

# Fleas (Siphonaptera) Associated with Mammals in the Mountain Area between the Kuban and Bolshaya Laba Rivers

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**Abstract**—The flea fauna of mammals in the area between the Kuban and Bolshaya Laba Rivers counts 47 species. Most of them parasitize several hosts. The species composition and the structure of flea communities in different altitudinal belts are characterized. The flea *Ctenophthalmus wagneri* and some other flea species with Ancient Mediterranean ranges show the highest dominance indices in the foothills. *Ctenophthalmus proximus* and *Leptopsylla taschenbergi*, possessing ranges of the Caucasian type, prevail in the middle mountain belt. *Megabothris turbidus* and some other boreal species dominate among the species collected in the high mountain belt.

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Earlier, we have analyzed the peculiarities of the fauna and host associations of the Caucasian fleas and determined the main ways of formation of the Caucasian flea fauna (Medvedev and Kotti, 2011, 2012). This communication is devoted to the characteristic of the regional flea fauna occurring on small mammals in a certain part of the Caucasian Isthmus. In particular, it contains the results of analysis of species distribution and their relative abundance in different altitude belts. The term “flea community” is used below to designate all the flea individuals inhabiting the study area (Chernov, 1984).

In the course of our work, we studied the territory of the northern slope of the Greater Caucasus situated between the Kuban valley in the east and the Bolshaya Laba valley in the west. According to the administrative division of Russia, the Kuban–Bolshaya Laba interfluvium belongs to the Karachay-Cherkess Republic. The territory has a diverse relief, with the deep valleys of the Kuban and its left tributaries alternating with sublatitudinal mountain ridges. The presence of isolated valleys conditions a considerable diversity of the species composition of various animal groups (Zamotajlov et al., 2010). Therefore, the study of the fauna in the Kuban and Bolshaya Laba interfluvium is of great interest from the point of view of zoogeographic analysis. The study of the flea fauna of this area is also of great medical significance, since it borders on the

territory of the Central Caucasian alpine natural plague focus, which is one of the most active plague foci.

The flea fauna of the mountain part of the Kuban–Bolshaya Laba interfluvium was studied for the first time during the expeditions headed by I.G. Ioff, who was one of the first researchers of these insects in Russia. Examination of mammals inhabiting the valleys in the upper reaches of the Kuban, Teberda, and Bolshoy Zelenchuk revealed 8 flea species on rodents, carnivores, and bats (Argyropulo, 1935, 1938; Ioff et al., 1946, 1950; Ioff, 1948, 1949). Of these, 3 flea species, namely *Amalaraeus arvicolae* (Ioff, 1948), *Ctenophthalmus chionomydis* Ioff et Rostigayev, 1950, and *Doratopsylla dampfi* Argyropulo, 1935, and also one subspecies, *Ctenophthalmus schuriscus hypanis* Ioff, 1950 (= *C. wagneri hypanis* Ioff, 1950) turned out to be new to science. Subsequently these forms were also found outside this region.

Later, Meladze (1954) and Khrustalev (1962) also studied the flea fauna of this region. They studied parasites of the red squirrel acclimated in the Teberda reserve as early as 1937. Still later, Rostigayev (1967) described a new subspecies *Ctenophthalmus kirschenblatti dombaicus* occurring on rodents and moles from the upper reaches of the Teberda and the Bolshoy Zelenchuk. The first review of the flea fauna of the Kuban–Bolshaya Laba interfluvium was published more

than 40 years ago, as a part of a monograph on the Caucasian flea fauna (Tiflov et al., 1977). By that time, the presence of 43 flea species parasitizing 32 mammal species had been established in the region.

Using our own collection material, we were able to confirm the presence of 33 flea species in the Kuban–Bolshaya Laba interfluve. It should be noted that until recently, the utmost attention has been devoted to the fleas parasitizing rodents, whereas the parasites of insectivores, bats, and carnivores have been less extensively studied. Up till now, there were no data on the fleas of the ermine and the domestic cat, and only fragmentary data on those of the least weasel, the common marten, and the badger. Besides, no attempts were made to characterize the flea fauna of this region as a whole and to consider its peculiarities in connection with vertical zonality and host associations of individual flea species.

#### MATERIALS AND METHODS

Our collections of fleas were carried out within the period between 2009 and 2013. In addition, we identified and analyzed the material collected from 1979 to 2008. In particular, collections of mammal fleas were carried out by the workers of plague control stations and other institutions: S.A. Ashibokova, N.F. Darskaya, G.Ya. Bobyr, A.N. Dobrolyubov, P.F. Emeljanov, B.K. Kotti, E.P. Kudzheva, A.N. Roman, M.A. Tarasov, M.P. Tarasov, K.V. Kharin, and K.Yu. Shkarlet.

At present, research of fleas in the Kuban–Bolshaya Laba interfluve embraces the valleys of the Kuban and its left tributaries, the Daut, Teberda, Aksaut, Bolshoy Zelenchuk, Kyafar, and Bolshaya Laba, mainly in those places where they cross the Bokovoi, Peredovoi, Skalistyi, and Pastbishchnyi Ranges.

Our flea collections were carried out at altitudes of 700 to 2700 m above sea level (a.s.l.). The main type of vegetation in the foothills below 1000 m a.s.l. is meadow-like steppes; broad-leaved and coniferous forests are typical of the medium mountain belt at 1000–2000 m a.s.l.; subalpine and alpine meadows are typical of the high mountain areas above 2000 m a.s.l.

Fleas were collected by us in different seasons. In total, over 1400 ind. of 20 species of rodents, carnivores, and insectivores were collected and examined. Besides, fleas in 395 nests of the common and Major's pine voles were studied. Altogether, 4500 flea specimens belonging to 33 species were studied by us.

Quantitative indices of the relative frequency of occurrence were calculated for mass flea species: the index of abundance (IA) and the index of dominance (ID, %) (Balashov, 2000). The names of the mammal species are given below according to Pavlinov and Lisovsky (2012).

#### *The Flea Hosts in the Kuban–Bolshaya Laba Interfluve*

The mammal fauna of the Kuban–Bolshaya Laba interfluve comprises 71 species, which is over a half of the total number of the mammal species known in the Caucasus.

The Caucasian mole *Talpa caucasica* and the blind mole *T. levantis* Satunin are widely distributed in the interfluve area. Of carnivores, there are the wolf *Canis lupus* L., the red fox *Vulpes vulpes* (L.), the brown bear *Ursus arctos* L., the common marten *Martes martes* (L.), the stone marten *M. foina* (Erxleben), the least weasel *Mustela nivalis* L., and the European badger *Meles meles* (L.). In addition, the ermine *Mustela erminea* L. occurs in the middle and high mountain belts. The northern white-breasted hedgehog *Eri-naceus roumanicus* Barrett-Hamilton and a number of bat species are typical of the foothill and middle mountain regions. Among bats, the great horseshoe bat *Rhinolophus ferrumequinum* Schreb., the common noctule *Nyctalus noctula* (Schreber), the parti-colored bat *Vespertilio murinus* L., the lesser mouse-eared bat *Myotis blythii* (Tomes), and the whiskered bat *M. mystacinus* (Kuhl) should be mentioned.

According to the trap capture data, the core of the small mammal population in the foothills is formed by the common vole *Microtus arvalis* (Pall.). The pygmy wood mouse *Sylvaemus uralensis* (Pall.) is also common there, whereas the striped field mouse *Apodemus agrarius* (Pall.), the house mouse *Mus musculus* L., the European water vole *Arvicola amphibius* L., and shrews of the genus *Sorex* L. are rarely recorded.

The dominant small mammal species in the middle mountain zone is the pygmy wood mouse, whereas the common species are Major's pine vole *Terricola majori* Thomas and 3 species of shrews, in particular the Caucasian pygmy shrew *Sorex volnuchini* Ognev, the Caucasian shrew *S. satunini* Ognev, and Radde's shrew *S. raddei* Satunin. Also characteristic of the middle mountain belt are the red squirrel *Sciurus vulgaris* L., the tree dormouse *Dryomys nitedula* (Pall.), the edible dormouse *Glis glis* (L.), and the Transcaucasian water shrew *Neomys teres* Miller.

In the subalpine and alpine altitude belts, Major's pine vole is the most abundant while the pygmy wood mouse and the Caucasian snow vole *Chionomys gud* (Satunin) are common. The insectivores are represented there by the brown-toothed shrews.

*The Species List and Range Types of Fleas in the Kuban–Bolshaya Laba Interfluve*

The list of species of different flea families represented in the mountain part of the Kuban–Bolshaya Laba interfluve is given below. The species recorded by us in this territory are marked with asterisks.

(1) Family Pulicidae Billberg, 1820 is represented by 4 species in this region: *Pulex irritans* L., 1758, *Archaeopsylla e. erinacei* (Bouche, 1835), *Ctenocephalides f. felis* (Bouche, 1835)\*, and *C. canis* (Curtis, 1826).

(2) Family Vermipsyllidae Wagner, 1889: 6 species: *Chaetopsylla (Arctopsylla) hyaenae* (Kol., 1846), *C. (Chaetopsylla) h. homoea* R., 1906, *C. (C.) t. trichosa* Kohaut, 1903\*, *C. (C.) caucasica* Smit, 1953, *C. (C.) r. rothschildi* Kohaut, 1903, and *C. (Achaetopsylla) mirabilis* Ioff et Argyropulo, 1934.

(3) Family Ceratophyllidae Dampf, 1908: 9 species: *Tarsopsylla o. octodecimdentata* (Kol., 1863), *Myoxopsylla (Miriampsylla) jordani* Ioff et Argyropulo, 1934, *Paraceras melis* (Walker, 1856), *Nosopsyllus (N.) consimilis* (Wagn., 1898), *Callopsylla (C.) caspia* (Ioff et Argyropulo, 1934), *Amalaraeus arvicolae* (Ioff, 1948), *A. improvisus* (Ioff, 1946)\*, *Megabothris (Gebrella) turbidus* (R., 1909), and *Ceratophyllus (Monopsyllus) s. sciurorum* (Schränk, 1803).

(4) Family Leptopsyllidae Rothschild, 1915: 6 species: *Frontopsylla (F.) c. caucasica* Ioff et Argyropulo, 1934, *Paradoxopsyllus h. hesperius* Ioff, 1946, *Amphipsylla rossica* Wagn., 1912, *Peromyscopsylla b. bidentata* (Kol., 1863), *Leptopsylla (L.) t. taschenbergi* (Wagn., 1898), and *L. (L.) segnis* (Schöncherr, 1811).

(5) Family Ischnopsyllidae Tiraboschi, 1904: 7 species: *Ischnopsyllus (I.) obscurus* (Wagn., 1898), *I. (I.) elongatus* (Curt., 1832), *I. (I.) intermedius* (R., 1898), *I. (I.) variabilis* (Wagn., 1898), *I. (I.) dolosus* Dampf, 1912, *Nycteridopsylla (N.) eusarca* Dampf, 1908, and *Rhinolophopsylla u. unipectinata* (Tasch., 1880).

(6) Family Hystrichopsyllidae Tiraboschi, 1904: 15 species: *Ctenophthalmus (C.) proximus* (Wagn.,

1903), *C. (Medioctenophthalmus) kirschenblatti* Argyropulo, 1936, *C. (M.) golovi* Ioff et Tiflov, 1930, *C. (M.) chionomydis* Ioff et Rostigayev, 1950, *C. (Euctenophthalmus) parvus* Argyropulo, 1935, *C. (E.) w. wagneri* Tiflov, 1928, *C. (E.) schuriscus* Ioff, 1940, *Palaeopsylla gromovi* Argyropulo, 1934, *P. alpestris* Argyropulo, 1946, *Doratopsylla dampfi* Argyropulo, 1935, *Rhadinopsylla (Actenophthalmus) caucasica* Argyropulo, 1946, *Paraneopsylla dampfi* Ioff, 1946\*, *Hystrichopsylla (H.) talpae* Curt., 1826, *H. (Hystricercas) satunini* Wagn., 1916, and *Atyphlocercas nupe-rum palinum* (J., 1931).

Thus, 47 flea species from 6 families occurring on mammals are presently known in the Kuban–Bolshaya Laba interfluve. Of these, 4 species were found for the first time during our research.

The ranges of mammal fleas inhabiting the study region may be divided into several groups. In particular, we distinguished 4 zoogeographic complexes of flea species (Kotova, 2013). The fleas introduced as the result of human activity were excluded from our analysis. These are, in particular, the cat flea *Ctenocephalides felis*, the dog flea *C. canis*, and also *Tarsopsylla octodecimdentata* and *Leptopsylla segnis*.

(1) The Boreal zoogeographic complex includes 16 flea species distributed in the northern part of Eurasia.

(2) The Ancient Mediterranean zoogeographic complex is represented by 10 flea species whose ranges embrace some part of the territory of South Europe, North Africa, and Western and Central Asia.

(3) The Caucasian zoogeographic complex includes 15 flea species endemic to the Caucasus. The ranges of a number of flea species recorded in the Kuban–Bolshaya Laba interfluve also embrace some territories adjoining the Caucasus. We consider such species as subendemic to the region in question.

(4) Species with broad ranges, which are also distributed outside the Holarctic. Only 2 species present in the Kuban–Bolshaya Laba interfluve have such ranges.

*Host Associations of Flea Species in the Kuban–Bolshaya Laba Interfluve*

(1) The parasites of insectivores. In the studied territory, the fleas *Doratopsylla dampfi* and *Palaeopsylla gromovi* parasitize various species of brown-toothed

**Table 1.** Fleas of small mammals in the high mountain belt of the Kuban–Bolshaya Laba interfluvial area

Flea species	Number of hosts examined						
	Total	Caucasian shrew	Radde's shrew	Major's pine vole	Common shrew	Caucasian snow vole	Pygmy wood mouse
	459	19	8	281	7	64	80
	Number of flea specimens						
<i>Amalaraeus improvisus</i>	14			6		8	
<i>Megabothris turbidus</i>	82			50	2	12	18
<i>Frontopsylla caucasica</i>	16			16			
<i>Paradoxopsyllus hesperius</i>	8					8	
<i>Amphipsylla rossica</i>	72			72			
<i>Leptopsylla taschenbergi</i>	45			6		1	38
<i>Ctenophthalmus proximus</i>	11			3			8
<i>C. kirschenblatti</i>	4			3			1
<i>C. golovi</i>	2			2			
<i>C. chionomydis</i>	7					7	
<i>C. schuriscus</i>	35		1	20		7	7
<i>C. wagneri</i>	34			24	1	9	
<i>Palaeopsylla gromovi</i>	4	1		3			
<i>Doratopsylla dampfi</i>	36	26	10				
<i>Rhadinopsylla caucasica</i>	1			1			
<i>Paraneopsylla dampfi</i>	5					4	
<i>Hystrichopsylla talpae</i>	25		3	15	2	5	
<i>H. satunini</i>	2			2			1
Total	403	27	14	223	5	61	73

shrews, and also the Transcaucasian water shrew. The flea *P. alpestris*, and also such species as *Hystrichopsylla satunini* and *H. talpae* were found on the Caucasian and blind moles. The two latter species also parasitize the Major's pine vole. It should be noted that the hedgehog parasite *Archaeopsylla erinacei* (Bouche, 1835) is also likely to be found in this territory. This flea is widely distributed in Europe, the Caucasus, and Southwest Asia; it may therefore be preliminarily included in the list of flea species of the Kuban–Bolshaya Laba interfluvial area.

(2) The parasites of carnivores. The fleas *Pulex irritans* and *Chaetopsylla trichosa* are parasites of canids. The flea *Ctenocephalides canis* was also found on the domestic dog. The feline parasites are represented by one species, *C. felis*, which was found by us for the first time on the domestic cat in the town of Ust-

Dzheguta and the aul (village) Zeyuko (Adyge-Khabl District). We also obtained data on the ermine fleas for the first time. According to our material, the ermine is parasitized by the flea *Chaetopsylla homoea* in the Caucasus, whereas in other parts of its range this flea occurs on the least weasel. Data on the badger parasites were also obtained for the first time. The fleas *Chaetopsylla trichosa* and *Paraceras melis* were found during examination of the captured badgers and the substrate collected near the entrance to their burrows. Both these species are known as specific ectoparasites of the badger. In addition, we collected parasites of the stone marten, namely *Chaetopsylla mirabilis*, *C. rothschildi*, and *C. caucasica*. We have found that the same flea species also parasitize the common marten. The parasite of the brown bear in the study region is the flea *C. hyaenae*.

**Table 2.** Fleas of small mammals in the foothills of the Kuban–Bolshaya Laba interfluvial area

Flea species	Number of hosts examined						
	Total	Longtailed shrews	Common vole	Water vole	Pygmy wood mouse	Field mouse	House mouse
	223	10	195	1	14	3	1
	Number of flea specimens						
<i>Nosopsyllus consimilis</i>	14		12		2		
<i>Megabothris turbidus</i>	50		46	3		1	
<i>Ceratophyllus borealis</i>	1		1				
<i>Amphipsylla rossica</i>	1		1				
<i>Ctenophthalmus proximus</i>	10	1	4		5		
<i>C. parvus</i>	6		6				
<i>C. wagneri</i>	206		202	2		2	
<i>P. gromovi</i>	11	11					
Total	299	12	272	5	7	3	0

Examination of carnivores also revealed a great number of fleas which are rodent parasites. For instance, transition of these fleas to small mustelids takes place not only during feeding on rodents but also as the result of mustelids using the rodent burrows and nests. According to our data, the number of rodent parasites found on carnivores was 1.5 times that of the fleas that are their specific parasites.

(3) The parasites of bats. Data on the fleas infesting bats in the Caucasus were obtained more than 30 years ago (Labunets and Degtyareva, 1985) during examination of bats from caves in the environs of Vazhny, Teberda, and Pregradnaya. The cited authors found the fleas *Ischnopsyllus (I.) obscurus* (Wagn., 1898) and *I. (I.) intermedius* (R., 1898), which are specific parasites of the parti-colored bat; *I. (I.) elongatus* (Curtis, 1832), a parasite of the common noctule; *I. (I.) dolosus* Dampf, 1912, a parasite of the lesser mouse-eared and whiskered bats; *I. (I.) variabilis* (Wagner, 1898), a parasite of the common pipistrelle; *Nycteridopsylla (N.) eusarca* Dampf 1908 and *Rhinolophopsylla unipectinata* (Taschenberg, 1880), parasites of the common noctule. Bats were not included in our collections. Thus, to date, 8 flea species of the family Ischnopsyllidae infesting bats are known in the Kuban–Bolshaya Laba interfluvial area.

(4) The parasites of rodents. Altogether, 25 flea species were found on rodents. The parasites of the Major's pine vole and the common vole are *Ctenophthalmus wagneri* and *C. schuriscus*, and also

*Megabothris turbidus* and *Amphipsylla rossica*. The flea *Amalaraeus arvicolae* parasitizes the European water vole (Ioff, 1948). According to our data, the Caucasian snow vole is the main host of *Callopsylla caspia*, *Paradoxopsyllus hesperius*, *Ctenophthalmus chionomydis*, and *Paraneopsylla dampfi*. A number of other fleas which are parasites of other vole species were also recorded on this host. In our material, *Myoxopsylla jordani* and *Ceratophyllus sciurorum* were found on the forest and edible dormice, and *C. sciurorum* and *Tarsopsylla octodecimdentata*, on the red squirrel. The main parasites of the pygmy wood mouse, widely distributed in the study region, are the fleas *Leptopsylla taschenbergi*, *Ctenophthalmus proximus*, and *Megabothris turbidus*, and also a number of other flea species associated with this host as well as with voles.

#### *The Structure of the Flea Population Associated with Small Mammals in the Kuban–Bolshaya Laba Interfluvial Area*

Judging by the literary and collection data and our own material, 9 flea species have been recorded so far in the foothill belt in the territory of the Kuban–Bolshaya Laba interfluvial area. The known faunas of the middle and high mountain belts include 18 flea species each (Tables 1–3). The Jaccard coefficient of similarity between the foothill and middle mountain faunas, and also that between the foothill and high mountain faunas is 0.4; that between the middle and high moun-

**Table 3.** Fleas of small mammals in the middle mountain belt of the Kuban–Bolshaya Laba interfluve area

Flea species	Number of hosts examined <sup>1</sup>											
	Total	Radde's shrew	Caucasian shrew	Caucasian pygmy shrew	Transcaucasian water shrew	Edible dormouse	Forest dormouse	Kluchor birch mouse	Major's pine vole	Common vole	Caucasian snow vole	Pygmy wood mouse
	734	22	28	20	4	1	2	1	127	11	107	411
	Number of flea specimens											
<i>Callopsylla caspia</i>	4										4	
<i>Megabothris turbidus</i>	60								22	7	7	24
<i>Ceratophyllus sciurorum</i>	21					11	10					
<i>Frontopsylla caucasica</i>	1								1			
<i>Paradoxopsyllus hesperius</i>	2										2	
<i>Amphipsylla rossica</i>	20								4		1	15
<i>Leptopsylla taschenbergi</i>	105		1						1		17	86
<i>Peromyscopsylla bidentata</i>	1								1			
<i>Ctenophthalmus proximus</i>	126								9	6	8	103
<i>C. chionomydis</i>	17									1	16	
<i>C. schuriscus</i>	30								23		1	6
<i>C. parvus</i>	6								6			
<i>C. wagneri</i>	26			1					7	7	10	1
<i>Palaeopsylla gromovi</i>	18	2	8	1	2				5			
<i>P. alpestris</i>	25	15	3	4	3							
<i>Doratopsylla dampfi</i>	47	9	14	6	5			1			3	9
<i>Rhadinopsylla caucasica</i>	22										20	2
<i>Hystrihopsylla talpae</i>	10								3		6	1
Total	541	26	26	12	10	11	10	1	82	21	95	247

Note: No fleas were found on the examined water vole and weasel (one specimen each).

tain faunas is somewhat higher, 0.6. Considerable differences in the species composition of fleas parasitizing small mammals in these three altitude belts have been established.

(1) In the Boreal zoogeographic complex the dominant species are *Hystrihopsylla talpae*, *Ceratophyllus sciurorum*, *Megabothris turbidus*, *Amphipsylla rossica*, and *Peromyscopsylla bidentata*. These species form the most abundant group in the high mountains, with an ID of 44.4%. The fraction of *Megabothris turbidus* was especially great in collections, due to the high abundance of their hosts in the high mountains (Table 1).

(2) The Ancient Mediterranean complex is characterized by such species as *Nosopsyllus consimilis*,

*Callopsylla caspia*, *Leptopsylla taschenbergi*, *Ctenophthalmus golovi*, *C. wagneri*, *Frontopsylla caucasica*, and *Paradoxopsyllus hesperius*. Fleas of this group occupy the first place in the population of fleas associated with small mammals in the foothills (ID 73.8%). The dominant species in this group is *Ctenophthalmus wagneri* (Table 2).

(3) As pointed out above, a special group of Caucasian endemics and subendemics can be distinguished among flea species inhabiting the Kuban–Bolshaya Laba interfluve. This group includes, in particular, *Amalaraeus improvisus*, *Ctenophthalmus proximus*, *C. chionomydis*, *C. kirschenblatti*, *C. schuriscus*, *C. parvus*, *Palaeopsylla gromovi*, *P. alpestris*, *Doratopsylla dampfi*, *Rhadinopsylla caucasica*, *Paraneop-*

*sylla dampfi*, and *Hystrichopsylla satunini*. Species of this complex occupy the first place in the flea population of the middle mountain belt (ID 53.9%). The prevalent species among them is *Ctenophthalmus proximus* (Table 3).

### CONCLUSION

Among 47 species of fleas parasitizing mammals in the Kuban–Bolshaya Laba interfluvium, local endemic species are absent. However, a number of Caucasian endemics are represented there. For example, the range of *Ctenophthalmus parvus* embraces the western part of the Great Caucasus, whereas the ranges of *Chaetopsylla caucasica* and *Amalaraeus improvisus* embrace the West and Central Caucasus. The ranges of other species are wider. The genera, including *Archaeopsylla erinacei*, *Atyphloceras nuperum*, *Hystrichopsylla satunini*, and *Doratopsylla dampfi* have disjunct European–Far Eastern ranges. These fleas mainly parasitize the inhabitants of the forest altitude belt. It should be noted that these fleas occur on hosts from different species and genera in different parts of their ranges. The broad host associations of these flea species testify to the existence of a broad forest zone in the South Palaearctic in the past (Matyushkin, 1976), when the ranges of the genera *Archaeopsylla*, *Atyphloceras*, *Hystrichopsylla*, and *Doratopsylla* were continuous.

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