

A Revision of the Genus *Cephaluris* Akhtar, 1947 (Nematoda, Oxyuridae) with Redescriptions of the North American Species

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ABSTRACT: The genus *Cephaluris* Akhtar, 1947 is reorganized, based on specimens collected in Canada (Alberta and Yukon Territory), USA (Colorado), USSR (Kazakhstan), and Japan. Both North American pikas, *Ochotona princeps* and *O. collaris*, are hosts to *C. coloradensis* Olsen, 1949, and *C. alaskensis* Akhtar, 1958. The latter species is a new host record for *O. princeps*. The North American species are redescribed, and differentiated on the basis of male morphology, the females being indistinguishable to the author. The genus is reduced from 8 to 6 species. *Cephalurus collaris* Akhtar, 1958 and *C. vakhanaica* Erhardova-Kotrla and Daniel, 1970, are considered synonyms of *C. coloradensis* and *C. ochotonae* Akhtar, 1947, respectively. *Cephaluris andrejevi* Shul'ts, 1948 from *O. rutila* of Kazakhstan and *O. hyperborea yesoensis* of Japan (a new host record), is morphologically close to *C. alaskensis*, as is *C. ochotonae* from *O. rutila* (a new host record) to *C. coloradensis*. Evidence is presented to suggest that species of *Ochotona* are each infected with two species of *Cephaluris*, one from each of two species-groups.

The pinworm genus *Cephaluris* Akhtar, 1947, of pikas (*Ochotona* spp.), is in a state of confusion. Much of the confusion has arisen due to the literature lag, as seven of the eight species were described within a 12 year period. Three species have been found previously in the two species of North American pikas: *C. coloradensis* Olsen, 1949 in *O. princeps*, and *C. alaskensis* Akhtar, 1958, and *C. collaris* Akhtar, 1958, in *O. collaris*. This paper revises host listings and redescribes the North American species, compares these with species from Asian hosts, and reduces the genus to six species.

Materials and Methods

Pikas were collected by shooting: *O. princeps* from the Rocky Mountains, east of the Kananaskis River in Alberta (51°N 115°W), and *O. collaris* from the Ogilvie Mountains of the Yukon Territory (65°N 138°W). They were necropsied within 6 hr of death. Nematodes were killed in dilute saline, fixed in glycerine-ethanol, and cleared in lactophenol-creosote. Measurements were made with the aid of an ocular micrometer, or camera lucida and measuring wheel. *En face* mounts in glycerine jelly were made of several other specimens from these two collections, after the method of Anderson (1958). Descriptions were based on these collections.

Other specimens of *O. princeps* were col-

lected by shooting, in Colorado (39°N 107°W), and Sheep River Alberta within 15 km of the Kananaskis River collection. Specimens from these two collections were made available through the courtesy of Drs. D. G. Cameron and J. S. Millar, respectively. An incision was made in the abdomen and carcasses were placed in AFA. Nematodes from these pikas were later transferred to glycerine-ethanol, and cleared in lactophenol-creosote for measurement.

Specimens of *Cephaluris* from freshly killed *Ochotona hyperborea yesoensis* collected in the Daisetzusan National Park Japan (43°N 142°E) by Dr. F. C. Zwickel, were treated as described above.

Specimens from one *O. rutila* collected in the Altai Mountains of Kazakhstan were sent by Dr. E. V. Gvozdev to Dr. R. L. Rausch, who loaned them to the author for examination. The collecting procedures used for these worms were not known to the author, and they had been stored in an unknown preservative.

Analyses of covariance (Steel and Torrie, 1960) were used to test differences between collection groups, using the body length of the worm as the independent variable. For the significance of regression, the 95% level was used, and for comparisons of means, the 99% level. In cases where there was not a significant regression, analyses of variance were applied using the 99% level of significance.

Table 1. Diagnosis of the two North American species of *Cephaluris* by male characteristics. Measurements are based on specimens from Kananaskis Alberta, and Ogilvie Mountains Yukon, for both species, and are given in micrometers.

	<i>Cephaluris alaskensis</i>	<i>Cephaluris coloradensis</i>
Buccal cavity	Cuticular ridges reach to about 5 behind anterior end of tooth (Fig. 5)	Cuticular ridges reach anterior end of tooth (Fig. 10)
Precloacal ventral ridge	Blunt rugged teeth often bunching into groups (Fig. 2)	Fine thin teeth, never bunching into groups (Fig. 7)
Distance of anterior end of ventral ridge from cloaca	942 (720–1310)*	1,372 (960–1660)
Tail tip (from caudal alae)	200 (155–244)	293 (224–348)
Caudal alae	5 to 8 subcuticular longitudinal bands present (Fig. 3)	Longitudinal bands absent (Fig. 8)
Width of transverse striations	10 (7–14)	11.5 (9–16)
Cervical alae	Continuous with, but clearly delimited from lateral alae (Fig. 1)	Posterior end not clearly delimited from lateral alae (Fig. 6)
Cloacal papillae	12 paired and 2 single (Fig. 3) One pair on anterior lips Bilobed papilla immediately posterior to cloaca, with a tiny pair on posterior lobe Second lateral papilla simple Cushion-like papilla greatly expanded	10 paired and 2 single (Fig. 8) None on anterior lips Papilla immediately posterior to cloaca not bilobed, with narrow pedunculate laterals Second lateral papilla with large medially projecting lobe Cushion-like papilla not greatly expanded

* Mean (range).

Logarithmic transforms did not increase the significance of regression so were not used.

Measurements are in micrometers unless otherwise indicated.

Results

Two species, *C. alaskensis* and *C. coloradensis*, were present in all North American collections studied. Although the males of these species were easily distinguishable (Table 1), the author was unable to differentiate two kinds of females.

Cephaluris alaskensis Akhtar, 1958

Redescription

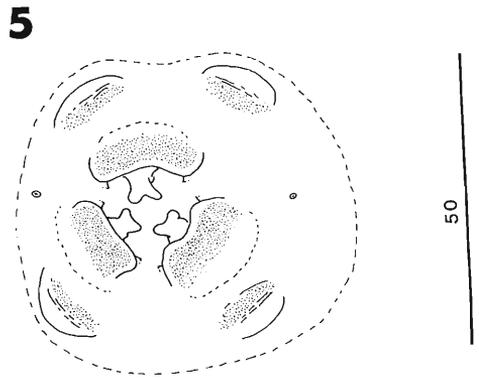
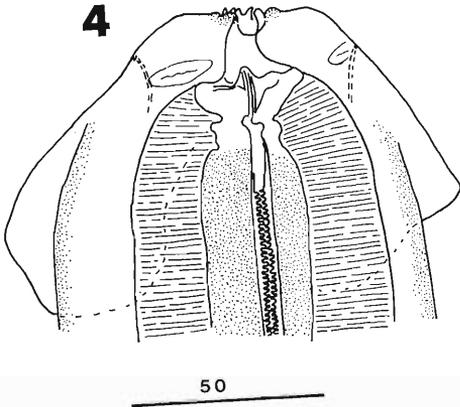
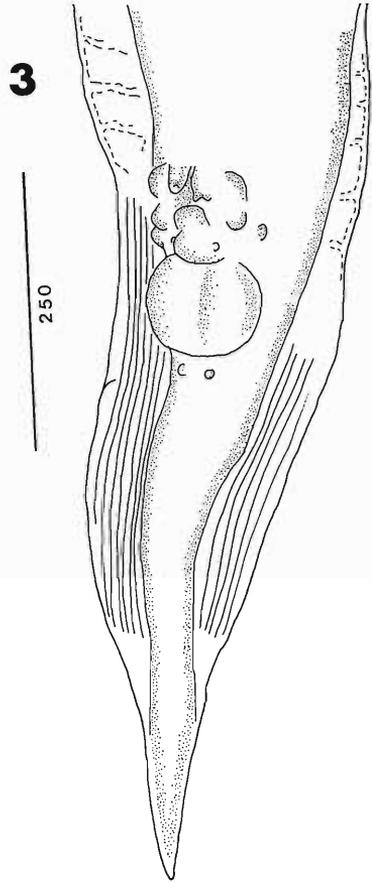
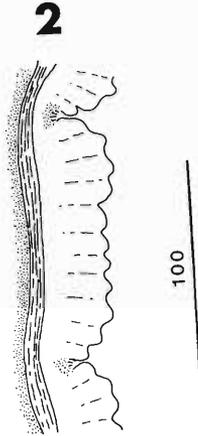
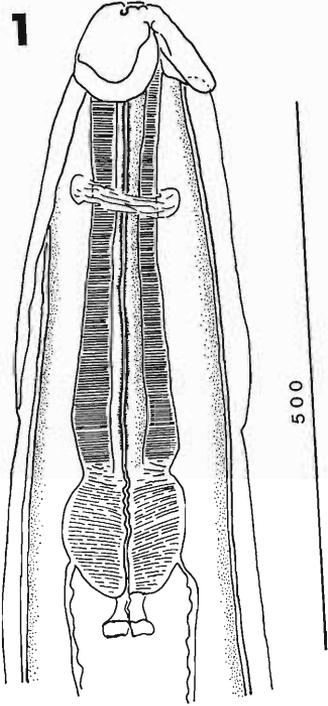
Medium-sized worms, with the cuticle striated transversely. Anterior end with a pair of posteriorly directed cuticular shields (Figs. 1, 12). Mouth surrounded by 3 bilobed lips, one dorsal, and 2 latero-ventral, 2 pairs of papillae, and a pair of lateral amphids (Figs. 5,

12). A pair of cervical alae begins just posterior to the shields, and extends posteriad, becoming continuous with the lateral alae, which extend almost the length of the body. The buccal cavity is 2-storied, and heavily lined with cuticular structures (Fig. 4). Esophagus club-shaped, with a muscular bulb at the posterior end, and an esophago-intestinal valvular apparatus, which extends from the bulb into the lumen of the intestine (Fig. 1). The triradiate lumen of the esophagus anterior to the bulb is lined with fine transverse striations, approximately 2 apart (Fig. 4).

Females

Measurements are shown in Table 2. Vulva anterior to mid-body, without flap (Fig. 11). A muscular ovejector runs anterior from the vulva, then curves posteriad. At the curve is a ring-shaped glandular structure surrounding the ovejector. Posterior to the level of the vulva, the ovejector widens into a thin-walled

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 Figures 1–5. Males of *Cephaluris alaskensis* Akhtar, 1958. 1. Dorsal view of anterior end. 2. Detail of precloacal ventral ridge. 3. Ventral view of posterior end. 4. Ventral view of anterior end. 5. *En face* aspect.



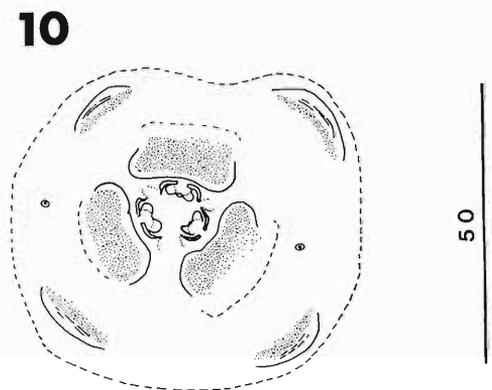
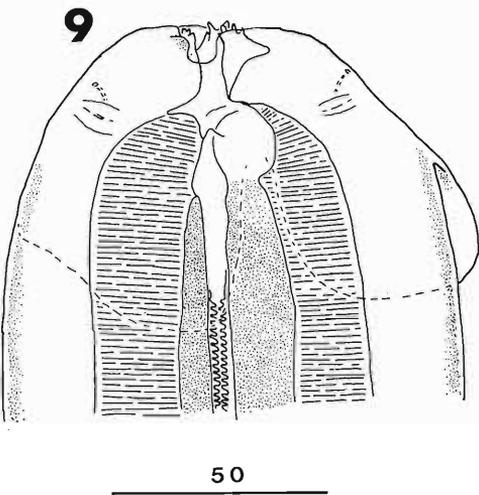
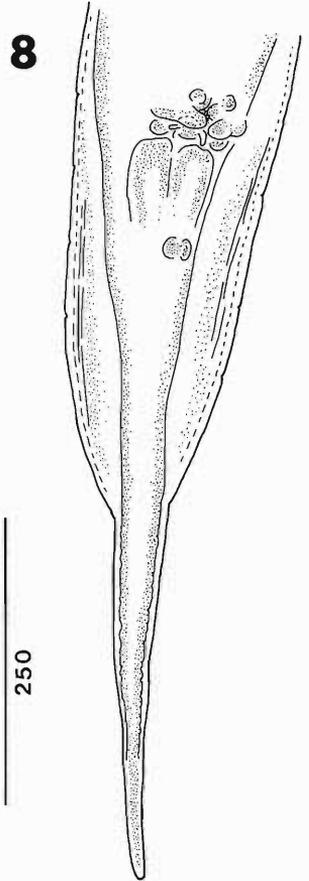
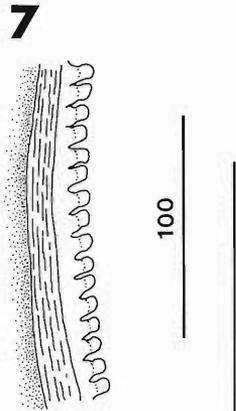
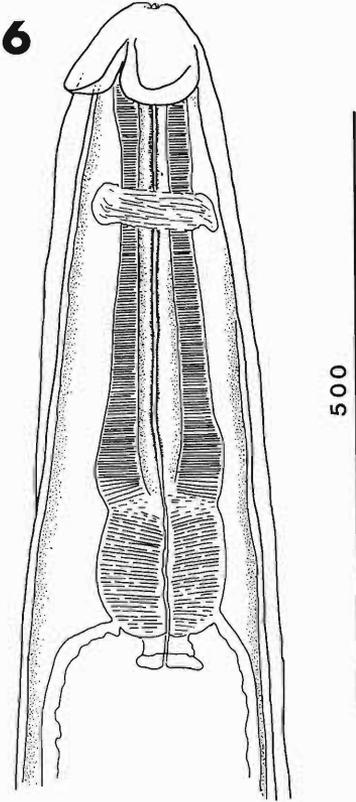


Table 2. Means (and ranges) of measurements of female *Cephaluwis* spp. Measurements are in micrometers unless otherwise stated.

Worm species*	<i>Cephaluwis andrejevi</i>				<i>C. ochotonae</i>		<i>C. alaskensis</i> and <i>C. coloradensis</i>	
	Host species	<i>Ochotona rutila</i>		<i>O. hyperborea yessoensis</i>		<i>O. rutila</i>		<i>O. princeps</i> and <i>O. collaris</i>
Number of worms	7	7	6	6	8	8	4	3
Length (mm)	14.1	(11.5-14.9)	12.6	(11.3-13.1)	14.9	(14.3-15.4)	11.3	(9.1-13.7)
Width	767	(640-820)	663	(550-790)	785	(740-840)	629	(540-760)
Striations	18.5	(16.8-20.9)	13	(10.4-17.4)	15.5	(13.3-17.4)	13.3	(10-19)
Lateral alae width	111	(93-123)	110	(93-123)	111	(102-123)	86	(58-137)
Esophagus length	951	(770-1020)	822	(790-840)	979	(950-1040)	774	(640-960)
Esophagus bulb width	196	(155-216)	180	(172-184)	199	(184-216)	159	(134-204)
Buccal cavity depth	58	(53-61)	51	(44-58)	58	(53-61)	45	(41-53)
Shield length	116	(96-137)	108	(99-117)	123	(102-134)	105	(88-128)
Nerve ring	256	(230-290)	236	(219-260)	275	(250-290)	217	(180-250)
Tail length (mm)	2.28	(1.97-2.53)	2.07	(1.89-2.21)	2.36	(2.15-2.50)	2.02	(1.65-2.42)
Distance of vulva from anterior end (mm)	5.83	(4.7-6.5)	4.93	(4.5-5.5)	6.05	(5.5-6.6)	4.63	(3.7-5.6)
Ring gland to vulva (along ovejector)	983	(910-1130)	1070	(940-1190)	1070	(910-1170)	931	(730-1270)
Egg length	107	(99-104)	105	(93-111)	107	(99-104)	113	(96-123)
Egg width	51	(50-53)	55	(53-58)	53	(50-55)	55	(47-64)

* Determined only on the basis of presence (*C. ochotonae*) or absence of vulval flap for Asian worms.

uterus which extends to at least mid-way between the anus and the tail tip (Fig. 13). In this region, the uterus divides; both arms run anteriorly to about the level of the ovejector. A narrow oviduct runs back along each uterus a short distance, and then recurves and runs anteriorly to the ovary (Fig. 11). The ovary continues anteriorly, gradually tapering, and recurves near its termination usually posterior to the esophagus. Each lip of the mouth bears on its medial surface, a blunt double-ended tooth, which has a sharp cuticular ridge, approximately 2 wide on each side (Fig. 12). The ridges extend to a depth of about 20 into the buccal cavity. Rectum with a cuticular lining (Fig. 13). Eggs asymmetrical, with a rugose shell, and a plug near one end (Fig. 14).

Males

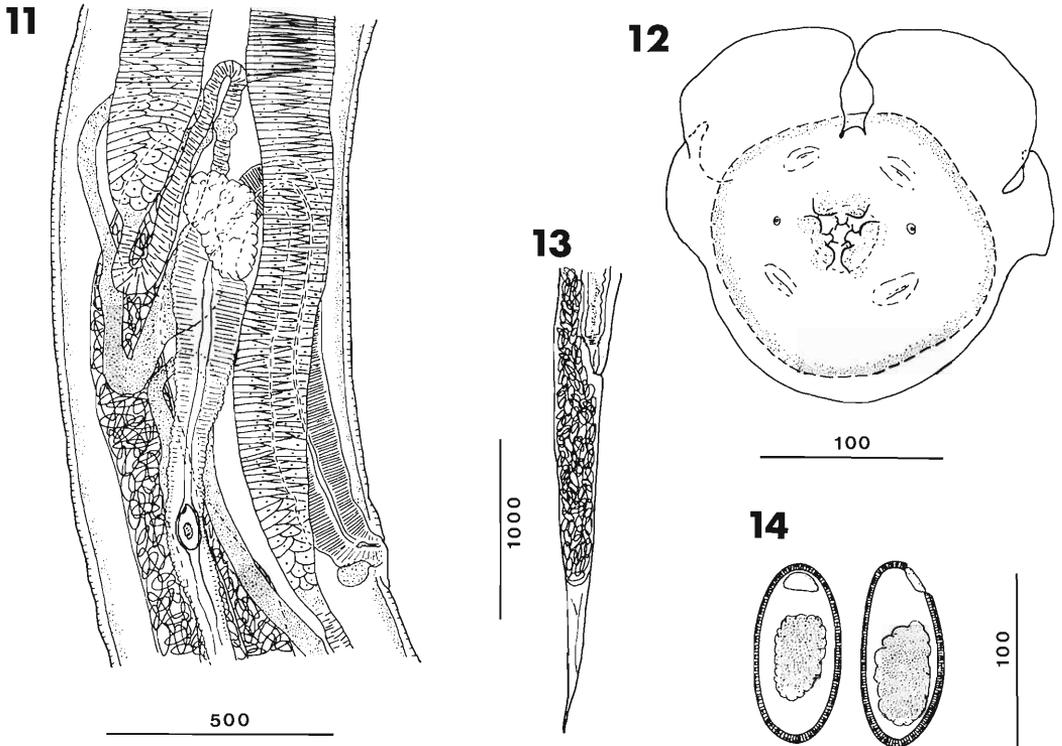
Measurements are shown in Table 3. Cervical alae continuous posteriorly with lateral alae, but clearly delimited from them (Fig. 1). An antero-medially directed tooth on the medial surface of each of the 3 lips (Figs. 4, 5). Teeth

are double-ended and blunt, and not ornamented at their anterior margin. A pair of sharp cuticular ridges approximately 1 wide, on each side of the tooth, begins about 5 behind the anterior extremity of the tooth, and extends about 5 deeper (Fig. 5). Caudal alae continuous anteriorly with lateral alae. Five to 8 subcuticular longitudinal bands inside each caudal alae (Fig. 3). Twelve paired and 2 unpaired cloacal papillae; 3 pairs lateral to cloaca; 1 pair on anterior lips of cloaca; an unpaired posterior papilla, divided into anterior and posterior lobes, the posterior one with a pair of tiny lateral papillae; a large cushion-like papilla posterior to those; and a small pair posterior to it (Fig. 3). Spicules and gubernaculum absent. Rectum with cuticular lining. A long ventral precloacal cuticular ridge with rounded serrations, often bunching into groups, present (Fig. 2).

Hosts: *Ochotona collaris*, *O. princeps*.

DISTRIBUTION: Ogilvie Mountains, Yukon; Talkeetna Mountains, Alaska; Rocky Mountains, southwest Alberta; Gunnison County, Colorado.

← **Figures 6-10. Males of *Cephaluwis coloradensis* Olsen, 1949. 6. Dorsal view of anterior end. 7. Detail of precloacal ventral ridge. 8. Ventral view of posterior end. 9. Ventral view of anterior end. 10. *En face* aspect.**



Figures 11-14. Females of *Cephaluris alaskensis* or *C. coloradensis*. Since these species are distinguishable on the basis of male characteristics only, separate figures for females were not possible. 11. Details of the reproductive system. 12. *En face* aspect. 13. Lateral view of posterior end. 14. Eggs. Scales in all figures are in micrometers.

Table 3. Means (and ranges) of measurements of male *Cephaluris* spp. For the North American species, measurements are given only for worms from the type host species. Measurements are in micrometers unless otherwise stated.

Worm species	<i>C. alaskensis</i>		<i>C. andrejevi</i>		<i>C. coloradensis</i>	<i>C. ochotanae</i>
	Host species		Host species		Host species	Host species
Number of worms	<i>Ochotona collaris</i>	<i>O. rutila</i>	<i>O. hyperborea yesoensis</i>	<i>O. princeps</i>	<i>O. rutila</i>	
	22	10	4	20	1	
Length (mm)	7.5 (6.0-9.1)	8.8 (7.6-9.6)	7.1 (6.1-8.5)	6.8 (5.1-7.5)	8.7	
Width	346 (270-440)	363 (300-400)	338 (250-430)	319 (260-350)	440	
Striations	10 (7-13)	12 (8-14)	8 (7.5-8.7)	12 (10-14)	14.5	
Lateral alae width	57 (41-76)	72 (67-76)	74 (61-88)	50 (38-70)	96	
Esophagus length	554 (450-700)	673 (550-730)	580 (520-660)	508 (410-550)	730	
Esophagus bulb width	116 (96-157)	140 (111-152)	127 (108-163)	110 (93-131)	169	
Buccal cavity depth	33 (29-35)	43 (38-47)	38 (35-41)	34 (29-40)	47	
Shield length	755 (640-880)	82 (70-96)	75 (67-82)	72 (58-88)	85	
Nerve ring	168 (140-200)	212 (190-230)	197 (175-219)	171 (150-180)	210	
Distance from cloaca to tip of tail	544 (410-760)	816 (540-930)	643 (520-790)	595 (530-670)	680	
Tail tip (from caudal alae)	186 (155-235)	296 (204-360)	170 (151-209)	285 (250-348)	250	
Distance from anterior of ventral ridge to cloaca	940 (750-1310)	924 (670-1200)	1040 (820-1410)	1364 (990-1620)	1950	

LOCATION IN HOST: Caecum and colon.

SPECIMENS DEPOSITED: USNM Helm. Coll. No. 73536.

Cephaluris coloradensis Olsen, 1949

Since only males of this species were found to differ from *C. alaskensis*, the general and female descriptions will not be repeated.

Males

Measurements are shown in Table 3. Cervical alae continuous posteriorly with lateral alae; the posterior delineation of the cervical alae inconspicuous (Fig. 6). An antero-medially directed double-ended tooth present on the medial surface of each of the 3 lips (Figs. 9, 10). Two sharp cuticular ridges about 2 wide, begin at the anterior extremity between the tips of each tooth and the lip, and extend about 10 into the buccal cavity, curving to the lateral sides of the tooth (Fig. 10). Caudal alae are continuous anteriorly with lateral alae. Longitudinal bands in caudal alae absent. Spicule and gubernaculum absent. Ten paired and 2 unpaired cloacal papillae (Fig. 8); none on anterior lips of cloaca; 3 pairs of lateral papillae, the second of which is enlarged, and has a medially-directed lobe; papilla immediately posterior to cloaca consists of one lobe with a pair of narrow pedunculate lateral papillae; large cushion-like papilla posterior to this, not greatly expanded, and is indistinctly divided medially; posterior pair of papillae very close together. Rectum with cuticular lining. Long cuticular ventral ridge with fine teeth, never bunching into groups (Fig. 7).

LECTOTYPE: USNM Helm. Coll. No. 37085.

HOSTS: *Ochotona princeps*, *O. collaris*.

DISTRIBUTION: Colorado; Rocky Mountains, Alberta; Ogilvie Mountains, Yukon.

LOCATION IN HOST: Caecum and colon.

SPECIMENS DEPOSITED: USNM Helm. Coll. No. 73535.

Comparisons of measurements of males by analyses of covariance (Fig. 15), show that while there are a large number of differences among worm species within a collection group in North America, very few differences exist among collection groups for each worm species. However, measurements of a relatively large number of structures (4 of 8) in

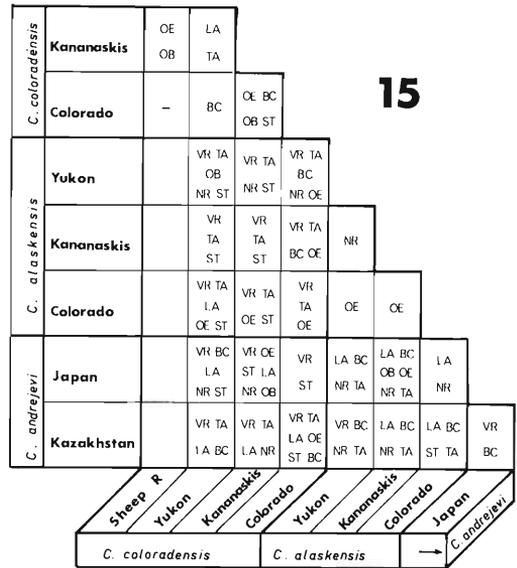


Figure 15. Comparisons of lengths or positions of structures for male *Cephaluris* spp. by analysis of covariance. Symbols in the boxes represent measurements which are significantly different ($P < 0.01$) for each pair. Boxes marked with (-) represent no significant differences. Where there were no analyses between members of a pair, the box is empty. The 8 measurements compared in the analyses are: width of transverse striations (ST), width of lateral alae (LA), depth of buccal cavity (BC), total length of esophagus (OE), width of esophageal bulb (OB), distance of nerve ring from anterior end (NR), distance of cloaca from posterior end (TA), and distance of anterior end of precloacal ventral ridge from cloaca (VR).

the Colorado sample of male *C. coloradensis* were found to differ significantly from the Kananaskis sample. Since these worms had been preserved differently, and it has been shown that procedural differences can affect measurements (Lamberti and Sher, 1969), the effect of differences in procedures was tested by comparing males from Sheep River with those from the Kananaskis and Colorado samples. The Sheep River worms were treated in the same manner as the Colorado group. No differences were found between the samples from Sheep River and Colorado (Fig. 15), suggesting that the differences between the samples from Kananaskis and Colorado were

due to different methods, rather than true differences in the worms.

Lists of measurements for worms from Asian hosts are included in Tables 2 and 3. All but one of the male worms were similar in appearance to *C. alaskensis*, but the author considers them to belong to a separate species because of size differences indicated by the analyses of covariance (Fig. 15). Worms from Kazakhstan were labelled as *C. andrejevi* Shul'ts, 1948 by Dr. Gvozdev, and although they are larger than the published descriptions, the author agrees with his determination, with the following exception. One male from Kazakhstan is definitely not *C. andrejevi*, but is probably *C. ochotonae* Akhtar, 1947, a new host record for *O. rutila*. Two kinds of females, distinguishable by the presence or absence of a vulvar flap, were found in the same collection. Akhtar (1947) described a flap for *C. ochotonae*; neither Shul'ts (1948) nor Spassky and Ryzhikov (1951) did so for *C. andrejevi*.

Only four males were found in *O. hyperborea yesoensis*. These are similar in appearance to both *C. alaskensis* and *C. andrejevi*, but are placed in the latter species because of the greater similarities of measurements (Fig. 15). The females, all without a vulvar flap, appear to be more similar to *C. andrejevi* from *O. rutila*, than to the pooled North American species (Table 2), although they are smaller than the former.

Discussion

Both *C. alaskensis* and *C. coloradensis* were universally present in the North American pika populations of this study. *Cephaluris alaskensis* in *O. princeps* is a new host record.

Akhtar (1958) described *C. collaris* from *O. collaris* collected in the Talkeetna Mountains of Alaska. He differentiated it from *C. coloradensis* by the following six characteristics: shallower buccal cavity, shorter esophagus, shorter tail, shorter ovejector, smaller eggs, and the presence of a doubly-papillate cushion-like papilla in the males. Inspection by the present author of syntype specimens of *C. coloradensis* established that Olsen (1949) had based his description of this species on specimens of both *C. coloradensis* and *C. alaskensis*. It is therefore necessary to review the differences between *C. coloradensis* and *C. collaris*.

Akhtar's (1958) measurements of esophagus

length and eggs for *C. collaris* are similar to those of *C. coloradensis* in this study, as is the appearance of the large cushion-like papilla in the males. The tail length of females also agrees with *C. coloradensis* in this study. His shorter tail length in the males may be due to a sample size of eight, as the present author has found this character to be quite variable. It is difficult to compare ovejector lengths, as those in the present study were measured along the ovejector to the ring gland, while Akhtar measured the straight line distance from the vulva to the ring gland. The latter method can be misleading and results in lower values, due to differing states of curvature of the ovejector. Akhtar's measurements of the buccal cavity agree with those in this study for females, but are smaller for males. However, he measured this structure in only one male, the smallest specimen.

The above-listed lack of differences between Akhtar's *C. collaris*, and *C. coloradensis* as re-described in this study, the same host species, and the close proximity of the collecting site for this study to the type locality for *C. collaris* (500 km), indicate that they are one and the same species. Therefore, *C. collaris* is a synonym for *C. coloradensis*.

In his key to the helminth species of North American pikas, Seesee (1973) uses the presence of a spicule to differentiate *C. coloradensis* from both *C. alaskensis* and *C. collaris*. Akhtar (1956b), Inglis (1959), and Spassky and Ryzhikov (1951) all pointed out that the structure referred to as the spicule in this genus (Olsen, 1949), is actually the cuticular lining of the rectum. Apparently Seesee (loc. cit.) ignored their arguments on this point, as no mention of them appears in his paper, although all three were cited. Seesee (loc. cit.), following Akhtar (1958), further differentiated *C. alaskensis* from *C. collaris* on the basis of presence in the former species of six long glands surrounding the anterior part of the esophagus. This has been found by the present author to be of no value in differentiating *C. alaskensis* from *C. coloradensis*. Some specimens of both species have the glands, while others appear not to have them.

Erhardova-Kotrla and Daniel (1970), apparently unaware of descriptions of *C. alaskensis*, *C. collaris*, *C. chabaudi* Inglis, 1959, and *C. andrejevi* males (first described by Spassky

and Ryzhikov, 1951), described *C. vakhanica* from *O. roylei* of Afghanistan. The only major characteristic they used to distinguish this species from *C. ochotonae* was absence of a spicule. As mentioned above, none of the species possess a spicule; Akhtar (1956b) revised his description of *C. ochotonae*. Therefore *C. vakhanica* is a synonym of *C. ochotonae*.

The genus *Cephaluris* now contains 6 species, 2 in North America, and 4 in Asia. These can be divided into 2 groups by morphology of males.

Key to Males of *Cephaluris* Akhtar, 1947

- 1A. Blunt, rugged teeth on ventral pre-cloacal ridge; subcuticular longitudinal bands or bosses in caudal alae; greatly expanded cushion-like posterior papilla .. Group 1 . . . (2)
- 1B. Fine, thin teeth on ventral ridge; longitudinal bands or bosses absent; relatively deflated cushion-like posterior papilla Group 2 . . . (4)
- 2A. Discontinuous bosses in caudal alae *C. hashmi* Akhtar, 1956
- 2B. Continuous longitudinal bands in caudal alae (3)
- 3A. Cloaca closer than 700 from tail tip; nerve ring closer than 195 from anterior end; buccal cavity shallower than 35; Nearctic distribution *C. alaskensis* Akhtar, 1958
- 3B. Cloaca further than 700 from tail tip; nerve ring further than 195 from anterior end; buccal cavity deeper than 35; Palearctic distribution *C. andrejevi* Shul'ts, 1948
- 4A. Cloacal papillae asymmetrical *C. chabaudi* Inglis, 1959
- 4B. Cloacal papillae symmetrical (5)
- 5A. Body shorter than 8 mm, and narrower than 400 mm; Nearctic distribution .. *C. coloradensis* Olsen, 1949
- 5B. Body longer than 8 mm, and wider than 400 mm; Palearctic distribution *C. ochotonae* Akhtar, 1947

The differences between *C. andrejevi* and *C. alaskensis* in Group 1 were so slight that these may not represent separate species. It

was impossible to distinguish between females of these two species, since there was no certainty as to the identity of the North American females, as stated above. Although differences in the males (Fig. 15) could be host-induced, or even an artifact caused by procedural differences, the author considers it safer at the present time to regard the two as separate species until more is known. It should be kept in mind that they are very closely related.

A similar situation exists with *C. ochotonae* and *C. coloradensis* in Group 2. Males of the latter species differ only in body length and width from the published description of *C. ochotonae*. The females of *C. ochotonae* possess a vulval flap, whereas no North American specimens of this genus had one.

With the exception of *O. hyperborea yesoensis* in Japan, from which only 4 male *Cephaluris* were recovered, the host population in each geographic location surveyed, harbored two species of *Cephaluris*, one from each group. This is a similar situation to that found in chimaeroid fishes, four species of which are host to two species of *Gyrocotyle*, one from each of two morphological groups (Land and Templeman, 1968). The situation in pikas differs however, in that both species are often present in the same individual. There also appears to be no competitive exclusion between *C. alaskensis* and *C. coloradensis* in either *O. collaris* or *O. princeps* (unpublished data). In addition, there is no obvious habitat segregation of these species within the caecum and colon of *O. collaris* (unpublished). That these species pairs should coexist in this fashion, and that the situation seems widespread in pikas, poses an evolutionary puzzle which requires further investigation.

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Literature Cited

- Akhtar, S. A.** 1947. A new genus of nematodes, parasitic in the pika. *Parasitol.* 38: 104-106.
- . 1956a. A new oxyurid (Nematoda:) parasitic in the Baluch pika. *Pakistan J. Sci. Res.* 8: 95-96.
- . 1956b. On the nematodes (family: Oxyuridae Cobb., sub-family: Labiostominae n. subf.) parasitic in the pika of Alaska—Part I. *Pakistan J. Sci. Res.* 8: 133-139.
- . 1958. On the nematodes (family: Oxyuridae Cobb., sub-family: Labiostominae n. subf.) parasitic in the pika of Alaska—Part II. *Pakistan J. Sci. Res.* 10: 56-62.
- Anderson, R. C.** 1958. Methode pour l'examen des nematodes en vue apicale. *Ann. de Parasitol.* 33: 171-172.
- Erhardova-Kotrla, B., and M. Daniel.** 1970. Parasitic worms of small mammals from the mountain regions of the Eastern Hindu Kush. *Folia Parasitologia (Praha)* 17: 201-216.
- Inglis, W. G.** 1959. Some oxyurid parasites (Nematoda) from *Ochotona rufescens vizier* (Mammalia: Lagomorpha) in Iran. *Bull. Soc. Zool. de France* 84: 178-187.
- Lamberti, F., and S. A. Sher.** 1969. A comparison of preparation techniques in taxonomic studies on *Longidorus africanus* Meryn. *J. Nematodol.* 1: 193-200.
- Land, J. Van Der, and W. Templeman.** 1968. Two new species of *Gyrocotyle* (Monogenea) from *Hydrolagus affinus* (Brito Capello) (Holocephali). *J. Fish. Res. Bd. Canada* 25: 2365-2385.
- Olsen, L. S.** 1949. A new species of oxyurid nematode from a pika, *Ochotona princeps figginsi*. *Trans. Amer. Microsc. Soc.* 68: 337-341.
- Seese, F.** 1973. The helminth parasites of the pika, *Ochotona princeps* (Richardson, 1828), in northern Idaho. *Amer. Midl. Nat.* 89: 257-265.
- Shul'ts, R. S.** 1948. Novye nematody ot Altaiskikh i Mongol'skikh gryzunov (Ochotonidae—pishchukhi). *Doklady Akad. Nauk SSSR* 61: 173-176.
- Spassky, A. A., and K. M. Ryzhikov.** 1951. Gel'minty pishchukh Pribaikal'ya. *Trudy Gel'mintol. lab. Akad. Nauk SSSR* 5: 34-41.
- Steel, R. G. D., and J. H. Torrie.** 1960. *Principles and Procedures of Statistics.* McGraw-Hill, New York, 481 p.

A Key to Larval Cestodes of Shallow-Water, Benthic Mollusks of the Northern Gulf of Mexico

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ABSTRACT: Eleven distinct species of larval cestodes recovered from shallow-water, benthic mollusks of the northern Gulf of Mexico are differentiated in an illustrated taxonomic key. They represent nine recognized genera in seven families of four orders and include the trypanorhynch, *Eutetrarhynchus* sp. and *Parachristianella* sp., the tetracyllideans, *Anthobothrium* sp., *Diocotaenia cancellata* (Linton, 1890), *Rhinebothrium* sp., *Acanthobothrium* sp. (of Regan, 1963), *Acanthobothrium* sp. (of Harry, 1969), and "*Scolex pleuronectis quadrilocularis*"; the lecanicephalideans, *Polyocephalus* sp. and *Tylocephalum* sp.; and the diphyllidaen, *Echinobothrium* sp. Infected mollusks are widely distributed along the Gulf of Mexico coastline. Benthic marine mollusks serve as intermediate or paratenic hosts for these larvae while elasmobranch fishes serve as final hosts.

Larval cestode parasites of shallow-water, benthic mollusks were collected during a three-year period from the eastern Gulf of Mexico (Florida Keys to the Mississippi Sound). During that study, 2,470 mollusks representing

36 gastropod species, 55 pelecypod species, and one octopus from 30 sampling localities were examined for larval cestodes. Eleven distinct species of larvae representing nine or ten recognized genera in seven families and