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# Anoplura (Lice) of small mammals in the South Trans-Urals

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**Abstract.** For this the research, 2035 individuals of small mammals of 18 species were examined in order to find out the presence of obligate hematophages (Anoplura); from those 984 lice of 5 species were collected. The species composition of Anoplura, the indices of occurrence, infestation and the abundance of Anoplura on the Insectivora and Rodentia were analyzed. There have been noted repeated cases of Anoplura parasitizing the mammals unusual for them, which reflects interspecific contacts of small mammals. The features of the biotopic confinement of the parasite were considered.

## 1. Introduction

Kurgan oblast extends from north to south for about 290 km, from west to east for about 430 km [1]. In the west, the region shares borders with the Chelyabinsk oblast, in the northwest it borders on the Sverdlovsk oblast, in the northeast on the Tyumen oblast, in the south it borders on the Kostanay and North Kazakhstan Regions of the Republic of Kazakhstan. The territory of the oblast is a flat plain with a slight slope from the southwest to the northeast, dissected by a hydrographic network into several weakly drained interfluves. The relief is complicated by shallow saucer-like depressions, lacustrine and marsh basins, and small ridges. Kurgan oblast is located in the southwestern part of Western Siberia; for the most part it is embraced by the boundaries of the forest-steppe biogeographical region [2]. The vegetation cover is represented by a complex of meadow, poaceae-forb meadow steppes and steppe meadows in combination with small-leaved forests (birch, aspen-birch and aspen) in peg-shaped depressions on elevated relief.

Among the animals of the Southern Trans-Urals (Kurgan oblast) small mammals are particularly interesting as their role in biocenoses and human economic activity is quite significant. Particular importance of these animals (murine rodents and shrews) is due to the fact that they serve as the hosts of many blood-sucking parasitic arthropods, which are carriers of various natural focal infections.

By now, there has been a sufficient number of papers dedicated the study of temporary blood-sucking arthropods: fleas, gamasid mites and ixodid ticks in the Kurgan oblast [3-9]. The research of persistent parasites (Anoplura) was not systemic though. Nevertheless, there are some papers by V.P. Starikov et al. [10], where they established the species composition of rodent Anoplura in the Kurgan oblast (*Hoplopleura edentula*, *H. acanthopus*, *H. longula*, *Polyplax ellobii*, *Neohaematopinus laeviusculus*) and considered the ecology of ectoparasites of the common mole vole, including Anoplura [10]. This group of obligate hematophages, due to constant bloodsucking, can provide long-term circulation of pathogens in populations of murine rodents. So, Anoplura are carriers of rickettsia, causing typhus [12], borrelia, causing relapsing fever [13], listeria, causing listeriosis [14] and others. More or less, these diseases are also found on the territory of the Southern Trans-Urals [15].

## 2. Materials and methods

The study of Anoplura infestation in small mammals was carried out from the beginning of May to the end of August 2020 on the territory of the Kurgan oblast in the Pritobolny, Ketovsky and Belozersky districts. There were 984 lice of 5 species. The animals were captured by using the methods of trapping grooves and trap lines [16-17]. In the course of this research, small mammals caught by other trapping



methods (mole traps, traps) were not considered. Russian and Latin names of small mammal species are given according to A.A. Lisovsky et al. [18].

Upon the Anoplura collection from small mammals, we followed the recommendations of E.F.Sosnina, M.V. Tikhvinskaya [19]. Permanent preparations were made from ectoparasites and fixed with Fora-Berlise solution without clarification [20-21].

The qualifiers of D.I. Blagoveshchensky [22], J.C. Beaucurnu [23] and V.N. Zarubina [24] were used to determine the Anoplura species. Latin names of species are given according to L. Durden and G. G. Musser [25]. As the ecological terms applied to parasites have not been established [26], in this paper, following Yu.S. Balashov we name the population of species from the host as macro-community (component community). In accordance with the norms adopted in faunistic studies, we divided the hosts of parasites into main, additional, and accidental.

For the analysis, we used the indices generally accepted in parasitology: the occurrence index - OI, %, the abundance index - AI, specimen; and the infestation intensity of animals with ectoparasites - II, specimen [27]

The statistical significance of the values of the occurrence index was examined according to the formula proposed by K.P. Fedorov [28]:

$$t_{dif} = \frac{P_1 - P_2}{\sqrt{M_{p_1}^2 + M_{p_2}^2}}; M_P = \sqrt{\frac{P(100-P)}{n}} \quad (1)$$

$P_1$  and  $P_2$  – comparable occurrence indices, %;

$M_{p_1}$ ,  $M_{p_2}$  – their errors;  $n$  – number of the examined animals.

The reliability criterion of differences in the abundance index was determined by the formula proposed by P.V. Terentyev and N.S. Rostova [29]:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{F}; F = \sqrt{\frac{S_1^2(n-1) + S_2^2(n-1)}{n_1 + n_2 - 2}} \sqrt{\frac{n_1 + n_2}{n_1 n_2}} \quad (2)$$

$X_1$ ,  $X_2$  – comparable abundance indices;

$S_1^2$ ,  $S_2^2$  – their standard deviations;

$n_1$ ,  $n_2$  – sizes of compared samples.

### 3. Results and discussion

In the South Trans-Urals, 27 species of small mammals (murine rodents and insectivores) can be found [30]. The population of this group of animals is represented by typically forest, moisture-loving species and open spaces species. We studied 2035 animals of 18 species: the common shrew *Sorex araneus* Linnaeus, 1758; the tundra shrew *S. tundrensis* Merriam, 1900; Laxmann's shrew *S. caecutiens* Laxmann, 1788; the Eurasian pygmy shrew *S. minutus* Linnaeus, 1766; the Eurasian least shrew *S. minutissimus* Zimmermann, 1780; the Eurasian water shrew *N. fodiens* Pennant, 1771; the northern birch mouse *Sicista betulina* Pallas, 1779; the bank vole *Myodes glareolus* Schreber, 1780; the northern red-backed vole *M. rutilus* Pallas, 1779; the narrow-headed vole *Lasiopodomys gregalis* Pallas, 1779; the short-tailed vole *Agricola agrestis* Linnaeus, 1761; the root vole *Alexandromys oeconomicus* Pallas, 1776; the common vole *Microtus arvalis* Pallas, 1778; the harvest mouse *Micromys minutus* Pallas, 1771; the striped field mouse *Apodemus agrarius* Pallas, 1771; the herb wood mouse *Sylvaemus uralensis* Pallas, 1811; the house mouse *Mus musculus* Linnaeus, 1758; the brown rat *Rattus norvegicus* Berkenhout, 1769. Common and pygmy shrews (*S. araneus*, *S. minutus* L) predominated among insectivores; rodents were dominated by the northern red-backed vole *M. rutilus* and the root vole *A. oeconomicus*, as well as the herb wood mouse *S. uralensis* and the harvest mouse *M. minutus*.

From all examined animals, we have noted 5 Anoplura species parasitizing in 12 species (66.6%): *Hoplopleura acanthopus* Burmeister, 1839, *H. edentula* Fahrenholz, 1916, *H. longula* Neumann, 1909, *H. affinis* Burmeister, 1839 and *Polyplax spinigera* Burmeister, 1839. The *H. affinis* (fig. 1) is most widely represented; it was found in 6 out of 18 species of small mammals; and it accounted for more than 50.1% of all recorded Anoplura. In turn, representatives of this species parasitized most of all on the herb wood mouse (81.6%); the highest rates of Anoplura infestation were in the striped field mouse

(Table 1). This type of louse is specific to the representatives of mice of the *Apodemus* and *Sylvaemus* genera.



Figure 1. ♂ *Hoplopleura affinis* Burmeister, 1839

Table 1.

Anoplura of small mammals in the South Trans-Urals (2020)					Infestation indices <sup>a</sup>		
Host type	Number of the examined mammals	Number of mammals infested	Number of Anoplura collected	Species of Anoplura	Occurrence index, %	Infestation index specimen.	Abundance index, specimen.
<i>S. araneus</i>	340	2	2	<i>H. affinis</i>	0.59	1.00	0.006
<i>S. tundrensis</i>	55	1	1	<i>H. affinis</i>	1.82	1.00	0.018
<i>S. caecutiens</i>	80	—	—	—	—	—	—
<i>S. minutus</i>	91	2	2	<i>H. affinis</i>	2.20	1.00	0.022
<i>S. minutissimus</i>	1	—	—	—	—	—	—
<i>N. fodiens</i>	34	—	—	—	—	—	—
<i>S. betulina</i>	89	1	1	<i>H. affinis</i>	1.12	1.00	0.011
		1	1	<i>H. acanthopus</i>	1.12	1.00	0.011
<i>M. glareolus</i>	17	—	—	—	—	—	—
<i>M. rutilus</i>	241	28	174	<i>H. edentula</i>	11.62	6.21	0.722
<i>L. gregalis</i>	114	6	12	<i>H. acanthopus</i>	5.26	2.00	0.105
<i>A. agrestis</i>	167	—	—	—	—	—	—
<i>A. oeconomus</i>	190	12	122	<i>H. acanthopus</i>	6.32	10.17	0.642
<i>M. arvalis</i>	91	4	14	<i>H. acanthopus</i>	4.40	3.50	0.154
<i>M. minutus</i>	82	8	76	<i>H. longula</i>	9.76	9.50	0.927
<i>A. agrarius</i>	15	3	90	<i>H. affinis</i>	20.00	30.00	6.000
<i>S. uralensis</i>	408	28	407	<i>H. affinis</i>	6.86	14.54	1.000
<i>M. musculus</i>	17	—	—	—	—	—	—
<i>R. norvegicus</i>	3	2	80	<i>P. spinulosa</i>	66.67	40.00	26.667

<sup>a</sup> Occurrence index is the number of individuals infected expressed as a percentage of the examined ones. Infestation index is the intensity of ectoparasitic infestation of mammals. Abundance index is the average number of the parasites per one mammal examined.

*H. acanthopus* is parasite in various hosts; their main hosts are voles [21; 24]. We found that the most number of these parasites was in *A. oeconomus*. Researching Anoplura from different regions of the Soviet Union in bank, red-backed, and grey red-backed voles showed that the *H. edentula* is common

for all the indicated representatives of the genus *Clethrionomys* (Myodes) [31]. *H. edentula* is a parasite of red-backed voles. *H. longula* is a parasite of the harvest mouse. *P. spinulosa* is a parasite of the genus *Rattus*.

Parasitizing of *H. edentula* on *M. glareolus* (according to our data) has been noted in the previous Southern Trans-Urals research papers. In 2020, no records on the species were found. Parasitizing of this obligate hemophagous on *Clethrionomys glareolus* for the European Russia was described by in the works of Yu.S. Balashov [32-33] et al. It is probably due to undersampling for the given host species in 2020, as well as for *M. musculus*, for which we have not found any evidence of parasitism of its specific species – *H. captiosa*. It was confirmed by E.F. Sosnina [34]. According to her data, *Mus musculus* was also characterized by low invasion. Perhaps, this is characteristic of it, as well as for some other Rodentia.

Occasional Anoplura were found rarely on *Sicista betulina* – *H. affinis* and *H. acanthopus*. Very low infestation by Anoplura is common for Insectivora as well. Parasitizing of specific Anoplura species, representatives of the genera *Sylvaemus* and *Apodemus*, was registered for *Sorex araneus*, *Sorex arcticus* and *Sorex minutus*. The data obtained are likely to be due to peculiarities of this group of animals' activity. So, for instance, they do not have their own permanent holes; they lead mobile mode of life, often visit holes and nests of Rodentia and consume their corpses. It is fair to assume that, the collected individuals had contacts with *A. agrarius* or with *S. uralensis*. Other representatives of Insectivora, such as *S. caecutiens*, *S. minutissimus* and *N. fodiens*, probably interacted less or had no interactions at all with infested individuals of small mammals (table 1).

Anoplura is marked by high parasite-host specificity. It can be due to nonseparable evolution course of a parasite and its host. Parasite Species that live on members of the same genus or host family are descendants of the same ancestor [35-36].

Table 2.

The distribution of Anoplura of small mammals in different types of biotopes in the Southern Trans-Urals (2020)

Type of biotope	Number of mammals examined	Number of mammals infested	Number of Anoplura collected	Species of Anoplura	Infestation measures		
					frequency index, %	infestation index, specimen.	abundance index, specimen.
forest	520	8	55	<i>H. edentula</i>	1.54	6.88	0.106
		1	1	<i>H. acanthopus</i>	0.19	1.00	0.002
		8	48	<i>H. affinis</i>	1.54	6.00	0.092
moist thickets	1032	16	112	<i>H. edentula</i>	1.55	7.00	0.109
		8	86	<i>H. acanthopus</i>	0.78	10.75	0.083
		9	21	<i>H. longula</i>	0.87	2.33	0.020
		22	409	<i>H. affinis</i>	2.13	18.59	0.396
open biotopes	390	1	1	<i>H. edentula</i>	0.26	1.00	0.003
		14	62	<i>H. acanthopus</i>	3.59	4.43	0.159
		3	59	<i>H. longula</i>	0.77	19.67	0.151
		3	42	<i>H. affinis</i>	0.77	14.00	0.108
buildings	93	3	6	<i>H. edentula</i>	3.23	2.00	0.065
		2	74	<i>P. spinulosa</i>	2.15	37.00	0.796

E. F. Sosnina [34] claimed that such a group of parasitic arthropods as Anoplura is characteristic of rodents. They predominate in parasitological collections. This is due to the biology of this group. One of the main features can be noted that they are permanent blood-sucking parasitic arthropods. They do

not leave the host body for a long time, as they are not able to exist independently [37]. Another significant reason is their quite short development of new generations. This takes several days. There are several dozen offspring per female, so in favourable seasons, researchers note the maximum number of Anoplura on some individuals – about 100 or more. In our collections, the maximum infestation was found for *R. norvegicus* – 80 specimens; *A. oeconomus* – 73 specimens; *S. uralensis* – 68 and 67 specimens; *Apodemus agrarius* – 58 and *M. minutus* – 44 specimens. These values may indicate that many host species have highly infected individuals, which can serve for dispersal to other host individuals.

We merged relatively close biotopes (a total of 29 surveyed) into the types. The greatest number and species diversity of hosts was found in moist thickets, forests and open biotopes, where the largest number of Anoplura species was found. *P. spinulosa* is a specific louse of *Rattus norvegicus*, a synanthropic rodent; therefore it is noted only for "buildings". Table 2 materials indicate that the connection between the parasite and the host is inextricable, since this group of obligate hematophagous is permanent parasites of a certain species or genus of animals, and the occurrence of the parasite is closely related to their confinement to a particular type of biotope.

#### 4. Conclusion

Anoplura parasitism is detected for 77.8% small mammal species. The greatest species diversity and abundance index are characteristic of mouse-like rodents that lead a more colonial lifestyle. Reproduction of all registered obligate hematophagous is observed throughout the study period (Mature eggs and larvae of different stages on the hair cover are frequent findings). The most numerous are representatives of the species *H. affinis*. The index of dominance of these insects is 50.1%. The main hosts are *A. agrarius* и *S. uralensis*, while the occasional hosts are *S. araneus*, *S. tundrensis*, *S. minutus* and *S. betulina*.

The second largest contributor to the taxocenosis is the specific wood mouse louse, *H. edentula*. It is found exclusively on its typical *M. rutilus*. Maximum indexes of abundance and infestation are present in the characteristic biotopes: forest and moist thickets.

*H. acanthopus* can be considered as the third widespread species. This species is relatively specific and is found on a fairly wide range of hosts. According to our data on *A. oeconomus*, *M. arvalis*, *L. gregalis* and *S. betulina*.

The fourth species is *H. longula*. Its main and only host is *M. minutus*

The final species is *P. spinulosa*, which main and only host is *R. norvegicus*.

Anoplura co-parasitization was not detected. Only for *S. betulina* parasitization of two species was noted. The macro community is represented by *H. acanthopus* and *H. affinis*. The highest indexes of Anoplura abundance are characteristic of "moist thickets", possibly affected by climate factors in 2020, when the average monthly temperatures exceeded those in 2019 0.3-2.6°C.

The conducted research enables to supplement the faunal composition of Anoplura of small mammals in the Southern Trans-Urals with two species: *P. spinulosa* and *H. affinis*.

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