







DOI: <https://doi.org/10.23859/estr-251110>

EDN: <https://elibrary.ru/tzqbno>

UDC 599.323:576.895

Article

Helminth infestation of the northern red-backed vole *Clethrionomys rutilus* in the North-Western Siberia

O.N. Zhigileva^{1*} , A.Yu. Levykh² , A.S. Perevalova¹ ,
L.Yu. Chernyavsky¹ 

¹ Tyumen State University, Volodarskogo St. 6, Tyumen, 625003 Russia

² Scientific Center for Arctic Studies, Respubliki St. 20, Salekhard, Tyumen Oblast, Yamalo-Nenets Autonomous Okrug, 629008 Russia

*zhigileva@mail.ru

Abstract. Protected areas (PAs) in northern Western Siberia, being important biodiversity hotspots, still remain relatively understudied for the diversity of many taxa. We present the first data on helminth infestation of the northern red-backed vole *Clethrionomys rutilus*, which is the dominant rodent species in the protected areas located in the taiga zone (Malaya Sosva State Nature Reserve, Kunovatsky Biological Sanctuary, and Angalsky Mys Natural Monument), the outskirts of Nadym town (Nadym Hills), and the Taz River floodplain. In 2019 and 2021, 231 northern red-backed voles were captured; 12 helminth species were registered as their parasites. The highest parasite species richness and abundance were observed for the northern red-backed vole inhabiting the protected areas located in the taiga zone. The parasite prevalence (P) and the abundance (A) were the highest in the Kunovatsky Biological Sanctuary ($P = 53\%$, $A = 0.79$) and the Malaya Sosva State Nature Reserve ($P = 45\%$, $A = 2.39$), decreasing northwards. The decline in helminth diversity from middle taiga to tundra was consistent with a corresponding change in rodent abundance. In the northern areas of Western Siberia, the helminth diversity in the northern red-backed vole was significantly lower comparing to the southern areas of the region. The obtained data on helminth species composition and infestation rates in *C. rutilus* allowed to fill a gap in the study of the helminth fauna of vast territories of North-Western Siberia, including those with conservation status.

Keywords: rodents, protected areas, parasites, invasion indicators, forest-tundra, taiga, tundra

ORCID:

O.N. Zhigileva, <https://orcid.org/0000-0002-3782-3014>

A.Yu. Levykh, <https://orcid.org/0000-0002-1749-0806>

A.S. Perevalova, <https://orcid.org/0009-0006-5726-7517>

L.Yu. Chernyavsky, <https://orcid.org/0000-0002-5843-0797>

To cite this article: Zhigileva, O.N. et al., 2026. Helminth infestation of the northern red-backed vole *Clethrionomys rutilus* in the North-Western Siberia. *Ecosystem Transformation* 9 (1), 87–101. <https://doi.org/10.23859/estr-251110>

Received: 10.11.2025

Accepted: 22.12.2025

Published online: 27.02.2026





DOI: <https://doi.org/10.23859/estr-251110>

EDN: <https://elibrary.ru/tzqbn0>

УДК 599.323:576.895

Научная статья

Зараженность гельминтами красной полевки *Clethrionomys rutilus* в экосистемах севера Западной Сибири

О.Н. Жигилева^{1*} , А.Ю. Левых² , А.С. Перевалова¹ ,
Л.Ю. Чернявский¹ 

¹ Тюменский государственный университет, 625003, Россия, г. Тюмень, ул. Володарского, д. 6

² Научный центр изучения Арктики, 629008, Россия, Тюменская область, Ямало-Ненецкий автономный округ, г. Салехард, ул. Республики, д. 20

*zhigileva@mail.ru

Аннотация. Особо охраняемые природные территории (ООПТ) севера Западной Сибири, являясь важными резерватами биоразнообразия, остаются относительно мало изученными в таксономическом отношении. В работе представлены первые данные о зараженности гельминтами красной полевки *Clethrionomys rutilus* – доминирующего вида грызунов в Государственном природном заповеднике «Малая Сосьва», Куноватском заказнике, памятнике природы «Ангальский мыс», а также в окрестностях г. Надым и пойме р. Таз. В 2019 и 2021 гг. отловлена 231 особь полевок, у которых выявлено паразитирование 12 видов гельминтов. На ООПТ в таежной зоне отмечено наибольшее видовое богатство и обилие паразитов. Значения экстенсивности инвазии (ЭИ) и индекса обилия (ИО) гельминтов у красной полевки были максимальны в Куноватском заказнике (ЭИ = 53%, ИО = 0.79) и заповеднике «Малая Сосьва» (ЭИ = 45%, ИО = 2.39) и снижались по направлению к северу. Сокращение видового состава гельминтов в направлении от средней тайги к тундре согласуется с соответствующим изменением обилия грызунов. Видовой состав гельминтов полевок северных районов Западной Сибири существенно беднее такового южных районов этого региона. Полученные данные по видовому составу гельминтов и показателям зараженности ими полевок восполняют пробел в изучении гельминтофауны обширных северных территорий Сибири, в том числе имеющих особый природоохранный статус.

Ключевые слова: грызуны, особо охраняемые природные территории, паразиты, показатели инвазии, лесотундра, тайга, тундра

ORCID:О.Н. Жигилева, <https://orcid.org/0000-0002-3782-3014>А.Ю. Левых, <https://orcid.org/0000-0002-1749-0806>А.С. Перевалова, <https://orcid.org/0009-0006-5726-7517>Л.Ю. Чернявский, <https://orcid.org/0000-0002-5843-0797>

Для цитирования: Жигилева, О.Н. и др., 2026. Зараженность гельминтами красной полевки *Clethrionomys rutilus* Pallas, 1779 в экосистемах севера Западной Сибири. *Трансформация экосистем* 9 (1), 87–101. <https://doi.org/10.23859/estr-251110>

Поступила в редакцию: 10.11.2025

Принята к печати: 22.12.2025

Опубликована онлайн: 27.02.2026

Introduction

The processes occurring in the Arctic, both natural and anthropogenic-induced, lead to significant changes in climate, soil status, and vegetation cover, affecting all components of various ecosystems (Groisman et al., 2013; Reshetko and Moiseeva, 2016; Sheftel and Yakushov, 2022; Talanova, 2018; Tchebakova et al., 2009). Protected areas (PAs) are exceptional objects for studying fundamental patterns of biodiversity dynamics due to almost complete absence of anthropogenic pressure. The PAs of the northern Western Siberia are important biodiversity reserves (Morgun and Istrati, 2019; Pastukhov, 2013); however, they remain relatively poorly studied in taxonomic terms, experiencing meantime a number of issues arisen due to irrational nature management (Bogdanova, 2022; Morgun et al., 2022). Censusing the species composition, occurrence, and abundance of different animal groups in PAs is a necessary initial step in long-term environmental monitoring programs for these areas.

Small mammals deserve special attention in such programs, as they occupy an important place in food webs, being one of the main model taxa for environmental monitoring due to their high abundance, short life cycle, and wide distribution (Avenant and Cavallini, 2007; Gashev et al., 2006; Levykh, 2018). Holding the role of intermediate or definitive parasite hosts, small mammals form helminth-host communities that can serve as indicators of ecosystem health due to their sensitivity to environmental transformations (Morand et al., 2006). There are only a few studies of parasite fauna of small mammals for the northern territories of Western Siberia (Krivopalov et al., 2022; Sheikina and Zhigileva, 2018). Furthermore, the helminth species composition requires reassessment considering recent major taxonomic revisions involving numerous groups of parasitic worms.

The study aims to assess helminth infestation in the northern red-backed voles inhabiting protected areas of the North-Western Siberia.

Materials and methods

The material was collected during non-selective sampling of small mammals by the trench and trapline methods in 2019 and 2021 in five regions of Western Siberia. In the Yamalo-Nenets Autonomous Okrug (YaNAO), mammals were captured at the Sterkh Biological Station (Kunovatsky Biological Sanctuary), in the vicinity of Salekhard city (Angalsky Mys Natural Monument) and Nadym town (Nadym Hills), and 50 km south-southeast of Tazovsky settlement (Taz River floodplain); in the Khanty-Mansi Autonomous Okrug–Yugra (KhMAO – Yugra), in the Malaya Sosva State Nature Reserve named after V.V. Raevsky (Shukhtungort settlement, Berezovsky District) (Fig. 1). The study areas belong to different natural and climatic subzones. The Malaya Sosva State Nature Reserve is located in middle taiga subzone, the Kunovatsky Biological Sanctuary, in northern taiga, the Nadym Hills, in forest-tundra, the Angalsky Mys Natural Monument, in transition area between forest-tundra to tundra, and the Taz River floodplain belongs to tundra.

Rodents were captured using snap traps and a trapping ditch. Snap traps were set in trapping lines (25–50 pcs. in series) in the most typical biotopes of the study areas. At the Sterkh Biological Station, the traps were set in a spruce-birch-cedar dwarf shrub-green moss forest (Kunovat River floodplain), in a birch-spruce-cedar dwarf shrub-white moss-green moss forest, a birch-cedar dwarf shrub-white moss-lichen sparse forest, and in a spruce-birch-cedar horsetail-couch grass forest; in the vicinity of

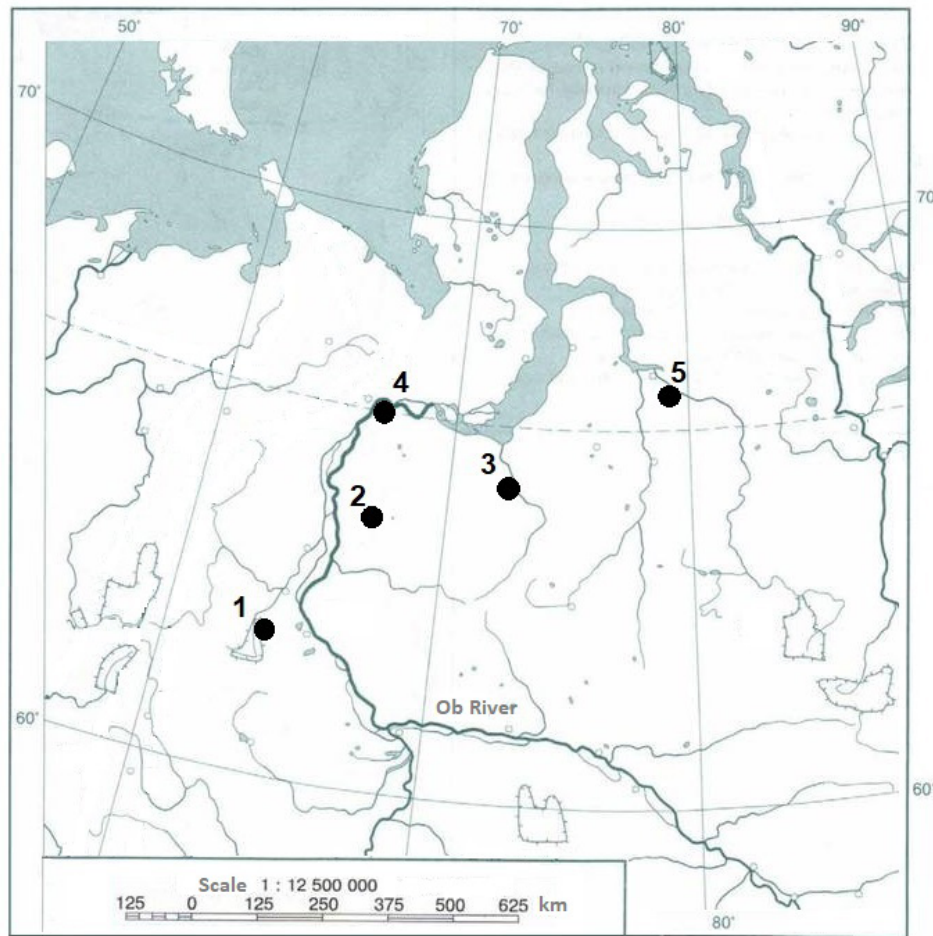


Fig. 1. Sampling site map: 1 – Malaya Sosva State Nature Reserve, 2 – Kunovatsky Biological Sanctuary, 3 – Nadym town, Nadym Hills, 4 – Angalsky Mys Natural Monument (Salekhard city environs), 5 – Taz River floodplain.

Salekhard city, in a larch-dwarf shrub-green moss forest and yernik¹-dwarf shrub tundra; in the vicinity of Nadym town, in spruce-birch-larch-cedar dwarf shrub-*Ledum*-true moss forest and cedar-spruce-larch horsetail-dwarf shrub-*Sphagnum* forest; in the Tazovsky district, in birch-larch with spruce yernik-*Ledum*-true moss and larch-*Ledum*-horsetail-lichen sparse forests; in the Malaya Sosva State Nature Reserve, in the forb-*Oxalis* pine and spruce forests, lingonberry-*Ledum* and lingonberry-true moss pine forests. In total, 231 individuals of the northern red-backed vole were caught and analyzed (Table 1).

A complete helminthological analysis of the gastrointestinal tract of rodents was performed according to standard methods (Anikanova et al., 2007). Cestodes were stained with Ehrlich's alum hematoxylin, permanent slides were prepared by embedding them in Canada balsam. Temporary slides were prepared for nematodes. Helminth species were identified using available reports (Ryzhikov et al., 1978; 1979) and taxonomic publications (Chechulin and Gulyaev, 1998; Galbreath et al., 2013; Gulyaev and Chechulin, 1996–1997; Haukisalmi et al., 2004, 2007, 2014; Makarikov et al., 2011, 2013; Pospekhova et al., 2023; Wickström et al., 2005).

Using the program Quantitative Parasitology 3.0. (Reiczigel & Rózsa, 2005), major parasite infestation indices were calculated: prevalence (*P*) – percentage of infected host individuals in regard to the total number of the host specimens studied; intensity of infestation (*I*) – minimum, maximum and average number of parasites in one infected individual; and abundance (*A*) – average number of parasites per host in a given sample. The data were analyzed using standard statistical methods in Microsoft Excel 2013 program.

¹ Yernik is the local name for dwarf arctic birch (*Betula nana*) thickets.

Table 1. Sampling sites and the number of *Clethrionomys rutilus* specimens examined.

No.	Site	Coordinates	Study period	Number of samples
Khanty-Mansi Autonomous Okrug – Yugra, Western Siberia				
1	Malaya Sosva State Nature Reserve	N 65.376378° E 64.098836°	July 2019	31
Yamalo-Nenets Autonomous Okrug, Western Siberia				
2	Kunovatsky Biological Sanctuary	N 65.181333° E 66.586806°	June, August 2021	91
3	Nadym Hills	N 66.586806° E 72.512306°	July 2021	80
4	Angalsky Mys Natural Monument	N 66.621917° E 66.555861°	July 2021	6
5	Taz River floodplain	N 67.018222° E 79.236722°	July 2021	23

Results

Northern red-backed vole *Clethrionomys rutilus* Pallas, 1779 is the most abundant species in all study areas; its share in rodent samples ranged from 67 to 96%. Other rodent species were few in number (tundra vole *Alexandromys oeconomicus* (Pallas, 1776), short-tailed field vole *Microtus agrestis* Linnaeus, 1761), or they were represented by single specimens (gray red-backed vole *Craseomys rufocanus* Sundevall, 1846, wood lemming *Myopus schisticolor* Lilljeborg, 1844, West Siberian lemming *Lemmus sibiricus* Kerr, 1792, and Siberian chipmunk *Eutamias sibiricus* Laxmann, 1769). In total, 12 species of helminths (6 cestode species and 6 nematode species) were found for the northern red-backed vole. The greatest number of parasite species (10) was found for the northern red-backed voles from the Kunovatsky Biological Sanctuary, located in northern taiga zone. In tundra, the helminth composition was limited to 2–4 of the most common species (Table 2).

Nematodes of genera *Heligmosomoides* Hall, 1916 and *Heligmosomum* Railliet and Henry, 1909 were common for the northern red-backed vole inhabiting middle and northern taiga and forest-tundra, but they practically disappeared when moving into tundra landscapes. The intensity of infestation of the northern red-backed vole by nematodes of the genus *Heligmosomoides* was the highest in taiga regions, ranging from 1 to 11, with an average of 5–7 helminth specimens per host. Helminth infestation declined toward forest-tundra zone, where an average of 2–3 nematodes per host (maximum of up to 6) were found. The prevalence of nematodes of the genus *Heligmosomoides* was also the highest in middle taiga and decreased northward. The most common nematode species was *Heligmosomoides laevis* Dujardin, 1845. This was the only Heligmosomatidae species found in the voles inhabiting tundra areas. Other nematode species, belonging to the genera *Heligmosomoides* and *Heligmosomum*, were found in the northern red-backed voles inhabiting middle and northern taiga, as well as forest-tundra.

In middle taiga, the northern red-backed vole was characterized by high infestation with nematodes and dominance of cestodes of the genus *Arostrilepis* Mas-Coma and Tenora, 1997. The latter had a high frequency of occurrence in all areas of the host species habitat. (Table 2). Cestode *Arostrilepis macrocirrosa* Makarikov, Gulyaev et Kontrimavichus, 2011 was found in the northern red-backed voles in all studied areas, from middle taiga to tundra. One tundra vole was also infected by this parasite species in the Kunovatsky Biological Sanctuary. The cestode *Arostrilepis tenuicirrosa* Makarikov, Gulyaev et Kontrimavichus, 2011 had a more limited distribution, found in the northern red-backed vole in the Kunovatsky Biological Sanctuary (northern taiga), in the vicinity of Nadym town (forest tundra), and in the floodplain of the Taz River (tundra).

Cestode *Paranoplocephala kalelai* Tenora, Haukisalmi et Henttonen, 1985 (Anoplocephalidae family) was not found for the northern red-backed voles inhabiting the Malaya Sosva State Nature

Table 2. Infection rates of *Clethrionomys rutilus* by particular helminth species. Values above the line are the prevalence, % ± SE (standard error); below the line, intensity of invasion, ind. (min—max); number in the brackets are the parasite abundance index.

Район отлова Природно- климатическая подзона	Malaya Sosva State Nature Reserve	Kupovatsky Biological Sanctuary	Nadym Hills	Angalsky Mys Natural Monument	Taz River floodplain
	Middle taiga	Northern taiga	Forest-tundra	Forest-tundra	Tundra
<i>Arostrilepis macrocirrosa</i>	$\frac{29.0 \pm 8.2}{1 (0.29)}$	$\frac{3.3 \pm 1.9}{1 (0.03)}$	$\frac{6.3 \pm 2.7}{1-2 (0.08)}$	$\frac{1 \text{ из } 6}{1 (0.01)}$	$\frac{17.4 \pm 7.9}{1 (0.17)}$
<i>Arostrilepis tenuicirrosa</i>	0	$\frac{6.6 \pm 2.6}{1 (0.06)}$	$\frac{3.8 \pm 2.1}{1 (0.04)}$	0	$\frac{13.0 \pm 7.0}{1 (0.13)}$
<i>Gulyaevia longivaginata</i>	0	$\frac{2.2 \pm 1.5}{1 (0.02)}$	$\frac{1.3 \pm 1.2}{1 (0.01)}$	0	0
<i>Paranoplocephala kalejai</i>	0	$\frac{7.7 \pm 2.7}{1 (0.07)}$	$\frac{1.3 \pm 1.2}{1 (0.01)}$	$\frac{1 \text{ из } 6}{1 (0.01)}$	0
<i>Paranoplocephala</i> sp.	0	$\frac{9.9 \pm 3.1}{1 (0.01)}$	0	0	0
<i>Mesocoeloides</i> sp. (larva)	0	$\frac{3.3 \pm 1.9}{1 (0.03)}$	0	0	0
<i>Heligmosomoides laevis</i>	$\frac{16.1 \pm 6.6}{2-11 (1)}$	$\frac{6.6 \pm 2.6}{1-11 (0.38)}$	$\frac{2.5 \pm 1.7}{1-6 (0.08)}$	0	$\frac{8.7 \pm 5.8}{1-3 (0.17)}$
<i>Heligmosomoides</i> sp.	$\frac{19.4 \pm 7.1}{1-10 (1)}$	$\frac{2.2 \pm 1.5}{1-3 (0.04)}$	$\frac{1.3 \pm 1.2}{2 (0.02)}$	0	0
<i>Heligmosomum mixtum</i>	$\frac{3.2 \pm 3.1}{1 (0.03)}$	$\frac{3.3 \pm 1.9}{1-5 (0.09)}$	$\frac{5.0 \pm 2.4}{1-3 (0.12)}$	0	0
<i>Heligmosomum</i> sp.	$\frac{3.2 \pm 3.1}{1 (0.03)}$	$\frac{2.2 \pm 1.5}{2 (0.04)}$	$\frac{3.8 \pm 2.1}{1 (0.03)}$	0	0
<i>Pterothominx sadovskoi</i>	0	0	$\frac{1.2 \pm 1.2}{1 (0.01)}$	0	0
<i>Trichuris arvicolae</i>	0	0	0	0	$\frac{4.3 \pm 4.2}{2 (0.09)}$
Total number of species	5	10	9	2	4

Reserve (middle taiga) and in tundra, but for those inhabiting northern taiga and forest-tundra areas. *Gulyaevia longivaginata* (Chechulin and Gulyaev, 1998) Haukisalmi, Hardman, Hoberg et Henttonen, 2014 was found for the northern red-backed voles inhabiting the Kunovatsky Biological Sanctuary and the vicinity of Nadym town (Nadym Hills). Infestation rates of anoplocephalid cestodes in forest-tundra were lower comparing to that in northern taiga (Table 2).

The other parasite species were found rarely. Three tetrathyridia (metacestode juvenile stages) of *Mesocestoides* sp. were found in the body cavity of three northern red-backed voles from the Kunovatsky Biological Sanctuary ($P = 3.3\%$, $I = 0.03$). One specimen of nematode *Pterothominx sadovskoi* (Morosov, 1956) Gagarin and Nasarova, 1966 was found in the individual of the northern red-backed vole from the Nadym Hills area ($I = 0.17$). Two specimens of *Trichuris arvicolae* Feliu, Spakulova, Casanova, Renaud, Morand, Hugot, Santalla et Durand, 2000 were found in one individual of the northern red-backed vole caught in the Taz River floodplain ($P = 4.3\%$, $I = 0.09$).

The highest total infestation rates of the northern red-backed voles were observed in protected areas located in the taiga regions. When moving to forest-tundra and tundra, infestation rates decreased. In the Malaya Sosva State Nature Reserve (middle taiga), the average infestation rate of the northern red-backed voles was the highest compared to all other studied areas (5 helminths per infected individual). In the Kunovatsky Biological Sanctuary (northern taiga), the highest prevalence was observed (53%). This indicator was significantly higher ($p < 0.05$) compared to that in the samples obtained in Nadym Hills (forest-tundra). Differences in infestation rates between the other studied areas were statistically insignificant (Table 3). The parasite abundance for the northern red-backed vole inhabiting middle taiga (2.4) was three times higher than that in northern taiga (0.8). This indicator was 0.3–0.6 in forest-tundra (Nadym Hills, Angalsky Mys Natural Monument) and tundra (floodplain of the Taz River).

Discussion

Our data on the distribution of the northern red-backed vole are consistent with the results of long-term monitoring of the population of small mammals in northern taiga of Western Siberia: the northern red-backed vole has been the dominant rodent species for 120 years of observations (Starikov and Vartapetov, 2021). The dominance of the northern red-backed vole in the study areas is due to the optimal habitat conditions of this species in most biotopes of the taiga ecosystems of Western Siberia, and, to a lesser extent, in the southern shrub subarctic tundra and pre-tundra sparse forests (Kislyi et al., 2019).

The greatest number of helminth species (10) was found in the northern red-backed voles inhabiting northern taiga; in forest-tundra and tundra, the number of helminth species decreases. Higher species

Table 3. Helminth infection rates of *Clethrionomys rutilus* in different areas. Asterisk* indicates single findings of parasites; ** – difference with the sample from Nadym Hills is statistically significant ($p < 0.05$).

No.	Site	Climatic subzone	Prevalence, % (mean \pm SE)	Intensity of invasion, ind.		Parasite abundance index
				min–max	average	
1	Malaya Sosva State Nature Reserve	Middle taiga	45.2 \pm 8.9	1–13	5.3	2.39
2	Kunovatsky Biological Sanctuary	Northern taiga	52.7 \pm 5.2	1–12	2.1	0.79
3	Nadym Hills	Forest-tundra	33.8 \pm 5.3	1–6	1.5	0.51
4	Angalsky Mys Natural Monument	Forest-tundra	33.3 \pm 19.2	1*	1*	0.33
5	Taz River floodplain	Tundra	34.8 \pm 9.9	1–4	1.4	0.56
Total			42.0 \pm 3.3	1–13	2.5	1.01

diversity of helminths in northern taiga compared to that in middle taiga is consistent with the increase in the abundance of the northern red-backed vole along with other vertebrate species. The latter is explained by some authors by the thinning of the forest stand, resulting in more favorable temperature regime in the lower forest layer (Kislyi et al., 2019). Further north (in forest-tundra and tundra), two to four species of helminths are found. Decreasing number of parasitic worm species infecting rodents in the southern subarctic tundra and near-tundra larch forests (relative to the taiga zone) has also been documented in a neighboring region: northwestern Yakutia in Eastern Siberia (Makarikov and Dokuchaev, 2021).

Most of the helminth species found are typical parasites of voles inhabiting forest areas. Nematodes *Heligmosomum mixtum* Schulz, 1929 and *Heligmosomoides* spp. are the most common and widespread species of parasites in the taiga zone (Bugmyrin et al., 2015). Cestodes of the genus *Arostrilepis* (*A. macrocirrosa* and *A. tenuicirrosa*), identified as *Arostrilepis horrida* (from Linstow, 1901) in earlier works (Zhigileva, 2011; Zhigileva et al., 2016), are commonly found in the northern red-backed vole inhabiting southern and central Siberia and the Far East (Makarikov et al., 2011; 2013). Molecular methods have confirmed a wider distribution of *A. tenuicirrosa*, up to northern Europe (Galbreath et al., 2013). Since *A. macrocirrosa* and *A. tenuicirrosa* are well identified morphologically (by the shape and size of the cirrus), there is no doubt about their presence in the voles inhabiting the north of Western Siberia.

The real distribution of anoplocephalid cestodes is a more complex issue due to the lack of reliable differential criteria, as well as the incompletely resolved phylogenetic relationships between cestodes associated with vole rodents (Haukisalmi et al., 2004; Wickström et al., 2005). Three well morphologically recognizable species of genus *Paranoplocephala* Lühe, 1910 from voles of southern Siberia (*Paranoplocephala omphalodes* (Hermann, 1783), *P. blanchardi* (Moniez, 1891), and *P. longivaginata* Chechulin and Gulyaev, 1998) (Chechulin and Gulyaev, 1998; Gulyaev and Chechulin, 1996–1997) are currently classified into three different genera: *Paranoplocephala*, *Microticola* Haukisalmi, Hardman, Hoberg and Henttonen, 2014 and *Gulyaevia* Haukisalmi, Hardman, Hoberg and Henttonen, 2014, respectively (Haukisalmi et al., 2014). The most common species *P. omphalodes* is considered to be a species complex; some of the species have not been described from Northeastern Eurasia; therefore, they are still identified as *P. cf. omphalodes* by a number of authors (Makarikov et al., 2016). *P. omphalodes* was thought to parasitize meadow voles of *Microtus* genus in Europe, while *P. kalelai*, the northern red-backed voles (Haukisalmi et al., 2004). However, subsequent studies revealed a broader distribution of these species (including in Siberia), as confirmed by molecular genetic methods (Krivopalov et al., 2022; Vlasenko et al., 2019). The closest geographical finding to our study area was a cestode specimen, found in the red-backed vole from the Khanty-Mansi Autonomous Okrug (Raduzhny) and identified as a special phylogenetic lineage of *P. kalelai* using molecular methods (Krivopalov et al., 2022). Although, this species is named to be specific for the gray red-backed vole (Haukisalmi et al., 2007). In any case, it is necessary to clarify the species affiliation of anoplocephalid cestodes of voles, inhabiting the north of Western Siberia, using molecular methods.

The finding of tetrathyridia of *Mesocestoides* sp. also requires additional research using molecular genetic methods. According to N.A. Pospekhova et al. (2023), the tetrathyridia isolated from the northern red-backed vole in northeastern Russia do not correspond to any of the five morphologically and molecularly confirmed *Mesocestoides* species. Moreover, similar studies have not yet been conducted in Western Siberia.

The nematode *Pterothominx sadovskoi* is a widespread parasite of voles; this species has been recorded in the northern red-backed vole inhabiting the Belogorye State Nature Reserve (Kononova and Prisniy, 2020). It is registered in the nematode fauna of North-Eastern Russia also as *Armocapillaria sadovskoi* (Yushkov and Ivashevsky, 1999).

In general, the helminth species composition of small mammals in the northern regions of Western Siberia is depauperate. Trematodes, acanthocephalans, nematodes of the genus *Syphacia* Seurat, 1916, and several other parasite species, commonly found in voles from more southern zones (namely, forest-steppe, sub-taiga, and southern taiga), are notably absent in the studied northern areas, while a total of 29 helminth species have been recorded in rodents in the southern territories (Zhigileva, 2011; Zhigileva et al., 2016). Moreover, the previously documented trend of an approximately twofold decline in both species richness and diversity indices of rodents and their helminths along forest-steppe → sub-taiga → southern taiga gradient persists (Zhigileva, 2011).

Helminth infestation of voles in the northern regions of Western Siberia (northern taiga, forest-tundra, and tundra) is also lower than in the southern regions (forest-steppe, sub-taiga, and southern taiga), where the prevalence may reach 81% in some study years (38% on average), intensity of infestation,

up to 191 helminths per individual (5.2 on average), abundance, 2.2 (Zhgileva, 2018). At the same time, the infestation rates of the red-backed vole in middle taiga (original data) and southern taiga (Zhgileva, 2018) do not differ, averaging as $P = 45\text{--}46\%$, $I = 1.9\text{--}2.4$. Parasite abundance indicates a decline in parasite load on the host population along the gradient from middle taiga to tundra. This pattern is likely driven by sparse host populations under suboptimal ecological conditions, as well as a harsh climate that negatively affects the survival of helminth eggs and larvae.

The helminth fauna of the red-backed vole obtained in this study complement the results of the study of the parasite fauna of insectivorous mammals in the Malaya Sosva State Nature Reserve (Sheikina and Zhgileva, 2018).

Conclusions

Twelve helminth species were found for the northern red-backed vole inhabiting the studied protected areas (Malaya Sosva State Nature Reserve, Kunovatsky Biological Sanctuary, and Angalsky Mys Natural Monument) and in the vicinity of Tazovsky settlement and Nadym town. The northern red-backed vole abundance affected the composition of the helminth species typical for this host. The most common parasites were nematodes of the genera *Heligmosomoides* and *Heligmosomum* and cestode *Arostrilepis macrocirrosa*. The highest parasite load was found for the northern red-backed voles inhabiting protected areas within the taiga zone. In the Kunovatsky Biological Sanctuary, 52% of red-backed voles were infested with helminths, with an average rate of 2 helminths per individual; in the Malaya Sosva State Nature Reserve, these rates were 45% and 5, respectively. The highest rates of parasite diversity and abundance were registered for the northern red-backed vole inhabiting protected natural areas in the taiga zone.

References

- Anikanova, V.S., Bugmyrin, S.V., Ieshko, E.P., 2007. Metody sbora i izucheniia gel'mintov melkikh mlekoopitaiushchikh [Methods of collecting and studying helminths of small mammals]. Karelian Scientific Center of the Russian Academy of Sciences, Petrozavodsk, Russia, 115 p. (In Russian).
- Avenant, N.L., Cavallini, P., 2007. Correlating rodent community structure with ecological integrity, Tussen-die-Riviere Nature Reserve, Free State province, South Africa. *Integrative Zoology* 2 (4), 212–219. <https://doi.org/10.1111/j.1749-4877.2007.00064.x>
- Bogdanova, O.V., 2022. Problemy prirodopol'zovaniia v gosudarstvennom prirodnom zakaznike regional'nogo znachenii «Nadymskii», YaNAO [Problems of nature management in the Nadymsky State Nature Reserve of regional significance, YNAO]. *Moskovskii ekonomicheskii zhurnal [Moscow Economic Journal]* 7 (3), 34. (In Russian). https://doi.org/10.55186/2413046X_2022_7_3_159
- Bugmyrin, S.V., Korosov, A.V., Bespiatova, L.A., Ieshko, E.P., 2015. Gel'mintofauna ryzhei polevki *Myodes glareolus* (Schreber, 1780) Kizhskogo arhipelaga [Helminth fauna of the bank vole *Myodes glareolus* (Schreber, 1780) in the Kizhi Archipelago]. *Parazitologiya [Parasitology]* 49 (1), 61–71. (In Russian).
- Chechulin, A.I., Guliaev, V.D., 1998. *Paranoplocephala longivaginata* sp.n. (Cyclophyllidea: Anoplocephalidae) – novaia tsestoda ot gryzunov (Rodentia) Vostochnoi Sibiri [*Paranoplocephala longivaginata* sp.n. (Cyclophyllidea: Anoplocephalidae) – new cestode from rodents (Rodentia) of Eastern Siberia]. *Parazitologiya [Parasitology]* 32 (4), 352–356. (In Russian).
- Galbreath, K.E., Ragaliauskaite, K., Kontrimavichus, L., Makarikov, A.A., Hoberg, E.P., 2013. A widespread distribution for *Arostrilepis tenuicirrosa* (Eucestoda: Hymenolepididae) in *Myodes* voles (Cricetidae: Arvicolinae) from the Palearctic based on molecular and morphological evidence: historical and biogeographic implications. *Acta Parasitologica* 58 (4), 441–452. <https://doi.org/10.2478/s11686-013-0170-6>
- Gashev, S.N., Zhgileva, O.N., Sazonova, N.A., Seliukov, A.G., Shapovalov, S.I. et al., 2006. Zooindikatory v sisteme regional'nogo ekologicheskogo monitoringa Tiimenskoi oblasti: metodika ispol'zovaniia

[Zooindicators in the system of regional environmental monitoring of the Tyumen region: methods of use]. Tyumen State University, Tyumen, Russia, 132 p. (In Russian).

- Groisman, P.Y., Blyakharchuk, T.A., Chernokulsky, A.V., Arzhanov, M.M., Marchesini, L.B. et al., 2013. Climate changes in Siberia. In: Groisman, P., Gutman, G. (eds.), *Regional environmental changes in Siberia and their global consequences*. Springer Environmental Science and Engineering. Springer, Dordrecht, 57–109. https://doi.org/10.1007/978-94-007-4569-8_3
- Guliaev, V.D., Chechulin, A.I., 1996–1997. Differentsial'naiia diagnostika *Paranoplocephala omphalodes* (Hermann, 1783) i *P. blanchardi* (Moniez, 1891) (Cestoda: Anoplocephalidae) [Differential diagnostics of *Paranoplocephala omphalodes* (Hermann, 1783) and *P. blanchardi* (Moniez, 1891) (Cestoda: Anoplocephalidae)]. *Selevinia*, 1–4. (In Russian).
- Haukisalmi, V., Wickström, L.M., Henttonen, H., Hantula, J., Gubanyi, A., 2004. Molecular and morphological evidence for multiple species within *Paranoplocephala omphalodes* (Cestoda, Anoplocephalidae) in *Microtus voles* (Arvicolinae). *Zoologica Scripta* 33 (3), 277–290. <https://doi.org/10.1111/j.0300-3256.2004.00148.x>
- Haukisalmi, V., Hardman, L.M., Hardman, M., Laakkonen, J., Niemimaa, J., Henttonen, H., 2007. Morphological and molecular characterisation of *Paranoplocephala buryatiensis* n. sp. and *P. longivaginata* Chechulin and Gulyaev, 1998 (Cestoda: Anoplocephalidae) in voles of the genus *Clethrionomys*. *Systematic Parasitology* 66, 55–71. <https://doi.org/10.1007/s11230-006-9059-1>
- Haukisalmi, V., Hardman, L.M., Hoberg, E.P., Henttonen, H., 2014. Phylogenetic relationships and taxonomic revision of *Paranoplocephala* Lühe, 1910 sensu lato (Cestoda, Cyclophyllidea, Anoplocephalidae). *Zootaxa* 3873, 371–415. <https://doi.org/10.11646/ZOOTAXA.3873.4.3>
- Kislyi, A.A., Ravkin, Y.S., Bogomolova, I.N., Tsybulin, S.M., Panov, V.V. et al., 2019. Distribution of northern red-backed vole *Myodes rutilus* (Pallas, 1779) in Western Siberia. *Contemporary Problems of Ecology* 12 (1), 10–22. <https://doi.org/10.1134/S1995425519010086>
- Kononova, M., Prisniy, Yu., 2020. Helminthes of mouse-like rodents in the Belogorye State Nature Reserve (Russia). *Nature Conservation Research* 5 (Suppl. 2), 11–18. <https://doi.org/10.24189/ncr.2020.036>
- Krivopalov, A., Vlasenko, P., Abramov, S., Akimova, L., Barkhatova, A. et al., 2022. Distribution and molecular diversity of *Paranoplocephala kalelai* (Tenora, Haukisalmi & Henttonen, 1985) Tenora, Murai & Vaucher, 1986 in voles (Rodentia: Myodes) in Eurasia. *Diversity* 14 (6), 472–478. <https://doi.org/10.3390/d14060472>
- Levykh, A.Yu., 2018. Melkie mlekopitaiushchie v biomonitoringe okhraniaemykh territorii (na primere Ishimskogo raiona Tiimenskoi oblasti) [Small mammals in the biomonitoring system of protected areas (on the example of the Ishim district of the Tyumen Region)]. *Samarskii nauchnyi vestnik [Samara Journal of Science]* 7 (3), 65–72. (In Russian).
- Makarikov, A.A., Dokuchaev, N.E., 2021. Tapeworms in rodents from the Lower Anabar River Basin, with a review of species diversity of Cestodes in Yakutia, Russia. *Acta Parasitologica* 66, 1012–1020. <https://doi.org/10.1007/s11686-021-00376-6>
- Makarikov, A.A., Gulyaev, V.D., Kontrimavichus, V.L., 2011. A redescription of *Arostrilepis horrida* (Linstow, 1901) and descriptions of two new species from Palaearctic microtine rodents, *Arostrilepis macrocirrosa* sp. n. and *A. tenuicirrosa* sp. n. (Cestoda: Hymenolepididae). *Folia Parasitologica (Praha)* 58 (2), 108–120. <https://doi.org/10.14411/fp.2011.011>

- Makarikov, A.A., Galbreath, K.E., Hoberg, E.P., 2013. Parasite diversity at the Holarctic nexus: species of *Arostrilepis* (Eucestoda: Hymenolepididae) in voles and lemmings (Cricetidae: Arvicolinae) from greater Beringia. *Zootaxa* **3608** (6), 401–439. <https://doi.org/10.11646/zootaxa.3608.6.1>
- Makarikov, A.A., Dokuchaev, N.E., Koniaev, S.V., 2016. Tsestody gryzunov Severnogo Priokhot'ia [Cestodes of rodents of Northern Priokhotye]. *Vestnik Severo-Vostochnogo nauchnogo tsentra DVO RAN [Bulletin of the North-Eastern Scientific Center of the Far Eastern Branch of the Russian Academy of Sciences]* **4**, 52–61. (In Russian).
- Morand, S., Krasnov, B.R., Poulin, R. (eds.), 2006. Micromammals and macroparasites from evolutionary ecology to management. Springer-Verlag, Tokyo, Japan, 647 p.
- Morgun, E.N., Istrati, O.S., 2019. Osobo okhraniaemye prirodnye territorii v lamalo-Nenetskom avtonomnom okruge: garmoniia, konflikty, prirodookhranno-proizvodstvennyi kompromiss [Specially protected natural areas in the Yamal-Nenets Autonomous District: harmony, conflicts, environmental and industrial compromise]. *Nauchnyi vestnik lamalo-Nenetskogo avtonomnogo okruga [Scientific Bulletin of the Yamalo-Nenets Autonomous Okrug]* **1** (102), 5–11. (In Russian). <https://doi.org/10.26110/ARCTIC.2019.102.1.001>
- Morgun, E.N., Levykh, A.I., Il'iasov, R.M., Kremenetskaia, M.V., Suppes, N.E., 2022. K sozdaniiu lokal'noi sistemy OOPT IaNAO: sviashchennoe mesto "Angal'skii mys" kak pamiatnik prirody [Reating a local protected area system in Yamalo-Nenets Autonomous District: the sacred site "Angalsky Mys" as a natural monument]. *Samarskii nauchnyi vestnik [Samara Journal of Science]* **11** (1), 86–98. (in Russian). <https://doi.org/10.55355/snv2022111111>
- Pastukhov, A.M., 2013. Rol' zapovednika "Verkhne-Tazovskii" v podderzhanii bioraznoobraziia v basseine reki Taz [The role of the Verkhne-Tazovsky Nature Reserve in maintaining biodiversity in the Taz River basin]. *Samarskaia Luka: problemy regional'noi i global'noi ekologii [Samara Luka: Problems of Regional and Global Ecology]* **22** (4), 152–153. (In Russian).
- Pospekhova, N.A., Pereverzeva, V.V., Dokuchaev, N.E., Primak, A.A., 2023. Filogeneticheskie sviazi predstavitelei roda *Mesocestoides* Vaillant, 1863 ot mikromammalii Vostoka Rossii i Aliaski [Phylogenetic relationships of representatives of the genus *Mesocestoides* Vaillant, 1863 from small mammals in the East of Russia and Alaska]. *Vestnik Severo-Vostochnogo nauchnogo tsentra DVO RAN [The Bulletin of the North-East Scientific Center]* **3**, 67–79. (In Russian). <https://doi.org/10.34078/1814-0998-2023-3-67-79>
- Reiczigel, J., Rózsa, L., 2005. Quantitative Parasitology 3.0. Budapest. Version: 20 April 2025. Web page. URL: <http://www.zoologia.hu/qp/qp.html> (accessed: 25.07.2025).
- Reshet'ko, M.V., Moiseeva, Yu.A., 2016. Klimaticheskie osobennosti i statisticheskie otsenki izmeneniia elementov klimata v raionakh vechnoi merzloty na territorii severa Zapadnoi Sibiri [Climatic features and statistical assessments of changes in climate elements in permafrost areas in the north of Western Siberia]. *Izvestiia Tomskogo politekhnicheskogo universiteta. Inzhiniring georesursov [Bulletin of the Tomsk Polytechnic University. Geo Assets Engineering]* **327** (4), 108–118. (In Russian).
- Ryzhikov, K.N., Gvozdev, E.V., Tokobaev, M.N., Shaldybin, L.S., Matsaberidze, G.V. et al., 1978. Opredelitel' gel'mintov gryzunov fauny SSSR: tsestody i trematody [Identifier of helminths of rodents of the fauna of the USSR: Cestodes and Trematodes]. Nauka, Moscow, Russia, 232 p. (In Russian).
- Ryzhikov, K.N., Gvozdev, E.V., Tokobaev, M.N., Shaldybin, L.S., Matsaberidze, G.V. et al., 1979. Opredelitel' gel'mintov gryzunov fauny SSSR: nematody i akantotsefaly [Identifier of helminths of rodents of the fauna of the USSR: Nematodes and Acanthocephalans]. Nauka, Moscow, Russia, 279 p. (In Russian).

- Sheftel, B.I., Yakushov, V.D., 2022. Impacts of climate warming on terrestrial species in the Middle Yenisei taiga. *Contemporary Problems of Ecology* 15 (1), 1–10. <https://doi.org/10.1134/S1995425522010073>
- Sheikina, Z.V., Zhigileva, O.N., 2018. Gel'minty zemleroe (Soricidae) zapovednika "Malaia Sos'va" (Rossiia) [Helminths of shrews (Soricidae) of the Malaya Sosva Nature Reserve (Russia)]. *Nature conservation research* 3 (3), 28–36. (In Russian). <https://doi.org/10.24189/ncr.2018.019>
- Starikov, V.P., Vartapetov, L.G., 2021. Geographic ecological analysis of small mammals of the northern taiga of Western Siberia. *Contemporary Problems of Ecology* 14 (1), 49–61. <https://doi.org/10.1134/S1995425521010078>
- Talanova, G.I., 2018. Klimat zapovednika "Malaia Sos'va": mnogoletnie dannye [Climate of the Malaya Sosva Nature Reserve: long-term data]. *Dinamika okruzhaiushchei sredy i global'nye izmeneniia klimata [Environmental Dynamics and Global Climate Change]* 9 (1), 22–45. (In Russian). <https://doi.org/10.17816/edgcc8946>
- Tchebakova, N.M., Parfenova, E., Soja, A.J., 2009. The effects of climate, permafrost and fire on vegetation change in Siberia in a changing climate. *Environmental Research Letters* 4 (4), e045013. <https://doi.org/10.1088/1748-9326/4/4/045013>
- Vlasenko, P., Abramov, S., Bugmyrin, S., Dupal, T., Fomenko, N. et al., 2019. Geographical distribution and hosts of the cestode *Paranoplocephala omphalodes* (Hermann, 1783) Lühe, 1910 in Russia and adjacent territories. *Parasitology Research* 118 (12), 3543–3548. <https://doi.org/10.1007/s00436-019-06462-z>
- Wickström, L.M., Haukisalme, V., Varis, S., Hantula, J., Henttonen, H., 2005. Molecular phylogeny and systematics of anoplocephaline cestodes in rodents and lagomorphs. *Systematic Parasitology* 62, 83–99. <https://doi.org/10.1007/s11230-005-5488-5>
- Yushkov, V.F., Ivashchevskii, G.A., 1999. Parazity pozvonochnykh zhivotnykh Evropeiskogo Severo-Vostoka Rossii. Katalog [Parasites of vertebrates animals of European North-East of Russia. The catalogue]. Publishing house of the Komi scientific center of the Ural Branch of the Russian Academy of Sciences, Syktyvkar, Russia, 232 p. (In Russian).
- Zhigileva, O.N., 2011. Correlation between biodiversity indices of small mammals and their helminthes in West Siberian ecosystems. *Contemporary Problems of Ecology* 4 (4), 416–422. <https://doi.org/10.1134/S1995425511040114>
- Zhigileva, O.N., 2018. Zarazhennost' gel'mintami krasnoi i ryzhei polevok pri sovместnom obitanii [Helminth infestation of red and bank voles in cohabitation]. *Sbornik trudov Vserossiiskoi nauchnoi konferentsii s mezhdunarodnym uchastiem "Sovremennye problemy parazitologii i ekologii. Chteniia, posviashchennye pamiati S.S. Shul'mana" [Proceedings of the All-Russian scientific conference with international participation "Modern problems of parasitology and ecology. Readings dedicated to the memory of S.S. Shulman"]*. Tolyatti, Russia, 99–109. (In Russian).
- Zhigileva, O.N., Gorbacheva, E.V., Ahmetshina, R.Z., 2016. Ekologo-parazitologicheskii monitoring populiatsii melkikh mlekopitaiushchikh gorodskikh i prigorodnykh territorii [Ecological and parasitological monitoring of small mammals populations in urban and suburban areas]. *Ekologicheskii monitoring i bioraznoobrazie [Environmental Monitoring and Biodiversity]* 1 (11), 41–45. (In Russian).

Список литературы

- Аниканова, В.С., Бугмырин, С.В., Иешко, Е.П., 2007. Методы сбора и изучения гельминтов мелких млекопитающих. Карельский научный центр РАН, Петрозаводск, Россия, 115 с.

- Богданова, О.В., 2022. Проблемы природопользования в государственном природном заказнике регионального значения «Надымский», ЯНАО. *Московский экономический журнал* 7 (3), 34. https://doi.org/10.55186/2413046X_2022_7_3_159
- Бугмырин, С.В., Коросов, А.В., Беспятова, Л.А., Иешко, Е.П., 2015. Гельминтофауна рыжей полевки *Myodes glareolus* (Schreber, 1780) Кижского архипелага. *Паразитология* 49 (1), 61–71.
- Гашев, С.Н., Жигилева, О.Н., Сазонова, Н.А., Селюков, А.Г., Шаповалов, С.И. и др., 2006. Зооиндикаторы в системе регионального экологического мониторинга Тюменской области: методика использования. Издательство ТЮмГУ, Тюмень, Россия, 132 с.
- Гуляев, В.Д., Чечулин, А.И., 1996–1997. Дифференциальная диагностика *Paranoplocephala omphalodes* (Hermann, 1783) и *P. blanchardi* (Moniez, 1891) (Cestoda: Anoplocephalidae). *Selevinia*, 1–4.
- Жигилева, О.Н., 2018. Зараженность гельминтами красной и рыжей полевок при совместном обитании. *Сборник трудов Всероссийской научной конференции с международным участием «Современные проблемы паразитологии и экологии. Чтения, посвященные памяти С.С. Шульмана»*. Тольятти, Россия, 99–109.
- Жигилева, О.Н., Горбачева, Е.В., Ахметшина, Р.З., 2016. Эколого-паразитологический мониторинг популяций мелких млекопитающих городских и пригородных территорий. *Экологический мониторинг и биоразнообразие* 1 (11), 41–45.
- Левых, А.Ю., 2018. Мелкие млекопитающие в биомониторинге охраняемых территорий (на примере Ишимского района Тюменской области). *Самарский научный вестник* 7 (3), 65–72.
- Макариков, А.А., Докучаев, Н.Е., Коняев, С.В., 2016. Цестоды грызунов Северного Приохотья. *Вестник Северо-Восточного научного центра ДВО РАН* 4, 52–61.
- Моргун, Е.Н., Истрати, О.С., 2019. Особо охраняемые природные территории в Ямало-Ненецком автономном округе: гармония, конфликты, природоохранно-производственный компромисс. *Научный вестник Ямало-Ненецкого автономного округа* 1 (102), 5–11. <https://doi.org/10.26110/ARCTIC.2019.102.1.001>
- Моргун, Е.Н., Левых, А.Ю., Ильясов, Р.М., Кременецкая, М.В., Суппес, Н.Е., 2022. К созданию локальной системы ООПТ ЯНАО: священное место «Ангальский мыс» как памятник природы. *Самарский научный вестник* 11 (1), 86–98. <https://doi.org/10.55355/snv2022111111>
- Пастухов, А.М., 2013. Роль заповедника «Верхне-Тазовский» в поддержании биоразнообразия в бассейне реки Таз. *Самарская Лука: проблемы региональной и глобальной экологии* 22 (4), 152–153.
- Поспехова, Н.А., Переверзева, В.В., Докучаев, Н.Е., Примак, А.А., 2023. Филогенетические связи представителей рода *Mesocestoides* Vaillant, 1863 от микромаммалий Востока России и Аляски. *Вестник Северо-Восточного научного центра ДВО РАН* 3, 67–79. <https://doi.org/10.34078/1814-0998-2023-3-67-79>
- Решетько, М.В., Моисеева, Ю.А., 2016. Климатические особенности и статистические оценки изменения элементов климата в районах вечной мерзлоты на территории севера Западной Сибири. *Известия Томского политехнического университета. Инжиниринг георесурсов* 327 (4), 108–118.
- Рыжиков, К.Н., Гвоздев, Е.В., Токобаев, М.Н., Шалдыбин, Л.С., Мацаберидзе, Г.В. и др., 1978. Определитель гельминтов грызунов фауны СССР: цестоды и трематоды. Наука, Москва, Россия, 232 с.

- Рыжиков, К.Н., Гвоздев, Е.В., Токобаев, М.Н., Шалдыбин, Л.С., Мацаберидзе, Г.В. и др., 1979. Определитель гельминтов грызунов фауны СССР: нематоды и акантоцефалы. Наука, Москва, Россия, 279 с.
- Таланова, Г.И., 2018. Климат заповедника «Малая Сосьва»: многолетние данные. *Динамика окружающей среды и глобальные изменения климата* 9 (1), 22–45. <https://doi.org/10.17816/edgsc8946>
- Чечулин, А.И., Гуляев, В.Д., 1998. *Paranoplocephala longivaginata* sp. n. (Cyclophyllidea; Anoplocephalidae) – новая цестода от грызунов (Rodentia) Восточной Сибири. *Паразитология* 32 (4), 352–356.
- Шейкина, З.В., Жигилева, О.Н., 2018. Гельминты землероек (Soricidae) заповедника «Малая Сосьва» (Россия). *Nature conservation research. Заповедная наука* 3 (3), 28–36. <https://doi.org/10.24189/ncr.2018.019>
- Юшков, В.Ф., Ивашевский, Г.А., 1999. Паразиты позвоночных животных Европейского Северо-Востока России. Каталог. Издательство Коми научного центра УрО РАН, Сыктывкар, Россия, 230 с.
- Avenant, N.L., Cavallini, P., 2007. Correlating rodent community structure with ecological integrity, Tussen-die-Riviere Nature Reserve, Free State province, South Africa. *Integrative Zoology* 2 (4), 212–219. <https://doi.org/10.1111/j.1749-4877.2007.00064.x>
- Galbreath, K.E., Ragaliauskaite, K., Kontrimavichus, L., Makarikov, A.A., Hoberg, E.P., 2013. A widespread distribution for *Arostrilepis tenuicirrosa* (Eucestoda: Hymenolepididae) in *Myodes voles* (Cricetidae: Arvicolinae) from the Palearctic based on molecular and morphological evidence: historical and biogeographic implications. *Acta Parasitologica* 58 (4), 441–452. <https://doi.org/10.2478/s11686-013-0170-6>
- Groisman, P.Y., Blyakharchuk, T.A., Chernokulsky, A.V., Arzhanov, M.M., Marchesini, L.B. et al., 2013. Climate changes in Siberia. In: Groisman, P., Gutman, G. (eds.), *Regional environmental changes in Siberia and their global consequences*. Springer Environmental Science and Engineering. Springer, Dordrecht, 57–109. https://doi.org/10.1007/978-94-007-4569-8_3
- Haukisalmi, V., Wickström, L.M., Henttonen, H., Hantula, J., Gubanyi, A., 2004. Molecular and morphological evidence for multiple species within *Paranoplocephala omphalodes* (Cestoda, Anoplocephalidae) in *Microtus voles* (Arvicolinae). *Zoologica Scripta* 33 (3), 277–290. <https://doi.org/10.1111/j.0300-3256.2004.00148.x>
- Haukisalmi, V., Hardman, L.M., Hardman, M., Laakkonen, J., Niemimaa, J., Henttonen, H., 2007. Morphological and molecular characterisation of *Paranoplocephala buryatiensis* n. sp. and *P. longivaginata* Chuchulin and Gulyaev, 1998 (Cestoda: Anoplocephalidae) in voles of the genus *Clethrionomys*. *Systematic Parasitology* 66, 55–71. <https://doi.org/10.1007/s11230-006-9059-1>
- Haukisalmi, V., Hardman, L.M., Hoberg, E.P., Henttonen, H., 2014. Phylogenetic relationships and taxonomic revision of *Paranoplocephala* Lühe, 1910 sensu lato (Cestoda, Cyclophyllidea, Anoplocephalidae). *Zootaxa* 3873, 371–415. <https://doi.org/10.11646/ZOOTAXA.3873.4.3>
- Kislyi, A.A., Ravkin, Y.S., Bogomolova, I.N., Tsybulin, S.M., Panov, V.V. et al., 2019. Distribution of northern red-backed vole *Myodes rutilus* (Pallas, 1779) in Western Siberia. *Contemporary Problems of Ecology* 12 (1), 10–22. <https://doi.org/10.1134/S1995425519010086>

- Kononova, M., Prisniy, Yu., 2020. Helminthes of mouse-like rodents in the Belogorye State Nature Reserve (Russia). *Nature Conservation Research* **5** (Suppl. 2), 11–18. <https://doi.org/10.24189/ncr.2020.036>
- Krivopalov, A., Vlasenko, P., Abramov, S., Akimova, L., Barkhatova, A. et al., 2022. Distribution and molecular diversity of *Paranoplocephala kalelai* (Tenora, Haukisalmi & Henttonen, 1985) Tenora, Murai & Vaucher, 1986 in voles (Rodentia: Myodes) in Eurasia. *Diversity* **14** (6), 472–478. <https://doi.org/10.3390/d14060472>
- Makarikov, A.A., Dokuchaev, N.E., 2021. Tapeworms in rodents from the Lower Anabar River Basin, with a review of species diversity of Cestodes in Yakutia, Russia. *Acta Parasitologica* **66**, 1012–1020. <https://doi.org/10.1007/s11686-021-00376-6>
- Makarikov, A.A., Gulyaev, V.D., Kontrimavichus, V.L., 2011. A redescription of *Arostrilepis horrida* (Linstow, 1901) and descriptions of two new species from Palaearctic microtine rodents, *Arostrilepis macrocirrosa* sp. n. and *A. tenuicirrosa* sp. n. (Cestoda: Hymenolepididae). *Folia Parasitologica (Praha)* **58** (2), 108–120. <https://doi.org/10.14411/fp.2011.011>
- Makarikov, A.A., Galbreath, K.E., Hoberg, E.P., 2013. Parasite diversity at the Holarctic nexus: species of *Arostrilepis* (Eucestoda: Hymenolepididae) in voles and lemmings (Cricetidae: Arvicolinae) from greater Beringia. *Zootaxa* **3608** (6), 401–439. <https://doi.org/10.11646/zootaxa.3608.6.1>
- Morand, S., Krasnov, B.R., Poulin, R. (eds.), 2006. Micromammals and macroparasites from evolutionary ecology to management. Springer-Verlag, Tokyo, Japan, 647 p.
- Reiczigel, J., Rózsa, L., 2005. Quantitative Parasitology 3.0. Budapest. Version: 20 April 2025. Интернет-ресурс. URL: <http://www.zoologia.hu/qp/qp.html> (дата обращения: 25.07.2025).
- Sheftel, B.I., Yakushov, V.D., 2022. Impacts of climate warming on terrestrial species in the Middle Yenisei taiga. *Contemporary Problems of Ecology* **15** (1), 1–10. <https://doi.org/10.1134/S1995425522010073>
- Starikov, V.P., Vartapetov, L.G., 2021. Geographic ecological analysis of small mammals of the northern taiga of Western Siberia. *Contemporary Problems of Ecology* **14** (1), 49–61. <https://doi.org/10.1134/S1995425521010078>
- Tchebakova, N.M., Parfenova, E., Soja, A.J., 2009. The effects of climate, permafrost and fire on vegetation change in Siberia in a changing climate. *Environmental Research Letters* **4** (4), e045013. <https://doi.org/10.1088/1748-9326/4/4/045013>
- Vlasenko, P., Abramov, S., Bugmyrin, S., Dupal, T., Fomenko, N. et al., 2019. Geographical distribution and hosts of the cestode *Paranoplocephala omphalodes* (Hermann, 1783) Lühe, 1910 in Russia and adjacent territories. *Parasitology Research* **118** (12), 3543–3548. <https://doi.org/10.1007/s00436-019-06462-z>
- Wickström, L.M., Haukisalmi, V., Varis, S., Hantula, J., Henttonen, H., 2005. Molecular phylogeny and systematics of anoplocephaline cestodes in rodents and lagomorphs. *Systematic Parasitology* **62**, 83–99. <https://doi.org/10.1007/s11230-005-5488-5>
- Zhgileva, O.N., 2011. Correlation between biodiversity indices of small mammals and their helminthes in West Siberian ecosystems. *Contemporary Problems of Ecology* **4** (4), 416–422. <https://doi.org/10.1134/S1995425511040114>

