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Shrews of the Nadym River Basin (North of Western Siberia)

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Abstract—The habitation of four species of shrews—*Sorex tundrensis* Merriam, 1990, *S. caecutiens* Laxmann, 1788; *S. minutissimus* Zimmermann, 1780; and *S. minutus* Linnaeus, 1766—has been determined in the Nadym River basin. Data on reproduction, age, and sex structure and nutrition and helminths (nematodes) are given. In underyearlings of the tundra shrew, the double prevalence of females over males is fixed. At present, for the nematode *Soboliphyme jamesoni*, the Nadym basin is identified by the western border of its distribution.

Keywords: shrews, *Sorex*, reproduction, age and sex structure, nutrition, helminths, the Nadym River, Western Siberia

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INTRODUCTION

In Western Siberia shrews were mainly studied in the south (Yudin, 1962; Glotov et al., 1978; Emel'yanova and Brunov, 1987; Vartapetov et al., 2008) and, until now, in the tundra, forest tundra, and northern taiga of this region they have been studied weakly. In full, this is related to the whole basin of the Nadym River.

Data on shrews of the north of Western Siberia are presented in manuscripts of B.S. Yudin (1962, 1971). According to his data, in the studied area there are eight species of shrews of the genus *Sorex*. For the Nadym River basin, Yudin (1962; map on page 36) indicated only the Eurasian pygmy shrew and the Arctic (= tundra) shrew. No data on structure of communities of shrews from the north of Western Siberia, sex or age composition of their populations, or biological peculiarities were presented. The aim of our work was the identification of species composition and biological peculiarities of shrews in the middle course of the Nadym River basin.

MATERIALS AND METHODS

The Nadym River is situated between the Ob and Yenisei rivers and flows into the southern part of the Gulf of Ob (Fig. 1). The river basin is placed completely southward of the Polar circle: the lower third is laid in forest tundra and the rest is in the subzone of the northern taiga (Ravkin et al., 2011). Shrews were caught in August–September 2005–2008 in the neighborhood of the Nadymskii station, located 30 km southward of Nadym (65°18′ N, 72°51′ E). The flat character and climate peculiarities cause considerable marshiness of this territory with a great number of lakes. The studied area is located in the zone of island distribution of permafrost. Areas of permafrost rocks are related to peat lands, hillocks, and ridge heaves. The zonal type of vegetation is presented by birch–larch and birch–pine shrub–lichen sparse growth of trees and larch shrub–moss open stands developed in preriver parts of the plain. Considerable areas on the flattened surface of the central part of plain are occupied by cloudberry–ledum–sphagnum–lichen peats and cotton–grass–sedge–sphagnum and shrub–sedge–moss bogs. The cedar ledum–lichen and ledum–sphagnum thin forests are characteristic of hillock heaves (Sorokina, 2003).

Twenty-meter grooves with two cones were used for animal catches and on the marshy area (due to high humidity) lines of break-back traps (per 25 items through 5 m) were installed.

Shrews were fixed in ethanol; they were further processed in the laboratory. Based on degree of teeth abrasion, the animals were divided into two age groups: overwintered and underyearlings. Testes sizes were estimated in males; uterus condition and development of lacteal glands were estimated in females. The brood size was identified based on the number of embryos and placental spots. In the last case, uteri were cleared in milk acid (Dokuchaev, 1990, 1992).

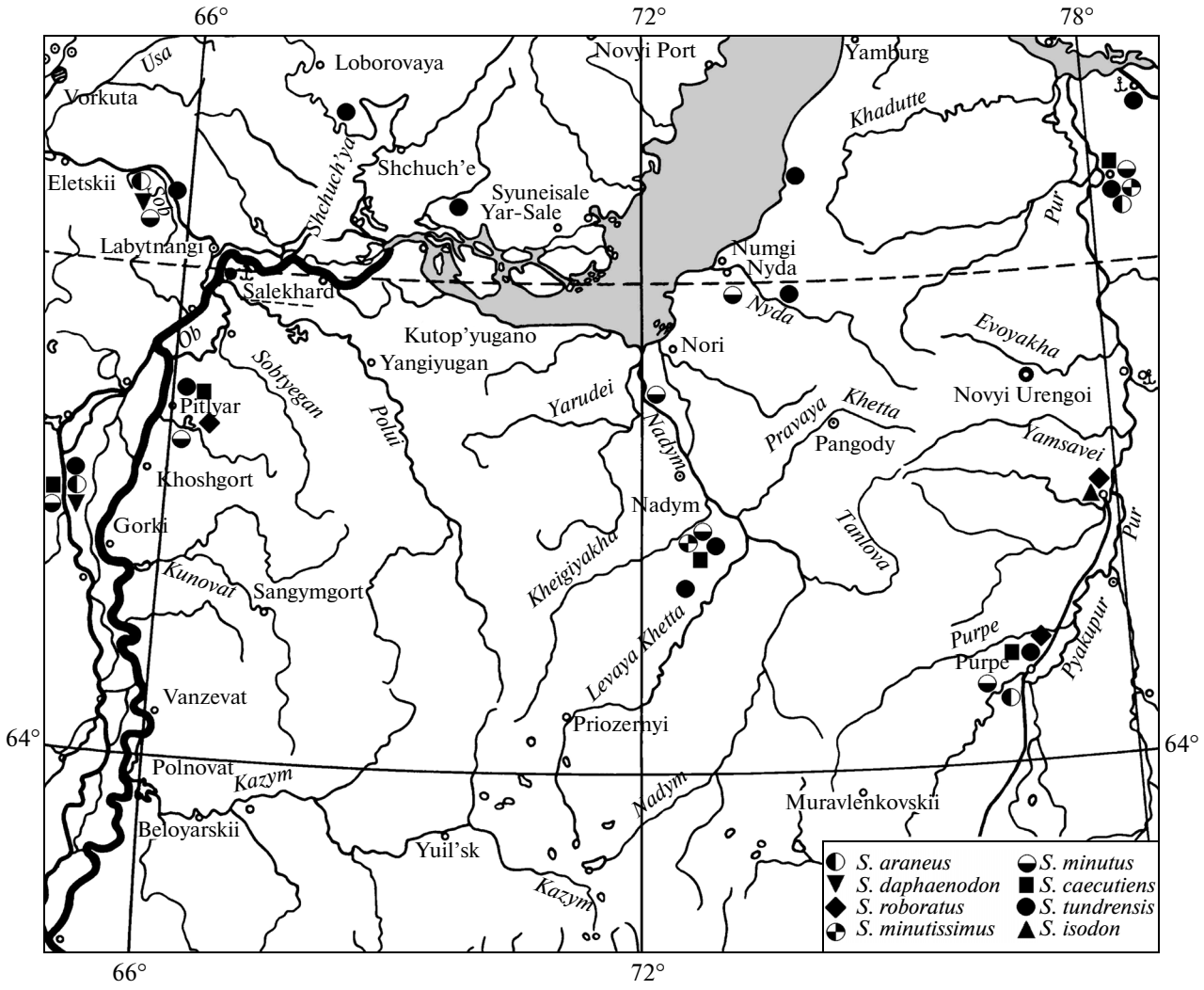

Fig. 1. Shrews of the Nadym River basin and neighboring territories (according to Yudin, 1962, 1971; Balakhonov, 1981; our data).

Like in 2005 and 2006, the sex was not determined for all shrews; data on sex composition are presented only for animals, caught in 2007 and 2008, and partial data on reproduction, age composition, and helminths are also used for 2005.

In the study of nutrition, the systematic belonging of food items was identified on nondigested fragments of the gastric contents of animals with the use of a MBS-1 binocular microscope.

Diaphragm, lungs (only in overwintered animals), stomach, urinary bladder, and body cavity were examined for the presence of nematodes, because intestinal helminths (cestodes) were completely macerated. Ninety-seven specimens of Laxmann's shrew and 110 specimens of the tundra shrew were examined for the presence of helminths. Species of nematodes were not identified due to their bad condition. Exceptions were only *Soboliphyme jamesoni* Read, 1952, whose identification was not problematic, and *Liniscus incrassatus* Dujardin, 1845, according to localization in the urinary bladder.

Statistical processing was performed using the Systat software. The significance of differences was estimated by Student's t-test or χ^2 (Urbakh, 1964).

RESULTS AND DISCUSSION

For the 4 years, a total of 285 specimens of shrews of 4 species were caught: *Sorex tundrensis* Merriam, 1990 (the tundra shrew); *S. caecutiens* Laxmann, 1788 (Laxmann's shrew); *S. minutissimus* Zimmermann, 1780 (the Eurasian least shrew); and *S. minutus* Linnaeus, 1766 (the Eurasian pygmy shrew). The tundra shrew (156 caught specimens) and Laxmann's shrew (123 caught specimens) were the most numerous. The Eurasian least shrew (five specimens) was present in catches of 2005–2007; the Eurasian pygmy shrew (two specimens) was found only in catches of 2007. In the region of study among caught shrews, the four species

Table 1. The age structure of the tundra and Laxmann's shrews from Nadym

Years	Species	Overwintered	Underyearlings	Totally
2005	*S. caecutiens*	5 (31.3)*	11 (68.7)	16
"	*S. tundrensis*	0 (0)	14 (100)	14
2007	*S. caecutiens*	3 (7.1)	39 (92.9)	42
"	*S. tundrensis*	5 (10)	45 (90)	50
2008	*S. caecutiens*	7 (17.9)	32 (82.1)	39
"	*S. tundrensis*	0 (0)	46 (100)	46

* The first number is absolute values; percentages are in brackets.

Table 2. Sex ratio in underyearlings of the tundra and Laxmann's shrews from Nadym

Years	*S. caecutiens*			*S. tundrensis*		
	n	males, %	females, %	*n*	males, %	females, %
2007	42	61.9	38.1	50	34.0	66.0
2008	39	41.0	59.0	46	32.6	67.4
Totally	81	51.9	48.1	96	33.3	66.7

n—amount of sampling.

(*S. araneus* Linnaeus, 1758, *S. daphaenodon* Thomas, 1907, *S. isodon* Turov, 1924 and *S. roboratus* Hollister, 1913), inhabiting adjoining with Nadym territories, were not found (Fig. 1).

Due to late catches (August–September), there were few overwintered animals. Overwintered individuals of the tundra shrew were not present in catches of 2008, but in 2007 there were in total five specimens (two males and three females). For Laxmann's shrew, unlike *S. tundrensis*, overwintered animals were registered in all years (in total there were 15 individuals—4 males and 11 females). Due to the small amount of overwintered animals, there is not much data on the reproduction of shrews. All overwintered males were without signs of spermatogenesis fading. The average brood in overwintered females (data on five females) of Laxmann's shrew was 7.4 ± 0.6 cubs. It is little more than was noted by Yudin (1962) for Western Siberia as whole. In *S. caecutiens* there was only one female underyearling, which reproduced. In its uterine horns there were eight placental spots.

Among tundra shrews there was only one overwintered female with nine placental spots. In this species arrived females reproduced more actively. In 2007 and 2008 eight such females were caught (12.9% of the total number of underyearlings), and in seven of them the size of the brood was identified. The average size of the brood in females of this age group was 7.8 ± 0.64 cubs. A single overwintered female of *S. minutissimus* had eight placental spots.

Age and sex structure in populations of shrews was quite dynamic (Ivanter, 1975; Dokuchaev, 1990). Underyearlings usually appear in catches of mid-June, and in July they comprise the largest part of caught animals. In August overwintered individuals comprise an inconsistent part of the population.

Data on age composition of the tundra and Laxmann's shrews from Nadym are presented in Table 1. It is possible to see that in Laxmann's shrew the amount of overwintered animals varied in years, comprising from 7.1 to 31.3%. In the tundra shrew in 2005 and 2008, overwintered individuals were absent in catches, but in 2007 there were only 10%. It shows that the diversion of overwintered animals in the population of *S. tundrensis* is faster than in *S. caecutiens*.

In the Nadym's material there was a considerable range of years in sex ratio in the group of underyearlings (Table 2). In Laxmann's shrews in 2007, far more males were caught than females, but in 2008 there was a reverse picture. Summary data for the 2 years gave only inconsiderable odds in favor of males ($\chi^2 = 0.14$, $p > 0.5$). In the tundra shrew in 2007 and 2008, among arrived animals, females were more numerous than males (Table 2). Summarily for the two years, the ratio of males and females was 1 : 2 (or 33.3 : 66.7%), which means twice as many females as males ($\chi^2 = 11.16$, $p < 0.01$). It is difficult to give an explanation for such considerable disproportion of sexes (in favor of females). As a rule, in shrews in the group of underyearlings, there is an almost equal sex ratio (1 : 1), or an inconsiderable prevalence of males is observed (Yudin, 1962; Ivanter, 1975; Dokuchaev, 1990).

An analysis of gastric contents has shown that Laxmann's shrews ate spiders and beetles more frequently, the occurrence of which reached 72.2 and 53.2%,

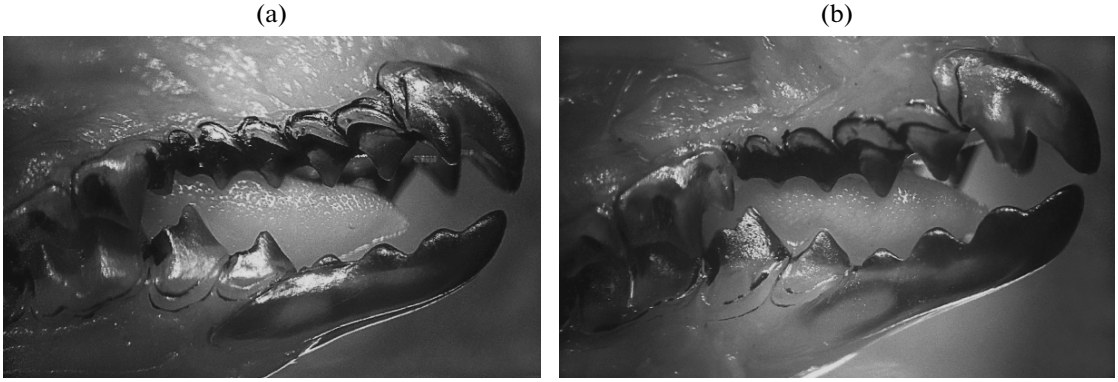

Fig. 2. Teeth of shrews with black deposits ((a) *S. caecutiens*, (b) *S. tundrensis*).

respectively (Table 3). Then downwards there were caterpillars, larvae of Diptera, and beetles with occurrences of 34.2, 27.8 and 22.8%, respectively. The rest of the invertebrates (imagoes of Diptera, nocturnal butterflies, cicadas, scale insects, Hymenoptera, aphids, Collembola, Myriapoda, and Opiliones) occupied only an inconsiderable part (from 1.3 to 5.1%) in the ration of Laxmann's shrews. In the stomach of one young Laxmann's shrew there were about 70 collembolans simultaneously. Due to their small size they are often eaten by shews (Dokuchaev, 1990; Ivanter and Makarov, 2001) and, as a rule, by single individuals.

The composition of food items in the tundra shrew was almost similar to Laxmann's shrew. In most groups of invertebrates, significant differences were found in the eating of spiders. In gastric contents of Laxmann's shrew, this type of provender was met significantly frequently (Table 3). Differences between studied species of shrews in the rest of the food items were not very significant. It is only possible to indicate that, in the nutrition of the tundra shrews, Hymenoptera, nocturnal butterflies, and Collembola were noted somewhat frequently.

It is worthy of notice that, according to Yudin's data (1962), in Western Siberia in the nutrition of the tundra and Laxmann's shrews, spiders comprised an inconsiderable part of their ration (1.7 and 2.9%, respectively).

As it was noted above, arrived animals were not observed with lung parasites. Among overwintered animals of the tundra shrew, lung nematodes were not found. In the same age group, each third individual of Laxmann's shrew had nematodes in lungs. It is known that two species of worms parasitize in the lungs of shrews—*Stefanskostrongylus* (=*Angiostrongylus*) *soricis* (Soltys, 1954) and *Paracrenosoma skrjabini* (Pologentev, 1935) (Karpenko and Odnokurtsev, 1990). Earlier, in shrews of Western Siberia, nematodes were not noted in lungs (Yudin, 1962; Kutaeva and Zhigileva, 2009; Zhihileva, 2011).

Nematodes *Capillaria* sp. were found in stomachs of seven overwintered and three young Laxmann's shrews (occurrence in different age groups was 46.7 and 3.7%, respectively). In the tundra shrew, similar rates had closer values (40.0 and 9.5%). In the urinary bladder of the nine overwintered Laxmann's shrews (in 60.0%), capillaria *L. incrassatus* were found, while in arrived animals they were not observed. On the contrary, none of the five overwintered specimens of the tundra shrew had nematodes in their urinary bladders, but in underyearlings of this species there were 6.7% animals with parasites.

In shrews of Western Siberia, of nematodes of the genus *Soboliphyme*, only *S. soricis* Baylis et King, 1932 were found (Yudin, 1962). In stomachs of shrews from Nadym we found soboliphyms of another species—*S. jamesoni*. In Laxmann's shrews these parasites were observed only in one overwintered individual, while in the tundra shrew they were found in 2 out of 5 overwintered (40%) and 13 out of 105 (12.4%) arrived animals. In the common shrew *S. araneus*

Table 3. Occurrence (%) of main food items of nutrition of the tundra and Laxmann's shrews from Nadym

Food items	*S. caecutiens* ($n = 79$)	*S. tundrensis* ($n = 92$)	Values χ^2
Spiders	72.2	44.6	6.52*
Beetles	53.2	57.6	0.17
Larvae of beetles	22.8	15.2	1.52
Larvae of Diptera	27.8	38.0	1.58
Caterpillars	34.2	26.1	1.09

n—number of studied stomachs.
* Significant differences.

from Tyumen oblast soboliphyms were also observed (Zhigileva, 2011), but their species was not identified. As a whole, it is possible to note that overwintered animals were infected by nematodes much more strongly than young individuals.

Some animals of the tundra and Laxmann's shrews in samples for 2007 and 2008 had black (a kind of resin) deposits on their teeth (Fig. 2). This was particularly expressed in 2008, when almost half of the Laxmann's shrews had 'black teeth,' and 7.7% of them had considerable deposits (like Fig. 2a). In the tundra shrew, this phenomenon was more strongly expressed. In this species, 74% of animals had such deposits, and one-third had considerable deposits (Fig. 2b). Neither age nor sex differences were identified. Because the deposits are only on teeth, it is logical to connect them with the consumption of polluted food items. When the nutrition of the two studied species of shrews is similar but there are obvious differences in this phenomenon, the explanation can probably be found in the peculiarities of certain biotopes that these shrews inhabit.

CONCLUSIONS

It is obvious that the incomplete species composition of shrews from the Nadym River basin has been revealed by us. Particularly, this is related to its upper part, where the inhabiting of species mostly connected with forest formations is possible. Interest is found in the disproportion of sexes with a double shift in favor of females in arrived animals of the tundra shrew. A special investigation is needed for the 'resinlike' deposits found on the teeth of animals.

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