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Parasitic Worms of Small Mammals from the Mountain Regions of the Eastern Hindu Kush*)

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Abstract. In small mammals trapped in the summer months of 1965 in the mountains of the Eastern Hindu Kush (Afghanistan, Vakhan region) at altitudes of 2850—4550 m we found 4 species of cestodes (*Hydatigera taeniaeformis*, *Andrya montana*, *Catenotaenia cricetorum*, *Paranoplocephala omphalodes*), and 6 species of nematodes, (*Citellina hindukushensis* sp.n., *Cephaluris vakhanica* n.sp., *Dermatoxys havliki* sp.n., *Aspiculuris dinniki*, *Aspiculuris arianica* sp.n., *Trichocephalus muris*). The present paper discusses their vertical distribution.

MATERIAL

Our material was collected by the second author who participated in the first Czechoslovak expedition to the eastern part of the Hindu Kush (Afghanistan, Vakhan region) in the summer of 1965. In July and August he collected material from small mammals in two valleys (Ishmurkh Darrah and Chap Darrah) at altitudes from 2850—4550 m. A total of 105 small mammals of the species *Marmota caudata* (Jacquemont, 1844), *Ochotona roylei* (Ogilby, 1839), *Alticola argentata* (Severtzov, 1879), *Apodemus sylvaticus* (L., 1758) and *Crocidura russula* (Hermann, 1780) were examined. With the exception of the last, all species were infected with parasitic worms. (For details of results of the examination of the hosts see HANZÁK and DANIEL—in press.)

The northern border of the Vakhan region is formed by the Ab-i-Panja River, the southern border by the main range of the Hindu Kush. Most of the animals were collected in the valley Ishmurkh Darrah connecting the territory of the main range with the valley of the Ab-i-Panja and joining it close to the settlement Ishmurkh (2750 m above sea level). Animals were collected also in the Chap Darrah valley running in parallel with the Ab-i-Panja valley. The latter valley cutting narrowly into the mountain range is much shorter and steeper. (For details see HADAČ and DANIEL — in press.)

Brief characteristics of the individual sites of collection:

A (the same designation has been used in Fig. 5 and Table 4)—4550 m above sea level—Ishmurkh Darrah. Most of the flora and fauna is concentrated on the plateau of a small island lying at the junction of two branches of the glacier which extends from the bifurcated end of the valley. Although this island is not covered with ice it shows signs of glacial activity.

*) Results of the First Czechoslovak Expedition to the Hindu Kush in 1965—Communication No. 3.

B — Ishmurkh Darrah, the area close to the head of the glacier at 3,880—4,000 m above sea level. Small grassy islets among debris under cliffs.
C — Chap Darrah, 3700 m above sea level. The bottom of the valley which starts to widen at this altitude is occupied by a moderately sloping plain covered with a plant association of *Artemisia leucotricha* Kraschenikov, 1965 and *Stipa himalaica* Roshev, 1924.
D — Coppice of willow bushes at the confluence of brooks flowing from the Ishmurkh Darrah and Chap Darrah (2,850 m above sea level).

SYSTEMATICS

1. *Hydatigera taeniaeformis* (Batsch, 1785)

The larva of this cestode species was found in the liver of *Apodemus sylvaticus* L., 1758 and of *Alticola argentata* (Severtzov, 1879), trapped in the Ishmurkh Darrah on sites "A" and "D" on Aug. 9 and 26, 1965.

2. *Andrya montana* Kirschenblatt, 1941

Recovered from the small intestine of 2 specimens of *Alticola argentata* (Severtzov, 1879) in the Ishmurkh Darrah, site "A", on June 6, 1965 and in the Chap Darrah, site "C", on Aug. 17, 1965. Kirschenblatt first described this species from rodents of the species *Microtus arvalis transcaucasicus* and *Chionomys nivalis* in the U.S.S.R.

3. *Catenotaenia cricetorum* Kirschenblatt, 1949

Recovered from the small intestine of three specimens of *Alticola argentata* (Severtzov, 1879) in the Ishmurkh Darrah, site "B", on July 25, 1965, site "A" on Aug. 8, 1965; in the Chap Darrah, site "C", on Aug. 17, 1965.

Kirschenblatt described this species from *Mesocricetus auratus brandti* and *Pallasiomys erythrourus* in the U.S.S.R. (Armenia and Georgia). Later it was recovered by Smith (1954) in the U.S.A. from *Peromyscus maniculatus* and described as the new species *C. peromysci*. In the following years, several authors recorded findings of this cestode species in small rodents from other European countries (Żarnowski 1955 from Poland; Dimitrova 1961 from Bulgaria; Tenora 1962 from Czechoslovakia). In the U.S.S.R. this species was found by Tokobayev (1962) in *Alticola argentata* in Kirgizia.

4. *Paranoplocephala omphalodes* (Hermann, 1783)

Recovered from the small intestine of two specimens of *Alticola argentata* (Severtzov, 1879)— Ishmurkh Darrah, site "A", on Aug. 8, 1965; Chap Darrah, site "C", on Aug. 20, 1965.

This species parasitizes various species of mice and voles of the holoarctic zone and is, according to Kirschenblatt (1948), the most frequent alpine species. Also Tokobayev recorded this species from the mountain range Tien Shan. In Czechoslovakia it has been recorded from the alpine zone of the High Tatra Mountains.

5. *Citellina hindukushensis* sp. n. Fig. 1

Recovered from the small intestine and the caecum of 4 specimens of *Marmota caudata* (Jacquemont, 1844) Chap Darrah, site "C", on Aug. 15 and 19, 1965.

Male: Overall length of holotype—7.2 mm (6—7.5 mm)*) maximum width 0.300 mm (0.300—0.370 mm). On the cephalic end cuticular alae extend to a distance of 0.124 mm (0.124—0.154 mm). Mouth followed by oesophagus enlarging in a bulb at its posterior end. Overall length of oesophagus including the bulb 0.600 mm (0.540—0.620 mm). Posterior end of body extended into lateral alae, length 0.119 mm (0.119—0.211 mm). Lobe-shaped bursa with 3 ribs of almost equal length. The dorsal rib attains 0.132 mm (0.124—0.154 mm) in length. The two lateral ribs lie almost at right angles to the dorsal rib. The ribs, widened at their base, attenuate towards their end. In addition to this arrangement of ribs one elongated process arises beyond the lateral ribs from each side. Cuticular formations, 0.061 mm in length, armed with suckers are situated close to the cloaca at its lateral sides; feebly chitinized spicule is 0.302 mm (0.264 to 0.372 mm) long and accompanied throughout its length by a barely visible membrane. The gubernaculum resembles an oval disk with a narrow groove through its middle. Size of gubernaculum 0.036 (0.036—0.044) × 0.023 (0.023—0.026) mm. **Female:** overall length 10 mm (8—11 mm), maximum width 0.660 mm (0.500 to 0.740 mm). Cephalic cuticular alae 0.210 (0.210—0.310) mm long. Length of oesophagus with bulb 0.740 mm (0.660—0.780 mm). Anal pore at 1.4 mm from posterior end of body. Vulva at 2.9 mm (1.9—2.8 mm) from anterior end of body; 2 cuticular combs arise in the front and at the back beyond body level. The vulva leads into a wide vagina with a highly developed musculature. Eggs asymmetric, one side more bulging, the opposite side flatter; filaments present at both poles. Size of eggs 0.078—0.093 by 0.035—0.042 mm.

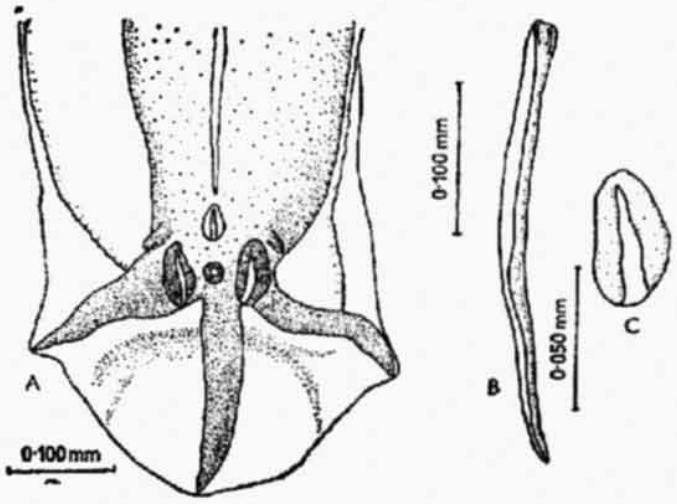

Fig. 1. *Citellina hindukushensis* sp. n.
A — bursa, B — spicula, C — gubernaculum.

Members of the genus *Citellina* parasitize rodents of the family *Sciuridae* and have been recorded from the holoarctic zone. A total of 9 species has been described of these 4 species being from marmots. The remaining species have been described from other hosts, but all are members of the family *Sciuridae*. They occur under various climatic conditions and have been found in the North and East of the U.S.A., in South California, in the subartic zone of Alaska, in Alpine mountain zones of the U.S.S.R. and in European mountain ranges.

Read (1957) studying material from the marmots *Marmota monax*, *M. monax canadensis*, *M. m. rufescens*, *M. marmota broweri*, *Citellus leucurus cinnamoneus*, *C. leucurus* of Alaska and the western and eastern mountain ranges of the U.S.A., and comparing this with the type material *Citellina triradiata* (Hall) and *C. marmotae* Manter from the U.S. National Museum concluded that all species described up to the present are identical and hence synonyms of the species *C. triradiata* (Hall, 1916).

*) (Measurements of paratypes in parentheses.)

Table 1. Measurements of *Citellina hindukushensis* sp. n. compared with those of the other members of the genus *Citellina* (in mm)

Measurements	*C. dispar* Prendel, 1928	*C. alatau* Spasskiy, Ryjikov et Sudarikov, 1950	*C. levini* Li, 1933	*C. marmotae* Manter, 1930	*C. petrovi* Schulz, 1930	*C. schulzi* Korneev, 1951	*C. skrjabini* Merkuscheva, 1955	*C. triradiata* (Hall, 1916)	*C. hindukushensis* n. sp.
body length–male	3.0 4.5	5.9–6.3	2.8–3.0	4.0–4.3	4.78–5.25	6–8	3.91–4.32	3.38–40	6–7.2
body width–male	0.233–0.269	0.420	0.130–0.180	0.260–0.280	0.282–0.300	0.267–0.292	0.253–0.399	0.200–0.285	0.300–0.370
oesophagus	0.402	0.630–0.644	0.170–0.480	0.510	0.564–0.614	0.508–0.667	0.391–0.474	0.410–0.450	0.540–0.620
cephalic alae	0.132	0.196	—	—	—	0.100–0.265	0.184–0.253	—	0.124–0.154
spicule	0.164–0.170	0.125	0.150–0.170	0.240–0.290	0.195–0.215	not given	0.142–0.184	0.043–0.052	0.264–0.372
gubernaculum	0.021–0.025	0.034×0.021	0.02–0.03	absent	0.030–0.037	0.053–0.063	0.023–0.028	—	0.036–0.044
body length – female	5.0–5.7	11.2–12.0	4.1–4.25	4.7–8.7	9.7–11.35	11.5–12.7	6.256–6.969	0.427–6.25	8.0–11.0
body width – female	0.293–0.593	0.560–0.574	0.19–0.25	0.390–0.520	0.581–0.664	0.470–0.670	0.460–0.621	0.430	0.500–0.740
oesophagus	0.195–0.212	0.70–0.75	0.580–0.590	0.620	0.670–0.747	0.760–0.860	0.483–0.529	0.515–0.525	0.660–0.780
cephalic alae	0.393–0.492	0.182–0.210	—	—	0.300	0.230–0.320	0.184–0.289	—	0.210–0.310
distance of vulva from anterior end	1.23–1.62	2.730	1.64–1.74	1.2–1.8	1.30–2.35	2.0–3.0	1.495–1.633	—	1.90–2.90
anal pore	—	2.100	0.48–0.59	1.100	1.7–3.1	—	0.90–0.92	0.850–0.950	1.400
length of eggs	0.081	0.069–0.075	0.051–0.066	0.068–0.073	0.078–0.082	0.068–0.081	0.074–0.078	not found	0.078–0.093
width of eggs	0.034–0.046	0.039–0.041	0.028–0.033	0.038–0.040	0.030–0.033	0.034–0.046	0.037–0.046	not found	0.035–0.042
host	*Citellus suslicus* *Citellus dauricus*	*Marmota menzbieri*	*Sciurus vulgaris*	*Marmota monax canadensis*	*Pteromys volans*	*Marmota sibirica*	*Citellus suslicus*	*Citellus leucurus cinnamoneus* *Citellus lateralis*	*Marmota caudata*

In his opinion, the differences in measurements are still within the range of variability. The marked differences in the size of the spicules are due to the feebly chitinous structure causing difficulty in establishing their correct length. This applies also to the gubernaculum. His views were strongly supported by the finding of male worms in Hall's material, whose spicules attained a length of 0.223 m, although the length in Hall's original description was 0.045—0.050 mm. Also the fact that Hall failed to find eggs in the female worms suggests that these parasites had not attained full maturity. In Read's opininion, the size of the spicule in Prendel's description of *Citellina dispar* — 1.64 mm — is a printing mistake and should read 0.164 mm.

TOKOBAYEV (1960) maintained that *C. alatau* Spassky, Ryzhikov, Sudarikov, 1954 is the most common parasite of susliks and marmots in Kirgiz.

Our material from *Marmota caudata* from Afghanistan is closest to the species listed by SKRYABIN et al. (1960) under the name *Citellina schulzi* Korneev, 1951. In 1951, however, no description was given of *Citellina schulzi* in the literature and this species was mentioned first by SKRYABIN et al. in 1960. The description lacks data on the size and shape of the spicule saying, "... the spicules are very feebly chitinized, their size is indistinct ..." (the distance of the anal pore of the females is missing) and there is no indication as to where the type material has been deposited and where the paratypes can be obtained from.

In view of these difficulties with the description of the species *Citellina schulzi* and also the fact that this species has not been recorded by any other author in the U.S.S.R., its validity seems doubtful and, therefore, we refrain from further reference to it.

The tabulation of the measurements (Table 1) of all species previously described revealed some variability; we had some doubts about Read's study of Hall's material in that there may have been two species of this genus. Therefore, we asked Dr. B. Holubičková for a statistical evaluation of the measurements of the spicules of our species to find out whether a different spicule length could be considered to be a diagnostic sign for differentiation of the individual species described. At the same time we wanted to obtain information on the coefficient of variability. The results of measuring 100 males specimens showed that the average spicule length is 0.311 mm with a standard deviation of 0.0214 mm, the coefficient of variability 6.9 %, the mean error 0.0022 mm on the average. The relatively low value of the coefficient of variability (v = 6.9 %) confirms the low variability of the species under consideration and indicates that the spicule length is a suitable diagnostic feature.

On the grounds of the statistical characteristics of this diagnostic feature it is possible to expect theoretically a variability range of 0.256—0.366 mm (at a 1 % level of significance). These figures are not absolute because, when a large amount of material is available, some values still belonging to the basic complex, may surpass this value.

This happened with our material. The maximum value (0.372 mm) is higher; but, when testing remote values it cannot be excluded (it is impossible to reject the zero hypothesis).

For these reasons we described our species as a new species.

The type material is deposited in the collection of the Institute of Parasitology, Czechoslovak Academy of Sciences, Prague under no. 1031.

6. *Cephaluris vakhanica* sp. n. Fig. 2

Recovered from the caecum of two specimens of *Ochotona roylei* (Ogilby, 1839), Chap Darrah, site "C", on Aug. 15 and 18, 1965.

Male: overall length 7.0 mm (6.8—7.2 mm), maximum width 0.292 mm (0.234 to 0.292 mm). Mouth, surrounded by 3 bilobate lips, leading into the buccal capsule. Lips bear two papillae. Cephalic end armed with a cuticular shield divided into two widely rounded lobes projecting on the dorsal side. The cervical alae extend down to the level of the oesophagus ending at 0.448 mm from the end of the head. Oesophagus 0.507 mm long. Posterior end of body elongate, cuticular alae of the tail not reaching the end of the body. Cloaca at 0.393 mm (0.393—0.420 mm) from tip of tail. On the ventral side a row of cuticular crests extending to 0.380—0.420 mm beyond the cloaca towards the anterior portion. One large posterior unpaired papilla and two smaller anterior papillae are situated close to the cloaca. Next to the smaller anterior papillae there are 2 pairs of praeanal papillae, 2 pairs of adanal and 4 pairs of postanal papillae. Neither a spicule nor a gubernaculum were observed in our material.

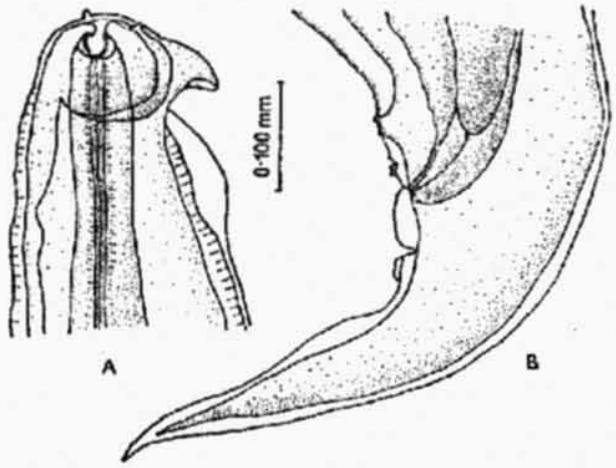

Fig. 2. *Cephaluris vakhanica* sp. n. A — cephalic portion, B — posterior end of the male body.

Female: overall length 11 mm (10—11 mm), maximum width 0.516 mm (0.468 to 0.528 mm), maximum width in oesophageal region 0.316 mm (0.316—0.374 mm). Cervical alae extend to 0.468 mm (0.448—0.468 mm). Oesophagus 0.660 mm (0.660—0.683 mm) long. Vulva at 4.0 mm (3.7—4.0 mm) from anterior end of body. Anal pore at 1.7 mm from posterior end of body. Eggs asymmetric, length 0.097 to 0.109 mm, width 0.050—0.054 mm.

The 4 species of the genus *Cephaluris* described until now are all parasites of members of the genus *Ochotona*.

In 1947, AKHTAR described the species *Cephaluris ochotonae* from *Ochotona rufescens* of Afghanistan and later, in 1956, another new species *C. hashmi*, differing from the former in body measurements, in the measurement of the individual organs and in the arrangement of the caudal papillae. In the U.S.S.R., SCHULZ (1948) described the species *C. andrejewi* from *Ochotona alpina*, differentiating it from *C. ochotonae*, the only then known species of this genus, by the small size of the females and their relatively large eggs. His material contained no male worms. In the U.S.S.R., this species is mentioned by all writers concerned with parasites of these rodents (DUBININ and DUBININA

Table 2. Measurements of *Cephaluris vakhanica* n. sp. compared with those of the other members of the genus *Cephaluris* (in mm)

Measurements	*Cephaluris ochotonae* Akhtar, 1947	*C. andrejewi* Schulz, 1948	*C. coloradensis* Olsen, 1949	*C. hashmi* Akhtar, 1956	*C. vakhanica* n. sp.
body length – male	8.270	not found	5.7–7.6	3.975	6.8–7.2
body width – male	0.230		0.250–0.350	0.270	0.234–0.292
oesophagus	0.545		0.480–0.660	0.240	0.507
cervical alae	0.330		–	0.500	0.448
cloaca	0.670		0.370–0.600	0.540	0.393–0.420
spicule	0.089		0.005	missing	missing
body length–female	18.450	8.22–9.54	8.8–12.5	7.230	10–11.1
body width–female	0.680	0.500	0.450–0.620	0.420	0.468–0.528
oesophagus	0.760	0.647–0.747	0.640–0.840	0.780	0.660–0.683
cervical alae	–	0.431		0.600	0.448–0.468
vulva	8.100	3.97–4.40	3.8–4.9	3.075	3.7–4.0
anal pore	3.500	–	1.39–2.18	1.990	1.700
length of eggs	0.084	0.113–0.124	0.111–0.118	0.086	0.097–0.109
width of eggs	0.044	0.054–0.063	0.048–0.052	0.043	0.050–0.054
host	*Ochotona rufescens*	*Ochotona alpina*	*Ochotona princeps figginsi*	*Ochotona rufescens vulturna*	*Ochotona roylei*

1951—in *O. daurica* and *O. alpina* from the Baikal, Spasskiy et al. 1951 in *O. alpina* also from the Baikal, Gvozdev 1956, 1962, 1964 in *O. alpina* and *O. pricei* from the Altai and central Kazakhstan, Tokobayev 1960 in *O. rutila* and *O. macrotis* from Kirgizia).

In America, Olsen (1949) described the 4th species of this genus from *Ochotona princeps figginsi* from Colorado under the name *C. coloradensis*, differing from *C. ochotonae* in the size of the body, in the size of the eggs, in the number of caudal papillae and in spicule length.

Our species from *Ochotona roylei* resembles the species *C. coloradensis* in the measurements of the body and of the individual organs, but differs from it in the length of the eggs, in the arrangement of the caudal papillae and in the absence of spicules in the male. The same differentiating features were found between our species and *C. ochotonae*, in which also a spicule has been described. Akhtar did not describe a spicule in *C. hashmi*. His species bears a very characteristic ornamental structure

on the caudal alae of the male worm not found in our or any of the other species. It appears from Table 2 that, apart from the large size of *C. ochotonae*, by contrast to the small *C. hashmi*, the distance of the vulva and of the anal pore and also the measurements of the eggs may be still within the range of variability; however, the presence or absence of the spicule and also the crestlike structure on the caudal alae of the males are important differentiating features.

The type material is deposited under no. 1032 in the collection of the Institute of Parasitology, Czechoslovak Academy of Sciences, Prague. The species was named after the region where it was found (Vakhan).

7. *Dermatoxys havliki* sp. n. Fig. 3

Parasitizes the large intestine and the caecum. It was recovered from 3 specimens of *Ochotona roylei* (Ogilby, 1839), Chap Darrah, site "C", on Aug. 15—19, 1965.

Male: overall length 11 mm (11—14 mm), maximum width 0.484 mm (0.440 to 0.484 mm). Mouth surrounded by three lips with 2 papillae; 2 palates are formed. One tooth is visible in the small buccal capsule. The paired cervical cuticular alae start at the site where the mouth passes into the buccal capsule, and extend to 0.748 mm (0.528—0.748 mm) from the anterior end of the body. Oesophagus 0.768 mm (0.768—0.880 mm) terminates in a small bulb. It is covered throughout its length with cuticular teeth. The tail portion possesses cuticular alae which terminate at 0.200 mm (0.176—0.220 mm) from the point of the tail. Cloaca at 0.700 mm (0.700—0.790 mm) from tail end surrounded by one pair of large and one pair of small preanal papillae, one pair of paranal and 3 pairs of postanal papillae. One unpaired papilla lies at the end of the cloaca. In front of the cloaca on the ventral side crest-like cuticular structures extend along both sides. Spicule and gubernaculum absent.

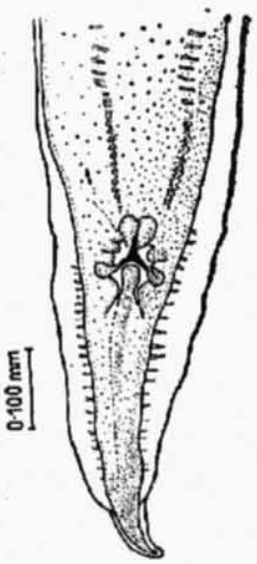

Fig. 3. *Dermatoxys havliki* sp. n. — end of the male body.

Female: overall length 17 mm (17—24 mm), maximum width 0.528 mm (0.528—0.616 mm). Oesophagus 1.0 mm (0.968 to 1.0 mm) long. The cervical alae terminate at 0.768 mm (0.748 to 0.792 mm) from the anterior end. The vulva is located almost in midbody at 9.2 mm (7.9—10.0 mm) from the anterior end and surrounded by low cuticular walls. The anal pore lies 3.0 mm (2.6—3.0 mm) from the end of the tail. Eggs asymmetrical, oval, size 0.123 × 0.052—0.057 mm.

We have placed this species in the genus *Dermatoxys*. This genus is characterized by cuticular crests on the ventral side of the male body. These worms are parasites of the hare, rabbit, squirrel and pika of Africa, India and the U.S.S.R. Schulz (1948) described from *Ochotona daurica* of Mongolia a new genus *Eugenuris* with the species *E. schumakowitschi*. Skryabin and Shikhobalova (1960) placed this species in the subfamily Aspiculurinae because no cuticular ornaments in the male worms are mentioned by Schultz in his description of the genus. Akhtar (1953) described a new genus

Pikaeuris with the species *Pikaeuris pikaeuris* from *Ochotona rufescens* of India, but synonymized it in 1956 with the genus *Eugenuris*. Simultaneously he described the third species of the genus *Eugenuris*, *E. talkeetnaeuris* from *O. collaris* of Alaska. This species differs from all described species in the number and arrangement of the caudal papillae, in the length of the cervical alae and in the structure of the lips. In both species described by AKHTAR the males possess the characteristic cuticular structure on the ventral side. DUBININ and DUBININA (1951) poiting out the small justification for creating the genus *Eugenuris*, placed the species described by SCHULZ in the genus *Dermatoxys*. While SKRYABIN et al. (1960) disagreed with them on this subject, GVOZDEV (1958) and TOKOBAYEV (1960) accepted their suggestion and listed their findings as *Dermatoxys schumakowitschi* (Schulz, 1948). We fully agree with the DUBININS on the synonymity of the genus *Eugenuris* with the genus *Dermatoxys*.

Dermatoxys schumakowitschi has been recorded from *Ochotona alpina*, *O. macrotis*, *O. rutila* from the whole territory of the U.S.S.R. (PANIN 1956, DUBININ and DUBININA 1951, SPASSKIY et al. 1951, GVOZDEV 1956, 1962, 1964, 1966, TOKOBAYEV 1960 etc.). The measurements of all organs of the individual species, except the tail end of the female and the length and width of the eggs (Table 3), are within the

Table 3. Measurements of *Dermatoxys havliki* sp. n. compared with those of the other members of the genus *Dermatoxys* (in mm)

Measurements	*Dermatoxys schumakowitschi* (Schulz, 1948)	*D. pikaeuris* (Akhtar, 1953)	*D. talkeetnaeuris* (Akhtar, 1956)	*D. havliki* sp. n.
body length—male	8.64—11.0	7.850	10.125—11.813	11.0—14.0
body width—male	0.453—0.494	0.520	0.375—0.438	0.440—0.484
oesophagus	0.756—0.864	0.740	0.984	0.768—0.880
cervical alae	—	1.800	0.752	0.528—0.748
cloaca	—	1.350	0.700	0.700—0.790
body length—female	12.39—18.0	19.050	18.210	17.0—24.0
body width—female	0.828—0.970	1.040	0.840—1.015	0.528—0.616
oesophagus	1.11—1.47	1.545	1.598	0.968—1.0
cervical alae	—	—	1.173	0.748—0.792
vulva	4.84—7.06	9.060	9.625	7.9—10.0
anal pore	1.0	2.640	2.147	2.6—3.0
length of eggs	0.083—0.090	0.090—0.100	0.120	0.123
width of eggs	0.050—0.054	0.040—0.050	0.60	0.052—0.057
host	*Ochotona daurica*	*Ochotona rufescens*	*Ochotona collaris*	*Ochotona roylei*

range of variability. The most important differentiating sign of this species is the shape of the mouth because of the different number and shape of the lips.

The mouth of the species *D. schumakowitschi* is surrounded by 6 lips bearing posteriorly two smaller lateral and 4 submedian teeth, that of the species *D. pikaeuris* and *D. talkeetnaeuris* have lips without teeth. The first species has 6 triangular teeth with 6 lateral lips, the latter has 6 cylindrical lips with dorsal cuticular valves. Our species has 3 lips bearing small papillae on the posterior side. The mouth capsule is armed with one tooth.

The type material is deposited under no. 1033 in the collection of the Institute of Parasitology, Czechoslovak Academy of Sciences, Prague. The species has been named in honour of the prominen t deceased Czech parasitologist Dr. Otto Havlík.

8. *Aspiculuris dinniki* Schulz, 1927

Recovered from the large intestine and the caecum of 4 specimens of *Alticola argentata* (Severtzov, 1879), Chap Darrah, site "C", on Aug. 16—20, 1965.

This species was first described by SCHULZ (1927) from *Microtus nivalis oseticus* from the northern Caucasus. Since then it has been recorded in Czechoslovakia from *Microtus nivalis* and *Pitymys tatricus* from the High Tatra Mountains and the Roháčská dolina (ERHARDOVÁ 1955, TENORA 1967), from *Mus musculus* in Kazakhstan (NAZAROVA, SVYESHMIKOVA 1930, cit. PANIN 1956) and from *Microtus nivalis* in Bulgaria by DIMITROVA et al. (1962). This is a parasite of the mountain zone bound together with its host to high altitudes, but can be transmitted to other small mammals, if it comes into contact with them.

9. *Aspiculuris arianica* sp. n. Fig. 4

Recovered from the large intestine of *Marmota caudata* (Jacquemont, 1844), Chap Darrah, site "C", on Aug. 19, 1965.

Male (holotype): overall length 3.3 mm, maximum width 0.122 mm. Cuticle with transverse striation. The cervical alae on the cephalic end extend to a distance of 0.158 mm and hence, do not follow the whole length of the oesophagus. The apical end is surrounded by a cuticular vesicle measuring 0.066 mm. The mouth is surrounded by 3 lips and 2 papillae. The oesophagus measures 0.330 mm and terminates in a bulb. Spicules and gubernaculum absent. The cloaca lies at 0.202 mm from the tip of the tail and is surrounded by 4 pairs of claviform papillae. One pair of papillae is preanal, situated slightly laterally, two pairs of large papillae are anal and one pair of smaller papillae postanal. These are followed by one unpaired papilla; two small papillae are placed close to the termination of the tail. The alae of the tail do not surround the tip of the tail.

Female: overall length 4 mm, maximum width 0.149 mm. Cervical alae extend to 0.158 mm from anterior end. Cuticular vesicle measures 0.070 mm. Oesophagus with bulb is 0.440 mm long. Anal pore lies 0.550 mm from tip of tail. Vulva situated at 0.700 mm from anterior end. Eggs not developed.

The 9 known species of the genus *Aspiculuris* parasitize various rodents of the holoarctic and neotropic zone.

AKHTAR (1955) divided the genus *Aspiculuris* into 5 subgenera on the grounds of the shape of the cervical alae and the presence or absence of the cephalic cuticular vesicle. He differentiated the individual species by the termination of the cervical alae and by the distance between these and the lateral alae. In our material, the cervical alae are entirely different from those of all species described (see Fig. 4). They are short, paired and not sickle-shaped at their termination. In addition to this important diagnostic sign our species differs in the cuticular cephalic vesicle, in measurements, in the length of the oesophagus and in the conspicuously small distance of the vulva from the anterior end (more than half).

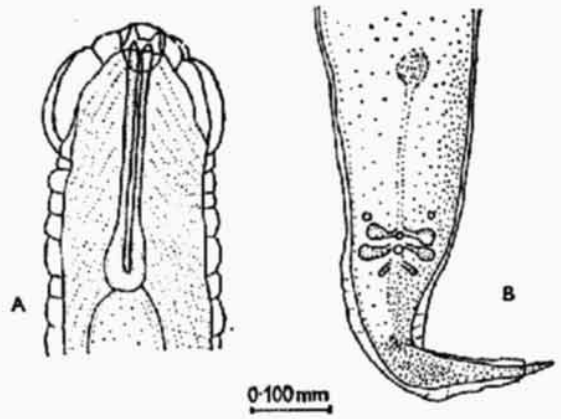

Fig. 4. *Aspiculuris arianica* sp. n.
A — anterior, B — posterior end of the male body.

The type material is deposited in the collection of the Institute of Parasitology, Czechoslovak Academy of Sciences, Prague, under no. 1034. The species is named after Ariana, the historical designation of today's Afghanistan.

10. *Trichocephalus muris* Schrank, 1788

Recovered from the caecum of two specimens of *Alticola argentata* (Severtzov, 1879), Chap Darrah, site "C", on Aug. 17 and 20, 1965.
This species has a cosmopolitan pattern of distribution and parasitizes various rodents.

DISCUSSION

Some interesting conclusions may be drawn from the results presented: 1. No trematodes were found in the hosts examined; 2. although the spectrum of species of the hosts examined and their absolute numbers decrease in higher altitudes, the percentage of invaded hosts increases; 3. the vertical distribution manifests itself also in the species composition of the parasitic worms: cestodes were found concentrated mainly in sites of the highest altitudes inhabited by small mammals; nematodes were concentrated in the middle parts of the valley; 4. the four new taxons found in our material seem to be endemic species.

An outline of natural conditions of the Eastern Hindu Kush and especially of the main working area—the Ishmurkh Darrah may be helpful in finding an explanation of our observations.

The Vakhan region of Afghanistan occupied by the northern part of the Eastern Hindu Kush, belongs climatically to the province of Central-Asiatic deserts (LINCHEVSKY and PROZOROVSKY 1949) and its climatic conditions are associated with those of the mountain systems of central Asia, particularly the Pamir. The main characteristic features of this region are exceptional aridity and a great fluctuation

Table 4. Altitudes in which the parasitic worms were collected

Vertical division of the valley	Species of the hosts	Numbers of hosts examined	Numbers of infected hosts	Number of hosts infected with the individual species												
				Cestoidea						Nematoda						
				Hydatigera taeniaeformis	*Andrya montana*	*Catenotaenia cricetorum*	*Paranoplocephala omphalodes*	*Catenotaenia cricetorum* and *Paranoplocephala omphalodes*	*Catenotaenia cricetorum* and *Andrya montana*	*Citellina hindukushensis* n. sp.	*Cephaluris vakhanica* n. sp.	*Dermatoxys hawliki* n. sp.	*Cephaluris vakhanica* n. sp. and *Dermatoxys hawliki* n. sp.	*Aspiculuris dinniki*	*Aspiculuris arianica* n. sp. and *Citellina hindukushensis* n. sp.	*Trichocephalus muris*
Layer I 2750—3200 m above sea level (Site D) *)	*A. argentata* *A. sylvaticus* *O. roylei* *C. russula*	24 14 1 20	0 1 0 0	— 1 — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —	— — — —
Layer II 3200—3800 m above sea level (Site B, C)	*M. caudata* *O. roylei* *A. argentata*	7 11 15	4 4 8	— — —	— — —	— — —	— — 1	— — —	— — 1	3 — —	— 1 —	— 2 —	— 1 —	— — 4	1 — —	— — 2
Layer III 3800 m and above (Site A)	*A. argentata*	13	4	1	1	1	—	1	—	—	—	—	—	—	—	—

*) Designation of sites the same as in Fig. 5 and on pp. 201, 202.

in temperature. The position of the Eastern Hindu Kush is somewhat exceptional within this wide and strictly continental area (TOLLNER 1964), because the inflow of arid air from the Asian Continent is met by the western flow of air from Europe resulting in snow fall during the cold season. Precipitation in the summer is connected with the Asian summer monsoons. Their south-western wing may reach

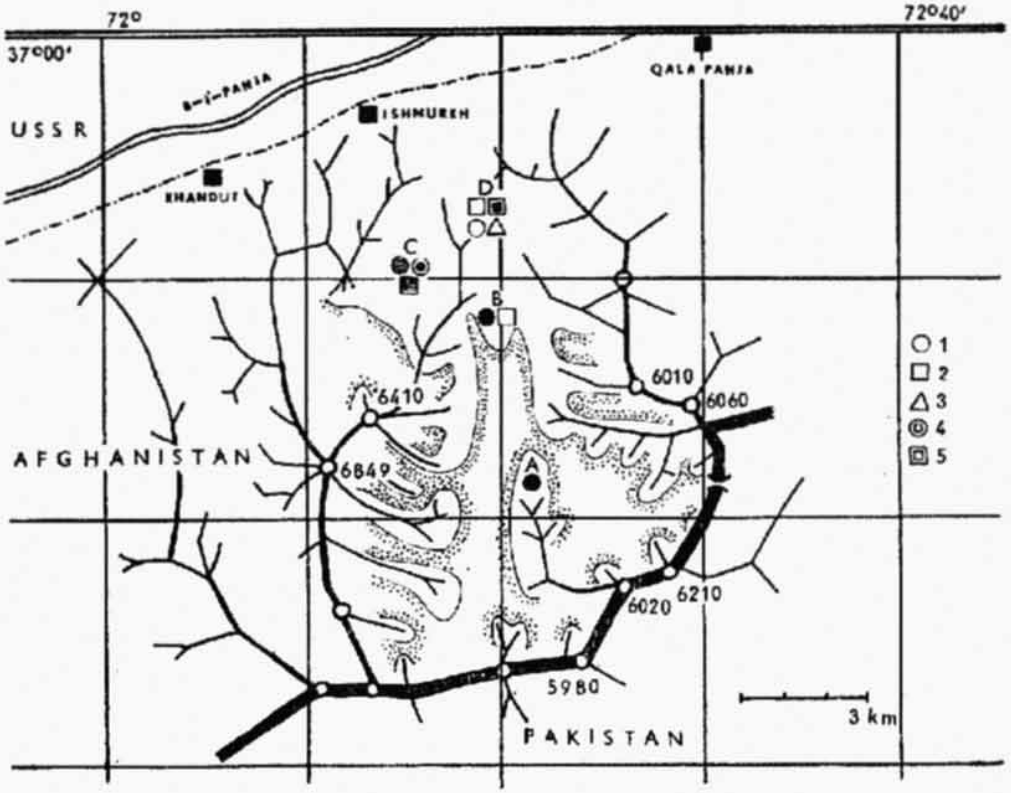

Fig. 5. Schematic demonstration of the Ishmurkh Darrah and Chap Darrah region. Thick lines indicate the course of the mountain ranges, (heights in meters), thin lines and dotted lines the glacial borders. The letters designate the site of collection (see pp. 201, 202). Explanation of the symbols: 1—occurrence of the species *Alticola argentata;* 2—*Ochotona roylei;* 3—*Crocidura russula;* 4—*Marmota caudata;* 5—*Apodemus sylvaticus;* empty symbols—negative results; black symbols—cestodes; dashes—nematodes.

even eastern Afghanistan and cause precipitation in altitudes of 3—4000 mm especially when striking the first mountain crests. The influence of the monsoon being dependent on the geographical longitude, is very different as shown e.g. by MITKIEWICZ 1964.

Vegetation conditions are in agreement with climatic conditions. Geobotanically, the Vakhan region belongs to the Central Asiatic desert province. LINCHEVSKY and PROZOROVSKY (1949) made a vertical division of this province into zones: the zone of the desertic semifruticose formation; the subalpine zone with high mountain steppe and the alpine zone, which grossly resembles the conditions met with in the area under consideration (HADAČ and DANIEL, in press). The Ishmurkh Valley can be divided into 3 zones:

Zone 1 — characterized by a broad, flat and only moderately rising bottom. The slopes are formed by highly eroded walls of conglomerate with very little vegetation

except the sites where the water flows more slowly (see description of site "D"). The steppe character of this area is confirmed by its flora and fauna (e.g. several invertebrate species in our collection etc.).

Zone 2 — at elevations ranging from 3200—3800 m. The valley rises very suddenly. Its walls are higher and steeper and formed of crystallic rock. Beneath the rocky scarp there are large fields of debris which are in continuous movement. The vegetation is restricted to small spots at the sites where the debris avalanche has been stopped by some obstacle. The flora as has the fauna has a transitory character changing ultimately into a mountain-type. Also site "C" in the neighbouring Chap Darrah valley belongs to this zone.

Zone 3 — is formed by part of the valley running upwards from the head of the glacier; this part is of true high mountain character whereby, in some sheltered places, the flora is richer and larger than in the lower zones and this rich vegetation increases in the direction of the main mountain range. This seems to be connected with the amount of precipitation as also suggested by RÖMER (1964). Similarly also the incidence of animals especially insects is greater in such places.

The described natural conditions may help in elucidating the first three items mentioned at the beginning of our discussion. Considering these facts it seems that a combination of the continental semidesert and steppe climate and the high altitudes in zone 1 and 2 together with the high-mountain conditions of zone 3 is not suitable for the development of intermediate hosts of trematodes which were not found in our material. Similarly, the limitation of the incidence of cestodes to the highest zone of the valley suggests that increased precipitation in the summer and consequently a richer vegetation account for the increased occurrence of intermediate hosts on small and isolated areas. Very important is the fact that the cestode species under consideration utilize insects as intermediate hosts. Nematodes (Oxyurata) which are most numerous in our material are the least dependent on conditions of the external environment. All findings were recorded from mountain steppes (site "C") inhabited by relatively dense populations of small mammals (*Alticola*, *Ochotona* and *Marmota*). This site seems to be typical of the occurrence of small mammals by contrast with the intermediary and steppe part of the valley.

Ten species of parasitic worms were recorded from the high mountain area; of these 4 were strictly host specific. These are mainly parasites of pikas and marmots.

Frequent studies of pikas in the palearctic and neoarctic zone revealed a total of 29 parasitic worm species; of these 21 species are specific of the pika. In our material these are the two species *Cephaluris vakhanica* and *Dermatoxys havliki*.

GVOZDEV (1962) on the basis of the results of his own studies and on those obtained by other Soviet writers (SCHULZ 1948, DUBININ and DUBININA 1951, TOKOBAYEV 1959, 1960, MACHULSKIY 1958) listed 15 species of parasites from 5 pika species (*O. alpina*, *O. pallasi*, *O. macrotis*, *O. pricei*, *O. daurica*) which, in his opinion, are systematically closely related to the parasites of North-American pikas

(*O. princeps* and *O. collaris*). The nematodes are members of the genus *Cephaluris*, *Dermatoxys* and *Labiostomum*, the cestodes of the genus *Schizorchis*. This, in GVOZDEV's opinion, confirms the suggestion of zoologists that the pikas came to North America from North-East Asia introducing their parasites to this territory. These changed under the new conditions of the external environment, leading to the origin of new species.

The results of GVOZDEV indicate that, in semisteppes, the parasites of other animals such as e.g. *Trichostrongylus colubriformis*, a parasite of sheep and goat and a facultative parasite of various rodents, *Nematodirus aspinosus*, a parasite of hare, *Syphacia obvelata* and *Moniliformis moniliformis*, a parasite of rodents, are transmitted through contact to the pikas.

AKHTAR (1941, 1947, 1953, 1955, 1956) studying parasites of *Ochotona rufescens* trapped near Kabul and in the Northwestern Hindu Kush, found in them nematodes of the suborder *Oxyurata* (*Dermatoxys*, *Labiostomum*, *Cephaluris*) but no cestodes. Neither did we find any cestodes in our material. *Citellina hindukushensis* and *Aspiculuris arianica* also parasitize the marmot species *Marmota caudata*.

By contrast, the rodent *Alticola argentata* was attacked mainly by cestodes of other small rodents inhabiting also other vegetation zones; in addition the nematode *Aspiculuris dinniki*, a parasite of the mountain zone without a marked host specificity and *Trichocephalus muris*, a common parasite of various rodents, were recovered from this host species.

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