovak Academy of Sciences (Hovorka 1971, p. 131). Cestodes identified as *H. christensoni* were reported also from bats of four species (genera *Eptesicus*, *Nyctalus*, and *Myotis*) in Poland by Sołtys (1959), but no morphological data were provided. In the paper containing the description of *Vampirolepis rysavyi* Tenora and Baruš, 1960, from *Eptesicus serotinus* (Schreber) in Moravia, Tenora and Baruš compared their specimens with *V. roudabushi* but did not consider *V. christensoni*. The same comparison was made by Andreiko *et al.* (1969) in distinguishing *V. spasskii* Andreiko, Skvortsov, and Konovalov, 1969, obtained from *Nyctalus noctula* (Schreber) in the Moldavian SSR. In the paper describing *V. novadomensis* Ryšavý, 1971 from *Myotis mystacinus* Kuhl in Bohemia, neither of the North American species was considered. Cestodes from bats in Poland were studied by Zdzitowiecki (1970), who identified *V. skrjabinariana* (Skarbilovich, 1946) from *E. serotinus* and *N. noctula*. This cestode, described from *E. turcomanus* (Eversmann) (= *E. serotinus turcomanus*) in the Voronezhsk Oblast' and in middle Asia, is similar morphologically to *H. christensoni* and *H. roudabushi* according to the original description and that by Zdzito-

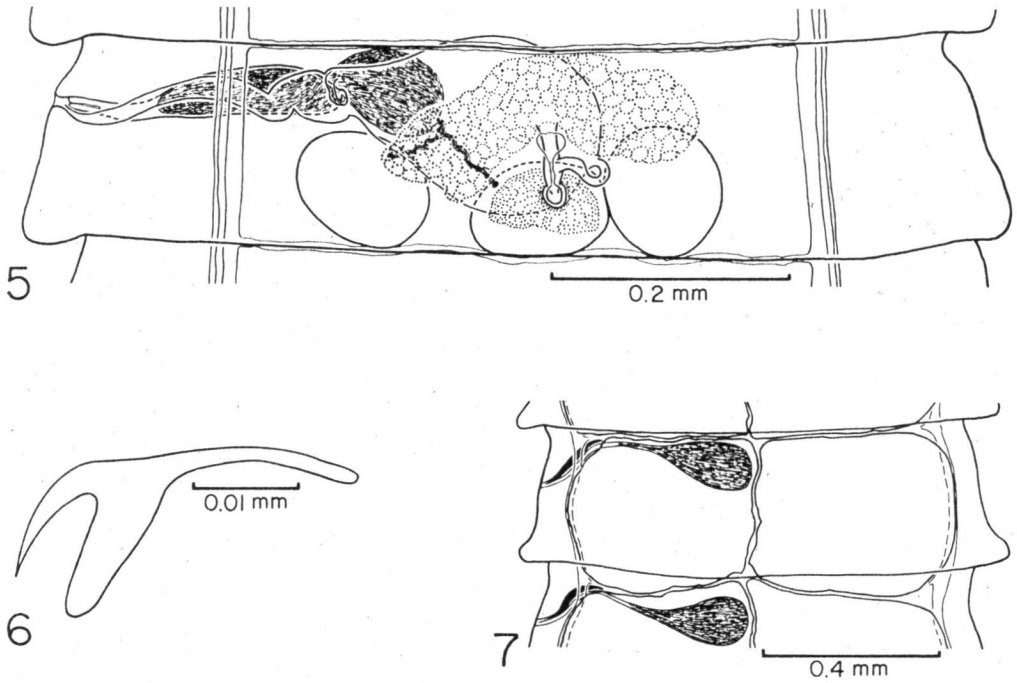

FIG. 5. Mature segment of *H. roudabushi*, ventral view. FIG. 6. Rostellar hook of *H. roudabushi*. FIG. 7. Gravid segment of *H. roudabushi*.

wiecki (1970), although the resemblance is not so apparent in the figures of the cestode identified as *V. skrjabinariana* by Andreiko (1973, p. 88). Zdzitowiecki considered the possibility that this species had been erroneously identified as *H. christensoni* by Soltys (1959). He mentioned also that Sołty's material had been lost, so that comparisons could not be made.

Rêgo (1962) reported *V. christensoni* from bats of three species (genera *Tadarida*, *Chiroptera*, and Molossidae sp. indet.) in Brasil, Paraguay, and Bolivia. There was good agreement in numbers and dimensions of the rostellar hooks, and Rêgo attributed discrepancies in some morphological details to differences in methods of fixation. The brief description of this cestode and figure of the mature segment (Rêgo 1962, Fig. 6) do not permit a conclusion about its specific identity. However, the figure of the gravid segment (Rêgo 1962, Fig. 7) shows that the uterus has a posterior concavity and does not enlarge to fill the space between the longitudinal excretory canals, a characteristic that seems clearly to indicate that the species from bats in South America is not *H. christensoni*.

Hymenolepis roudabushi Macy and Rausch, 1946
(Figs. 5–7)

Material studied—OHIO: *Eptesicus fuscus*, 17 (including 1 paratype); *Nycticeius humeralis*, 15 (including 2 paratypes); *Lasionycteris noctivagans*, 1. IOWA: *E. fuscus*, 1 (type).

Description

Strobila 39 to 74 long, with 270 to 488 segments; maximum width, attained in gravid segments, 1.55. Strobilar margins serrate; anterior portion of strobila not markedly attenuated. All segments wider than long. Length/width ratios of mature and gravid segments usually about 1:5 and 1:4, respectively. Scolex small, 0.240 to 0.325 wide, not set off from neck. Rostellum thick, about 0.120 long when extended, with a single row of about 45 hooks, 0.035 to 0.040 long (av. of 25, 0.038). Suckers 0.084 to 0.096 in greater diameter. Neck 0.496 to 0.775 long, and 0.418 to 0.465 wide. *Anlagen* of genital organs usually visible in first discernible segments. Genital pores unilateral, dextral, situated anterior to middle of segmental margin; genital ducts passing dorsally across longitudinal excretory canals. Ventral

canals 0.012 to 0.037 in diameter, connected by narrow transverse canal; dorsal canals 0.006 to 0.010. Cirrus sac long and rather cylindrical, 0.180 to 0.272 in length by 0.040 to 0.072 in maximum diameter (av. 0.233 by 0.049), extending somewhat anteromediad from genital pore, anterior to poral testis. Internal seminal vesicle 0.116 to 0.228 long, occupying most of cirrus sac; poral end of cirrus sac with numerous glandular cells. Duct to cirrus sac making loop at aporal end of latter, then forming ellipsoidal external seminal vesicle 0.080 to 0.200 long by 0.060 to 0.100 in greatest diameter, situated anterior to poral testis and dorsal to seminal receptacle. Testes subspherical, 0.112 to 0.164 in transverse diameter by 0.092 to 0.140 (av. 0.138 by 0.122); usually one poral and two aporal, sometimes contiguous, in transverse row along posterior margin of segment and extending through greater part of segmental length. Poral testis usually transversely elongate. Testes not in contact with longitudinal excretory canals laterally. Vagina opening in genital atrium posteroventral to orifice of male duct, extending anteromediad along ventral surface of cirrus sac, increasing gradually in diameter and, after bending at aporal end of cirrus sac, forming large seminal receptacle. Seminal receptacle more or less globular, 0.248 to 0.280 in transverse length by 0.128 to 0.180 in greatest diameter, reaching mediad to or beyond midline of segment and occupying most or all of segmental length near midline; usually extending slightly into posterior part of preceding segment. Ovary usually weakly bilobed, sometimes slightly arched, 0.180 to 0.328 wide by 0.080 to 0.120 in greatest length (av. 0.246 by 0.094), situated ventrally near middle of segment, often with aporal end slightly more anterior. Vitelline gland with smooth margins or weakly lobed, 0.068 to 0.120 wide by 0.036 to 0.072 in length (av. 0.085 by 0.056), situated ventrally at posterior margin of segment near midline, in space between first and second testis or ventral to medial testis. Early uterus arising dorsal to ovary, consisting of bilateral lobes connected anteriorly by isthmus. Uterus filling space between longitudinal excretory canals in gravid segments, often slightly overlapping canals dorsally; aporal uterine lobe larger. Genital ducts persisting in gravid segments; seminal receptacle prominent. Eggs subspherical, with thin outer covering; 0.035 to 0.045 by 0.032 to 0.045 (av. 0.041 by 0.036). Embryo 0.025 to 0.030 by 0.022 to 0.030. Embryonic hooks about 0.020, 0.016, and 0.015 long; second pair thickest.

Remarks

In his synopsis of species assigned to the genus *Vampirolepis*, Spasskii (1954, p. 154) concluded that *H. roudabushi* is conspecific with *H. christensoni*, considering the described morphological differences to be within the range of expected morphological variation in a single species. He attributed the difference in degree of serration of the strobilar margins to state of contraction of the respective strobilae. Ubelaker (1966) asserted that these cestodes are distinct, but did not discuss the differential characters.

The original description of *H. roudabushi* did not include the dimensions of the cirrus sac, although its relationships were portrayed (Macy and Rausch 1946, Fig. 6). The long cirrus sac extending mediad anterior to the poral testis and the larger hooks of different shape clearly separate *H. roudabushi* from *H. christensoni*. In the present material, the serration of the strobilar margins was usually more pronounced than was shown in the original description (Macy and Rausch 1946, Figs. 6 and 7). Since all but one of the available specimens of *H. roudabushi* had been mounted with the scolex intact, relatively few hooks could be measured accurately. The lengths obtained (0.035 to 0.040) were somewhat less than those reported originally (0.038 to 0.043). The hooks of *H. roudabushi* are longer than those of *H. christensoni* and are distinguished further by their relatively long, rather strongly curved handle. The arrangement of the testes was usually as described, but some variation was observed (e.g., testes contiguous; two poral, one aporal). The dimensions obtained for the eggs of *H. roudabushi* were smaller than those given in the original description. Since formalin-preserved strobilae were not available, more accurate measurements could not be made.

H. roudabushi has been reported also from *Nycticeius humeralis*, *Eptesicus fuscus*, and *Myotis lucifugus* in Iowa (Blankespoor and Ulmer 1970; Ubelaker and Kunz 1971), and from *E. fuscus* and *M. keeni* in Kansas (Ubelaker 1966; Nickel and Hansen 1967). *H. roudabushi* occurs most commonly in *N. humeralis*, and is

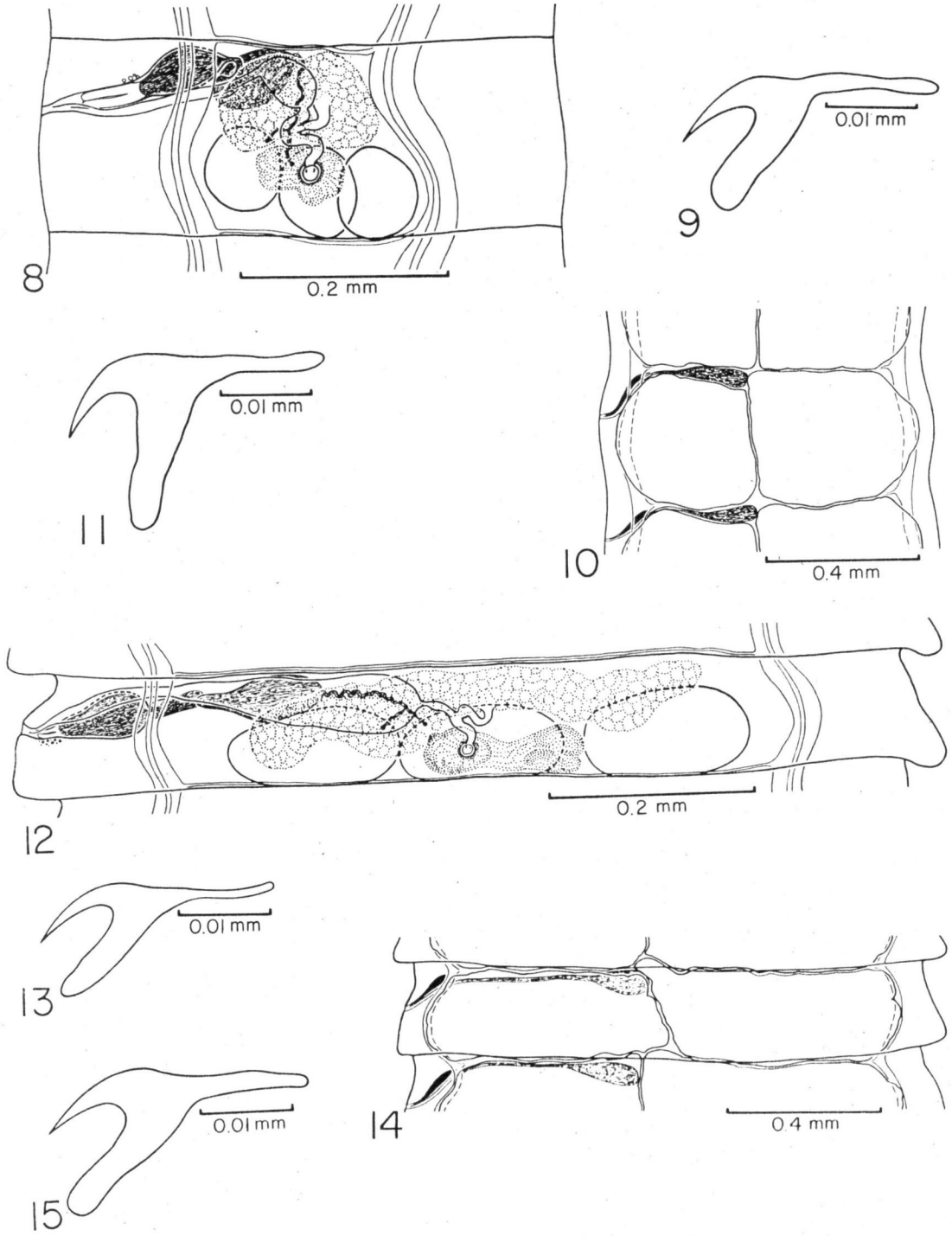

FIG. 8. Mature segment of *Hymenolepis gertschi*, ventral view. FIG. 9. Rostellar hook of *H. gertschi*. FIG. 10. Gravid segment of *H. gertschi*. FIG. 11. Rostellar hook of *H. gertschi* from *Plecotus townsendi*. FIG. 12. Mature segment of *H. lasionycteridis* sp. nov., ventral view. FIG. 13. Rostellar hook of *H. lasionycteridis*. FIG. 14. Gravid segment of *H. lasionycteridis*. FIG. 15. Rostellar hook of *Hymenolepis* sp. from the Hawaiian hoary bat.

thus far the only species of cestode to be reported from this bat. Ten of the 13 specimens examined in central Ohio were infected, with numbers of cestodes ranging from one to four per animal.

Hymenolepis gertschi Macy, 1947
(Figs. 8–11)

Material studied—OREGON: *Eptesicus fuscus*, 1; *Myotis californicus*, 2 (topotypes); *Plecotus townsendi*, 1.

Description

Strobila up to 61 long, with 330 segments; maximum width, attained in gravid segments, 0.9. Strobilar margins not serrate; segmental margins straight or slightly convex. Segments wider than long, with increase in relative length beginning in immature segments; length/width ratios of mature and gravid segments about 1:3 and 1:2.5, respectively. Scolex about 0.400 wide, set off slightly from neck. Rostellum with single row of up to 50 hooks, 0.031 to 0.035 long; suckers 0.096 to 0.108 in greater diameter. Neck 1 to 2 long, and 0.325 to 0.418 wide. Genital pores unilateral, dextral, situated anterior to middle of segmental margin. Genital ducts passing dorsally across longitudinal excretory canals. Ventral canals 0.012 to 0.037 in diameter, connected by narrow transverse canal; dorsal canals 0.005 to 0.008. Cirrus sac 0.126 to 0.154 long by 0.031 to 0.043 in maximum diameter (av. 0.143 by 0.037), directed slightly anteriad, with aporal end extending mediad beyond longitudinal excretory canals. Internal seminal vesicle 0.080 to 0.107 long. Duct to cirrus sac making loop medial to excretory canals, then dilating abruptly, forming large external seminal vesicle anterior or posterior to aporal end of cirrus sac, and anterior to poral testis. External seminal vesicle 0.075 to 0.117 long by 0.035 to 0.060 in diameter (av. 0.093 by 0.047), reaching midline of segment. Testes subspherical, 0.060 to 0.088 in transverse diameter by 0.072 to 0.100 (av. 0.076 by 0.084), contiguous, usually in transverse row in posterior half of segment; four testes occasionally present. Vagina opening in genital atrium posteroventral to orifice of male duct, extending mediad ventrally, usually partly anterior or posterior to cirrus sac. Increasing gradually in diameter, vagina dilating medial to poral excretory canals, forming elongate seminal receptacle. Seminal receptacle 0.057 to 0.080 long by 0.035 to 0.055 in maximum diameter near aporal end (av. 0.069 by 0.041), extending mediad to midline, with aporal end directed posteriad. Ovary usually reniform, 0.145 to 0.180 wide by 0.072 to 0.125 long (av. 0.163 by 0.099), situated anteriorly in segment, occupying most of field between longitudinal excretory canals, and slightly overlapping testes posteriorly. Aporal half of ovary larger and extending farther anteriad. Vitelline gland with three to six lobes, 0.075 to 0.117 by 0.055 to 0.092 long (av. 0.090 by 0.067), situated on midline posterior to ovary and ventral to medial testis. Uterus arising posteriorly as bilobed structure with anterior isthmus; uterine lobes enlarging, filling central field of gravid segment and slightly overlapping longitudinal excretory canals; aporal uterine lobe larger. Genital ducts persisting in gravid segments; seminal receptacle extending mediad across poral uterine lobe, not reaching midline of gravid segment. Eggs spherical, with thin outer covering; 0.052 to 0.062 in diameter (av. 0.055). Embryo 0.025 to 0.030 in greater diameter. Embryonic hooks about 0.015, 0.015, and 0.012 long; second pair thickest.

A specimen of *H. gertschi* from *Eptesicus fuscus*, collected at the W. L. Findley National Wildlife Refuge, Benton County, Oregon, on 3 June 1974, has been deposited in the U.S. National Museum Helminthological Collection, No. 73838.

Remarks

Spasskii (1954, p. 156) expressed the opinion that *H. gertschi* is morphologically very similar to *H. christensoni* and *H. roudabushi*, and considered that further study would be required to establish its taxonomic status. In the present study, *H. gertschi* was readily distinguished from the other two species by its non-serrate strobilar margins, greater length/width ratio of mature and gravid segments, and the more anterior position of the genital ducts and ovary relative to the testes.

The present material agreed substantially with the original description of *H. gertschi*, and some of the discrepancies are no doubt attributable to differences in state of development of the mature segments upon which the respective descriptions were based. However, characteristics of the hooks were notably variable. According to the original description (Macy 1947), this cestode has 35 to 41 hooks that range from

0.026 to 0.029 in length. The specimen from *E. fuscus* had 50 hooks measuring 0.033 to 0.035; that from *Plecotus townsendi* had only 28 hooks, 0.031 to 0.033. In the latter, the hooks were of distinctive shape, having the guard nearly vertical to the long axis (Fig. 11). The cestode from *E. fuscus* also had eggs of larger size than was reported originally; the specimen from *P. townsendi* did not have fully developed eggs. A larger series of specimens is required to establish the limits of morphological variation in *H. gertschi*.

H. gertschi appears to be the most uncommon of the cestodes in North American bats. In addition to the records from Oregon, it has been reported from *Myotis thysanodes* and tentatively from *Tadarida brasiliensis* in New Mexico (Cain and Studier 1974; Cain 1966), and from *M. velifer* in Kansas (Nickel and Hansen 1967).

Hymenolepis lasionycteridis sp. nov.

(Figs. 12–14)

Material studied—OREGON: *Lasionycteris noctivagans*, 12; *Myotis californicus*, 3; *M. yumanensis*, 2; *M. evotis*, 19; *M. volans*, 8; *M. lucifugus*, 6; *Eptesicus fuscus*, 4. OHIO: *M. lucifugus*, 1.

Description

Strobila 58 to 100 long, with 615 to 734 segments; maximum width, attained in early gravid segments, 1.9. Strobilar margins strongly serrate, with intersegmental boundaries well defined. Segments wider than long; strobila attenuated anteriorly, with very gradual increase in segmental length posteriad. Length/width ratio of mature segments 1:8 to 1:6; of gravid segments, about 1:6. About half of segments in strobila pregravid or gravid; only 7 to 15% of total number in strobila mature. Scolex 0.168 to 0.220 wide, distinctly set off from neck. Rostellum about 0.130 long when extended, with single row of 38 to 40 hooks 0.024 to 0.029 long (av. 0.025); handle of hooks short and attenuated. Suckers 0.070 to 0.084 in greater diameter. Neck 0.930 to 2.6 long, and 0.100 to 0.140 wide. Genital pores unilateral, dextral, situated at middle of segmental margin; genital pore sinistral in occasional segments. Genital ducts passing dorsally across longitudinal excretory canals. Ventral canals 0.025 to 0.032 in diameter, connected by narrow transverse duct; dorsal canals 0.006 to 0.012. Cirrus sac elongate-piriform, 0.107 to 0.148 long by 0.040 to 0.048 in maximum diameter (av. 0.125 by 0.045), directed slightly anteriad, with aporal end frequently overlapping longitudinal excretory canals. Internal seminal vesicle 0.075 to 0.105 long; poral end of cirrus sac surrounded by glandular cells. Duct to cirrus sac making two loops medial to aporal end of latter, dilating medial to longitudinal excretory canals, forming external seminal vesicle. External seminal vesicle elongate, 0.112 to 0.162 long by 0.037 to 0.065 in maximum diameter (av. 0.134 by 0.053), situated medial to end of cirrus sac, anterior to and contiguous with poral testis. Testes elongate, 0.100 to 0.176 in transverse diameter by 0.068 to 0.108 (av. 0.129 by 0.091), arranged in transverse row, and occupying most of length of segment. Two or four testes per segment not unusual. Opening into genital atrium ventral to orifice of male duct, vagina extending somewhat anteriad, then mediad, enlarging gradually and forming elongate seminal receptacle. Seminal receptacle 0.168 to 0.284 in transverse length by 0.040 to 0.076 in maximum diameter near aporal end (av. 0.234 by 0.053), extending mediad dorsal to ovary in anterior half of segment, usually not reaching midline. Ovary long and relatively narrow, 0.240 to 0.468 in transverse width by 0.064 to 0.092 long (av. 0.328 by 0.080), situated anteriorly in segment ventral to testes. Lobed vitelline gland elongate, 0.124 to 0.160 in transverse width by 0.036 to 0.052 long (av. 0.139 by 0.044), near midline posterior to ovary and ventral to testes. Uterus dorsal to ovary, first visible laterally near posterior margin of segment, and consisting of bilateral lobes connected by isthmus anteriorly; uterine duct arising ventrally, running anteriad. In gravid segments, uterine lobes discrete, filling segment between longitudinal excretory canals and frequently overlapping canals dorsally. Aporal uterine lobe larger. Walls of gravid uterus thick and cellular. Genital ducts persisting in gravid segments; seminal receptacle usually visible at anterior margin of poral uterine lobe. Eggs ellipsoidal, with thick outer covering; 0.037 to 0.048 by 0.030 to 0.037 (av. 0.044 by 0.034). Embryo 0.025 to 0.032 in transverse diameter. Embryonic hooks about 0.015, 0.015, and 0.013 long; second pair thickest.

Type host—*Lasionycteris noctivagans*; recorded also from bats of other species (see above).

Habitat—Small intestine.

Type locality—East Pilot Rock Spring, Mt. Ashland, Jackson County, Oregon.

Type—Holotype, U.S. National Museum Helminthological Collection, No. 73839, from bat collected on 28 August 1974; paratype, No. 73840, from *L. noctivagans* collected at the H. J. Andrews Experimental Forest, Lane County, Oregon, on 1 July 1972.

Remarks

In bats infected by *H. lasionycteridis* sp. nov., numbers of cestodes ranged from 1 to 9. Both *H. lasionycteridis* and *H. christensoni* occurred in two, *Myotis lucifugus* and *M. californicus*; other mixed infections were not observed in the present study.

The characteristics of the strobila usually suffice to distinguish *H. lasionycteridis* from congeners occurring in bats in North America. Because of the large number of strongly delineated segments of similar size and proportions, the strobila of this cestode has a distinctive appearance. In fully developed specimens (i.e., in which apolysis had occurred), mature segments were few and about three-quarters of the strobilar length consisted of pregravid and gravid segments in which the distinctive form (transversely elongate) of the uterus was evident even in unstained specimens. *H. lasionycteridis* is distinguished also by its egg, which is ellipsoidal and has a thick (about 0.003) outer covering, contrasting with the subspherical to spherical, thin-walled egg of the other species (cf. Fig. 4). The thick outer covering apparently imparts a darker color to the egg of this cestode. Undistorted eggs from formalin-preserved specimens measured 0.050 to 0.057 by 0.040 to 0.047 (av. 0.054 by 0.043 mm).

H. lasionycteridis is morphologically most similar to *H. christensoni*, from which it is distinguished by its smaller rostellar hooks (determined from separately mounted hooks from 20 specimens of *H. lasionycteridis*), characteristics of the egg, and proportions and relationships of the genital organs. The smaller hooks of different shape, characteristics of the egg, and differences in relationships of the cirrus sac and other organs separate *H. lasionycteridis* from *H. roudabushi*. Its serrate strobilar margins, structure of the egg, and arrangement of the genital organs corresponding to the different proportions of the mature segments distinguish *H. lasionycteridis* from *H. gertschi*.

With the exception of the yet unsubstantiated reports of *H. christensoni* in Eurasia, there is no indication that bats in North America have any cestodes in common with those on the other continents. However, a species occurring in Eurasia, *Staphylocystis acuta* (Rudolphi, 1819), has been reported from bats in Cuba by Prokopič and del Valle (1967). That some of these cestodes have a holarctic, or even more extensive distribution must be considered as a possibility, and comparison of *H. lasionycteridis* with morphologically similar species in Eurasia and South America seems necessary.

Species of *Hymenolepis* s.l. occurring in bats have been distributed among several genera, according to the taxonomic concepts of Spasskii (1954) and Yamaguti (1959). In his classification of hymenolepidids from mammals, for species characterized in part by the presence of three testes, Spasskii attached considerable taxonomic significance to the arrangement of the testes relative to the female genital organs, in accordance with the system devised earlier by Skriabin and Matevosian (cf. Spasskii 1959). The reliability of characters used in distinguishing some of these genera has been considered by Rybicka (1959). Additional narrowly conceived genera were established by Yamaguti (1959) for hymenolepidids having three testes. Not only are generic limits difficult to discern in some cases, but the problem of generic allocation is complicated by deficiencies in early descriptions, making uncertain the taxonomic status of various species. Vaucher (1971, p. 83) concluded that such inadequacies alone provide sufficient grounds for considering recent attempts to subdivide the genus *Hymenolepis* s.l. to be premature. Unfortunately, descriptions and figures of some recently described species are as inadequate as some published during the last century. Since I am unable to distinguish some of the nominal genera on the basis of morphologic characters alone, and since the generic status of some species described from bats is clearly uncertain, *H. lasionycteridis* is compared with all species of *Hymenolepis* s.l. having an armed rostellum and three testes, from bats in Eurasia and South America. For present purposes, it is convenient to consider separately the members of each nominal genus.

Of the genera recognized by Spasskii (1954), three included cestodes of bats: *Staphylocystis* Villot, 1877; *Myotolepis* Spasskii, 1954; and

Vampirolepis Spasskii, 1954. The genus *Triodontolepis* Yamaguti, 1959 was established for *Hymenolepis tridontophora* Sołtys, 1954 from shrews in Poland, and to it was assigned also *H. miniopteri* Sandars, 1957 from a bat, *Miniopterus blepotis* (Temminck), in Australia. More recently, from bats in Japan (Honshu), Sawada (1966 *et seqq.*) has described 18 species of hymenolepidids characterized in part by the presence of three testes. These cestodes were placed by Sawada in four genera: *Vampirolepis*, 3; *Hymenolepis* sensu Spasskii, 1954, 6; *Rodentolepis* Spasskii, 1954, 2; and *Insectivorolepis* Żarnowski, 1956, 7. Sixteen of the 18 species were recorded from one species of bat, *Rhinolophus ferrumequinum* (Schreber). Other species described recently from bats have been placed either in the genus *Vampirolepis* or in *Hymenolepis* s.l.

In addition to questions concerning the validity of some of these generic allocations, some irregularities exist in the application of generic names. *Hymenolepis skrjabinariana* Skarbilovich, 1946 was designated type species of the genus *Vampirolepis* by Spasskii (1954), and other species assigned to this genus included *V. grisea* (van Beneden, 1873), with *Milina grisea* van Beneden, 1873 and *Hymenolepis grisea* (van Beneden, 1873) listed as synonyms. Stunkard (1961) pointed out that if *V. grisea* is congeneric with *V. skrjabinariana*, and if the generic distinction is valid, *Vampirolepis* (written *Vampirella* in Stunkard's paper) would be a synonym of *Milina* van Beneden, 1873.

Spasskii (1954) had tentatively assigned *H. grisea* to the genus *Vampirolepis*, since whether it had rostellar hooks was not known; however, he considered that the structure of the rostellum indicated that hooks would be found to be present. From the study of specimens from *Myotis myotis* (Borkhausen) in Czechoslovakia, Tenora and Baruš (1960) determined that *V. grisea* has an unarmed rostellum, and consequently transferred it to the genus *Myotolepis*. They concluded also that the species described as *Dicranotaenia crimensis* Skarbilovich, 1946 is conspecific with *V. grisea*. Thus, as pointed out by Zdzitowiecki (1970), *Myotolepis* becomes a synonym of *Milina* van Beneden, since *D. crimensis* had been designated type species of the genus *Myotolepis* by Spasskii (1954). Andreiko (1973, p. 84) concurred with the removal of *V. grisea* to the genus *Myotolepis*, but retained *M. crimensis* as a valid species. Andreiko concluded also that *Hymenolepis odaensis* Sawada, 1968, described from bats in Japan, should be placed in the genus *Myotolepis* rather than in *Hymenolepis* sensu Spasskii, and further that it is conspecific with *M. crimensis*.

It is thus apparent that species of *Hymenolepis* s.l. from bats fall into seven genera according to the classifications of Spasskii (1954) and Yamaguti (1959): *Milina* van Beneden, 1873 (syn. *Myotolepis* Spasskii, 1954); *Staphylocystis* Villot, 1877; *Hymenolepis* Weinland, 1858 sensu Spasskii, 1954; *Vampirolepis* Spasskii, 1954; *Rodentolepis* Spasskii, 1954; *Insectivorolepis* Żarnowski, 1956; and *Triodontolepis* Yamaguti, 1959. Those assigned to *Milina*, *Hymenolepis* sensu stricto, and *Insectivorolepis* need not be considered further here, since they either lack a rostellum or the rostellum is vestigial and unarmed. Some of the remaining genera are difficult to distinguish, and the respective diagnoses do not appear to include any morphological character by which the genera *Vampirolepis* and *Rodentolepis* can be consistently separated.

Triodontolepis is distinguished essentially by the form of the rostellar hooks, which have a bifurcate guard. Whether or not this character is a valid taxonomic discriminant at the generic level, it serves to separate *T. miniopteri* from the other hymenolepidids known from bats. The taxonomic status of species assigned to this genus has been discussed recently by Prokopič (1972). The genus *Staphylocystis* includes two species from bats, *S. acuta* (Rudolphi, 1819), in Europe (and reported from Cuba), and *S. syrdariensis* (Skarbilovich, 1946), from *Pipistrellus* in middle Asia. *S. bacillaris* (Goeze, 1782), a parasite of moles and shrews in Europe, has been reported from *Nyctalus* in Japan (Yamashita and Mori 1953), but this record seems questionable. *H. lasionycteridis* is distinguished from *S. acuta* by its smaller hooks (0.038–0.040 in *S. acuta*) as well as by other characters (cf. von Janicki 1906). From *S. syrdariensis*, it differs in having larger hooks (0.020 in *S. syrdariensis*) and in the arrangement of the testes (forming a triangle in the middle of the segment in *S. syrdariensis*) (cf. Skarbilovich 1946, Fig. 2).

Two species from bats have been assigned to the genus *Rodentolepis*, *R. taruiensis* Sawada, 1967 and *R. macrotesticulatus* Sawada, 1971,

described respectively from *Rhinolophus cornutus* Temminck and *R. ferrumequinum* (Schreber) in Japan. *H. lasionycteridis* differs from *R. taruiensis* in having more numerous rostellar hooks, an apparently longer cirrus sac, and in the arrangement of the testes (in *R. taruiensis*, 23 hooks; cirrus sac not reaching longitudinal canals; one testis poral, two aporal). It is readily distinguished from *R. macrotesticulatus* (hooks 0.018 mm) by its much larger hooks. Sawada's description of one testis poral and two aporal in the latter species is not substantiated in the photograph (Sawada 1971, Fig. 7).

As presently conceived, the genus *Vampirolepis* apparently includes 10 species that occur in bats in Eurasia: *V. balsaci* (Joyeux and Baer, 1934); *V. kerivoulae* (Hübscher, 1937); *V. pipistrelli* (López-Neyra, 1941); *V. skrjabinariana* (Skarbilovich, 1946); *V. rysavyi* Tenora and Baruš, 1960; *V. isensis* Sawada, 1966; *V. multihamatus* Sawada, 1967; *V. hidaensis* Sawada, 1967; *V. spasskii* Andreiko, Skvortsov, and Konovalov, 1969; and *V. novadomensis* Ryšavý, 1971. In addition to other characters, its larger hooks distinguish *H. lasionycteridis* from the following: *V. balsaci* (0.018–0.022 mm); *V. kerivoulae* (0.022–0.023 mm); *V. pipistrelli* (0.021–0.023 mm); *V. hidaensis* (0.017 mm); and *V. novadomensis* (0.016 mm).

H. lasionycteridis differs from *V. skrjabinariana* in having hooks of smaller size, a smaller cirrus sac not extending mediad anterior to the poral testis, and eggs of different form (in *V. skrjabinariana*, hooks 0.036–0.041 mm; egg thin-walled and spherical). The arrangement of the testes distinguishes *H. lasionycteridis* from *V. isensis* and *V. spasskii*. In these, the one poral and two aporal testes are widely separated, with the intervening space occupied by the ovary and vitelline gland. Compared with *V. multihamatus*, *H. lasionycteridis* has a different arrangement of the testes and differences in the egg (in *V. multihamatus*, one testis poral, two aporal; egg subspherical and thin-walled). *H. lasionycteridis* is distinguished from *V. rysavyi* by hooks of smaller size, a gravid uterus of different form, and a cirrus sac which extends farther mediad (in *V. rysavyi*, hooks 0.037 mm; gravid uterus not bilobed). The egg of *V. rysavyi* is unknown.

Two of the three species of *Hymenolepis* s.l. described from bats in Malaya possess an armed rostellum. *H. lasionycteridis* is distinguished from *H. malayensis* Prudhoe and Manger, 1969 by its larger hooks, different position of the genital pore, and arrangement of the testes (in *H. malayensis*, hooks 0.022 mm; genital pore far anterior; poral testis widely separated from aporal testes). Compared with *H. hipposideri* Prudhoe and Manger, 1969, *H. lasionycteridis* has larger, more numerous hooks, a relatively smaller cirrus sac not extending so far mediad, a different arrangement of the testes, and a different form of gravid uterus (in *H. hipposideri*, 16–19 hooks, 0.022–0.024 mm; testes, one poral, two aporal).

Besides *V. decipiens* (Diesing, 1850), known from bats in Paraguay and Brasil (Rêgo 1962), evidently three species of *Hymenolepis* s.l. with an armed rostellum are known from bats in South America and adjacent islands: *H. chiropterophila* Pérez Vigueras, 1941 (transferred to the genus *Vampirolepis* by Prokopič and del Valle, 1967), in Jamaica and Cuba; *V. guarany* Rêgo, 1961, in Paraguay and Brasil; and *V. elongatus* Rêgo, 1962, in Brasil.

H. lasionycteridis differs from *V. decipiens* in extent of the cirrus sac mediad, position of ovary, and arrangement of the testes (in *V. decipiens*, cirrus sac not reaching longitudinal excretory canals; ovary entirely anterior to testes; one testis poral, two aporal). Compared with *V. chiropterophila*, *H. lasionycteridis* is distinguished by its much larger cirrus sac, different form of uterus, and differences in the egg (in *V. chiropterophila*, cirrus sac 0.100–0.105 by 0.040–0.045 mm; uterus not bilobed; outer covering of egg having bipolar thickenings). *H. lasionycteridis* is readily separated from *V. guarany* by its much smaller hooks (0.050 mm in *V. guarany*). The latter has a short, relatively wide (up to 2.53 mm) strobila and an apparently smaller egg (0.034 mm). Compared with *V. elongatus*, *H. lasionycteridis* has much larger hooks, a much larger cirrus sac, and a different arrangement of the genital organs (in *V. elongatus*, hooks 0.017–0.018 mm; cirrus sac 0.092 by 0.029; genital organs grouped in the central part of the segment).

Cestodes from the Hoary Bat in Hawaii

Cestodes were found in 8 of 61 hoary bats collected in the vicinity of Honokaa, Island of Hawaii. Numbers in infected animals ranged from one to four, for a total of 14 specimens. Eleven of these cestodes, from five bats, were

identified as *H. lasionycteridis*, with which they agreed in all taxonomically significant characters. A specimen from a bat collected on 22 June 1965 has been deposited in the U.S. National Museum Helminthological Collection, No. 73841.

The identity of three cestodes, occurring singly, could not be established. These consisted of one complete specimen with gravid segments, one with pregravid segments, and fragments of a third. The cestode with gravid segments was about 80 mm long, with a maximum width of 1.9 mm. The strobilar margins were slightly serrate, and the length/width ratio of mature segments was about 1:5. Compared with the species of *Hymenolepis* occurring in North American bats, these cestodes resembled *H. roudabushi* in the size and relationships of the cirrus sac (0.180 to 0.232 mm long) and in the arrangement of the testes (one poral, two aporal). However, they had smaller hooks of different form (Fig. 15). The eggs were subspherical, with an average size of 0.038 by 0.036 mm. The condition of these cestodes did not permit further comparisons.

Discussion

Four species of *Hymenolepis*, *H. christensoni*, *H. roudabushi*, *H. gertschi*, and *H. lasionycteridis*, appear essentially to be restricted in occurrence to bats in the temperate zone of North America. On zoogeographic grounds, palearctic and nearctic bats would not be expected to have any cestodes in common, but the occurrence of some of the same species in nearctic and neotropical bats would seem possible.

Bats representing several of the same vespertilionid genera have a continuous distribution from north-temperate North America to beyond the equator in South America. Two species, *Lasiurus cinereus* and *L. borealis* (Müller), occur widely on both continents, and a third, *Tadarida brasiliensis*, is distributed from the southwestern United States to southern South America (beyond latitude 40° S). The ranges of some nearctic species, such as *Eptesicus fuscus*, extend into subtropical North America. However, bats in subtropical and tropical regions seem to have a distinctive fauna of cestodes, and there has been no indication that any of the nearctic species of *Hymenolepis* occurs in these regions. The extent of their distribution southward is unknown, since cestodes in bats in continental North America below about latitude 32° N have not been investigated. In Cuba, Prokopič and del Valle (1967, Table 1) examined 297 bats representing 17 species and found cestodes in only 6 bats (the feeding habits of some species would seem to preclude their infection by cestodes). Neither of the two cestodes found, *Staphylocystis acuta* and *Vampirolepis chiropterophila*, has been recorded from bats in North America.

The range of hosts known for the four nearctic species of *Hymenolepis* seems to be sufficiently wide to indicate that these cestodes in the strobilar stage are not host-specific at the infrageneric or generic levels, with the possible exception of *H. christensoni*, which is known thus far only from bats of the genus *Myotis*. Since their intermediate hosts have not been identified, there is no information concerning host specificity in the larval stage. However, differential rates of occurrence of these cestodes in bats of the various species permit the inference that their larval stages are adapted to development in insects of different groups (?orders), on which bats of the respective species prey selectively. Qualitative differences in the diets of insectivorous bats would seem to be related to a combination of ecologic and ethologic factors, including geographic locality, variety of prey species utilized, seasonal changes in the composition of insect faunas, time and duration of feeding, habitat where feeding occurs, and migratory habits of the bats (cf. Black 1974; Kunz 1974). In Oregon, C. O. Maser observed that rates of infection of bats by cestodes were much higher in the humid coastal region than in the arid regions east of the Cascade Range (personal communication).

Some degree of host specificity in the larval stages of these cestodes is perhaps implied also by their absence from bats in subtropical and tropical regions, where ostensibly suitable final hosts are abundant. Similar conditions may exist at the northern limits of the range of bats in North America. No cestodes were found in *Myotis lucifugus* in Alaska west of longitude 140° W, where the bats seem to feed mainly on small flies (Diptera). The one infected bat collected within the political boundaries of Alaska was obtained below latitude 56° N, in the humid coastal forest. The occasional finding of *M. lucifugus* in sheltered places near the northern limits of its range after the onset

of cold weather in autumn suggests that the animals are not migratory, and consequently would not be exposed to infection at lower latitudes (R. L. Rausch, unpublished).

The presence of suitable intermediate hosts in the indigenous fauna made possible the persistence of *Hymenolepis lasionycteridis* in hoary bats that colonized the Island of Hawaii. Although this bat was recognized as an immigrant species by Perkins in 1903 (p. 466), its geographic origin has not been established. The occurrence of *H. lasionycteridis* in the Hawaiian hoary bat indicates that at least some of the progenitors of the insular population originated in western North America. In that region, hoary bats disperse in summer as far northward as southern British Columbia, and winter in the southern United States or perhaps Mexico (Findley and Jones 1964). The pattern of prevailing winds in late summer would seem to favor transport of bats from the continent to the Hawaiian Islands. It is perhaps significant that the point on the continent nearest Hawaii is at about latitude 32° N, in southern California, although bats may be dispersed over much greater distances at sea, apparently depending upon wind patterns (cf. Koopman and Gudmundsson 1966). The possibility of a South American origin seems much more remote, not only because of the greater distance, but because the hoary bat apparently does not occur west of the Andes (cf. Cabrera 1957). Hawaii might have been colonized by a single group of migrating bats carried offshore by winds, but individuals or small numbers might reach the island at intervals, as has occurred in Iceland (Koopman and Gudmundsson 1966).

Another cestode, *Cycloskrjabinia taborensis* (Loewen, 1934) might also be expected to occur in the hoary bat in Hawaii, since it seems characteristically to be a parasite of bats of the genus *Lasiurus* in North America (Tromba 1954; Stunkard 1961; Blankespoor and Ulmer 1970; Cain and Studier 1974). The intermediate host of this Linstowiine cestode is probably also an insect (Stunkard 1961).

Acknowledgments

This study was made possible through the generous cooperation of several colleagues. Cestodes from bats in Oregon were provided by Mr. Chris O. Maser and Mrs. Rita Maser, Puget Sound Museum of Natural History, University of Puget Sound, Tacoma, and by Miss Laurel E. Keller, Oregon Cooperative Wildlife Research Unit, Department of Fisheries and Wildlife, Oregon State University, Corvallis; those from the Hawaiian hoary bat were provided by Dr. P. Quentin Tomich, Research Unit, State of Hawaii Department of Health, Honokaa. Specimens were lent by Dr. Ralph W. Macy, Portland State University, Portland, and by Dr. J. Ralph Lichtenfels, Animal Parasitology Institute, Agricultural Research Service, Beltsville. Otherwise unavailable literature was provided by Professor S. N. Boev, Institute of Zoology, Academy of Sciences of the Kazakh SSR, Alma-Ata, and by Academician A. A. Spasskii, Institute of Zoology, Academy of Sciences of the Moldavian SSR, Kishinev. At the University of Alaska, Mrs. V. R. Rausch prepared the figures, and Mr. G. C. Kelley assisted with the photography. These contributions are gratefully acknowledged.

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