

Helminths of *Erinaceus roumanicus*

Subjects: **Parasitology**

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Among Eulipotyphla, the Erinaceinae subfamily containing the well-known hedgehogs of Eurasia and Africa deserves special attention. The helminth fauna of the Northern white-breasted hedgehog *Erinaceus roumanicus* was studied in the Republic of Mordovia (Russia) for the first time. A total of 54 parasite species were recorded across *Erinaceus europaeus*, *E. roumanicus*, *E. concolor* and *E. amurensis*. Among all the studied species of hedgehogs, *E. europaeus* (35 species) and *E. roumanicus* (36) have the richest helminth faunas. The diversity of the parasite communities of *Erinaceus* spp. is due to the wide distribution and varied diet of these mammals. Most of the helminths found in hedgehogs are transmitted along trophic chains.

Erinaceus spp.

parasitic worms

Western European hedgehog

Northern white-breasted hedgehog

Southern white-breasted hedgehog

Amur hedgehog

Palearctic

1. Introduction

Small terrestrial mammals, such as the Eulipotyphla and Rodentia, are important elements of ecosystems due to their high species diversity, fitness, and diet specializations. This animal group, due to its high abundance and wide distribution, is an integral part of any semi-aquatic or terrestrial biocenosis and it is of great practical importance ^{[1][2][3][4][5]}. Small wild animals are the main forage resource for predatory mammals, birds of prey, and some reptiles (mainly snakes) ^{[6][7][8]}. Small mammals are of great importance in rural environments as many are a source of parasites and some diseases of domestic animals and livestock ^{[9][10][11][12][13][14]}.

Hedgehogs are nocturnal and spend most of their active time foraging ^[15]. These omnivores have ecological plasticity that allows them to inhabit various biotopes. They are present in many habitat types (habitats) if their primary forage (invertebrates) and suitable nest sites are sufficiently available ^{[16][17]}. Hedgehogs are often found in urban and suburban environments ^[17].

Hedgehogs of the Erinaceidae family are widespread in the Palearctic. Currently, four hedgehog species of the genus *Erinaceus* are known: *Erinaceus europaeus* Linnaeus 1758, *Erinaceus roumanicus* Barrett-Hamilton, 1900, *Erinaceus concolor* Martin, 1837 and *Erinaceus amurensis* Schrenk, 1858. *Erinaceus roumanicus* has only recently been defined as a valid species ^[15]. Three hedgehog species inhabit Western Palearctic: *E. europaeus*, *E. roumanicus*, and *E. concolor* ^[18]. The Western European hedgehog *E. europaeus* inhabits the forest

areas of Western and Central Europe (including the British Isles), Southern Fennoscandia, Estonia, and the north and central regions of European Russia [\[19\]](#)[\[20\]](#)[\[21\]](#)[\[22\]](#)[\[23\]](#)[\[24\]](#).

The Northern white-breasted hedgehog *E. roumanicus* inhabits Central and Eastern Europe, the south of Western Siberia and the North Caucasus. *Erinaceus roumanicus* and *E. europaeus* are sympatric in central Europe (the Balkans, Poland, the Czech Republic, and Slovakia) and central regions of European Russia [\[21\]](#)[\[22\]](#)[\[24\]](#). The northern border of the species range in Russia is at the level of 56° north latitude; in the south it is distributed to the Caucasus [\[24\]](#).

The Southern white-breasted hedgehog *E. concolor* is found in the Middle East, isolated from *E. roumanicus* by the Bosphorus Strait and the Caucasus Mountains [\[21\]](#)[\[22\]](#). Until recent times, *E. roumanicus* was considered to belong either to *E. europaeus* or to *E. concolor*, and it has only recently been identified as a valid species [\[25\]](#).

The only *Erinaceus* species inhabiting the Eastern Palearctic is the Amur hedgehog *E. amurensis*. Its range covers the Russian Far East, and northeastern China, Korea, and Japan [\[26\]](#).

Hedgehogs harbor a wide range of numerous zoonotic pathogens, parasitic infections, and bacterial diseases [\[15\]](#)[\[27\]](#). Species-specific endoparasites, such as lungworms *Crenosoma striatum* cause bronchitis and bronchopneumonia [\[28\]](#). Nematodes (mainly *Eucoleus* spp. and *Aonchotheca* spp.) are prevalent lung and intestinal parasites [\[28\]](#)[\[29\]](#).

Hedgehogs as final, intermediate, and paratenic hosts can be involved in the life cycles of helminths that parasitize other vertebrates. So, hedgehogs can be infected by *Alaria alata* (mesocercaria), *Spirometra erinacei* (plerocercoid), *Physocephalus sexalatus* (juvenile), and *Trichinella* spp., which are zoonotic parasites [\[30\]](#)[\[31\]](#)[\[32\]](#)[\[33\]](#). The epidemiological and epizootic potential of many parasites carried by hedgehogs determines the interest in their study of the parasite fauna of these animals.

2. Helminths of *Erinaceus roumanicus* in Mordovia (Russia)

Nine helminth species in twenty-three hedgehogs from the Republic of Mordovia were found, including two trematodes, one cestode, five nematodes, and one acanthocephalan (**Table 1**). The total infestation of hedghogs by helminths was 100%, the index of helminth mean abundance was 118.5. The intensity range of hedgehog invasion by helminths was from 17 to 514 specimens. Most of helminths (6 species) found in the hedgehogs of Mordovia parasitize at the mature stage. Three species (the trematode *S. strigis*, the nematodes *P. sexalatus* and *A. minuta*) were found at the larval stage. Hedgehogs are paratenic hosts for these parasites. Five species are host-specific parasites of hedgehogs: the cestode *H. erinacei*, the nematodes *A. erinacei*, *P. clausa*, *C. striatum*, and the acanthocephalan *N. major*. Another four species are accidental (or unusual) parasites of hedgehogs.

Table 1. Helminth fauna of *Erinaceus roumanicus* in Mordovia (Russia).

Helminth Species	Location in Host	P, %	IR, Spec.	MA
Trematoda <i>Isthmiophora melis</i> (Schränk, 1788)	small intestine	13.0	2–86	4.0
<i>Strigea strigis</i> (Schränk, 1788), metacercaria	mesentery around oesophagus and trachea	4.3	2	0.1
Cestoda <i>Hymenolepis erinacei</i> (Gmelin, 1789)	small intestine	52.2	1–97	7.8
Nematoda <i>Aonchotheca erinacei</i> (Rudolphi, 1819)	stomach, small intestine	56.5	1–149	19.5
<i>Physaloptera clausa</i> Rudolphi, 1819	stomach	100	9–420	77.4
<i>Crenosoma striatum</i> Zeder, 1800	bronchi	8.7	3–18	0.9
<i>Physocephalus sexalatus</i> (Molin, 1860), juv.	walls of stomach and small intestine	13.0	8–177	8.6
<i>Agamospirura minuta</i> Sharpilo, 1963	gastric mucosa and first third of small intestine	4.3	3	0.1
Acanthocephala				
<i>Nephridiorhynchus major</i> (Bremser, 1811)	small intestine	4.3	2	0.1

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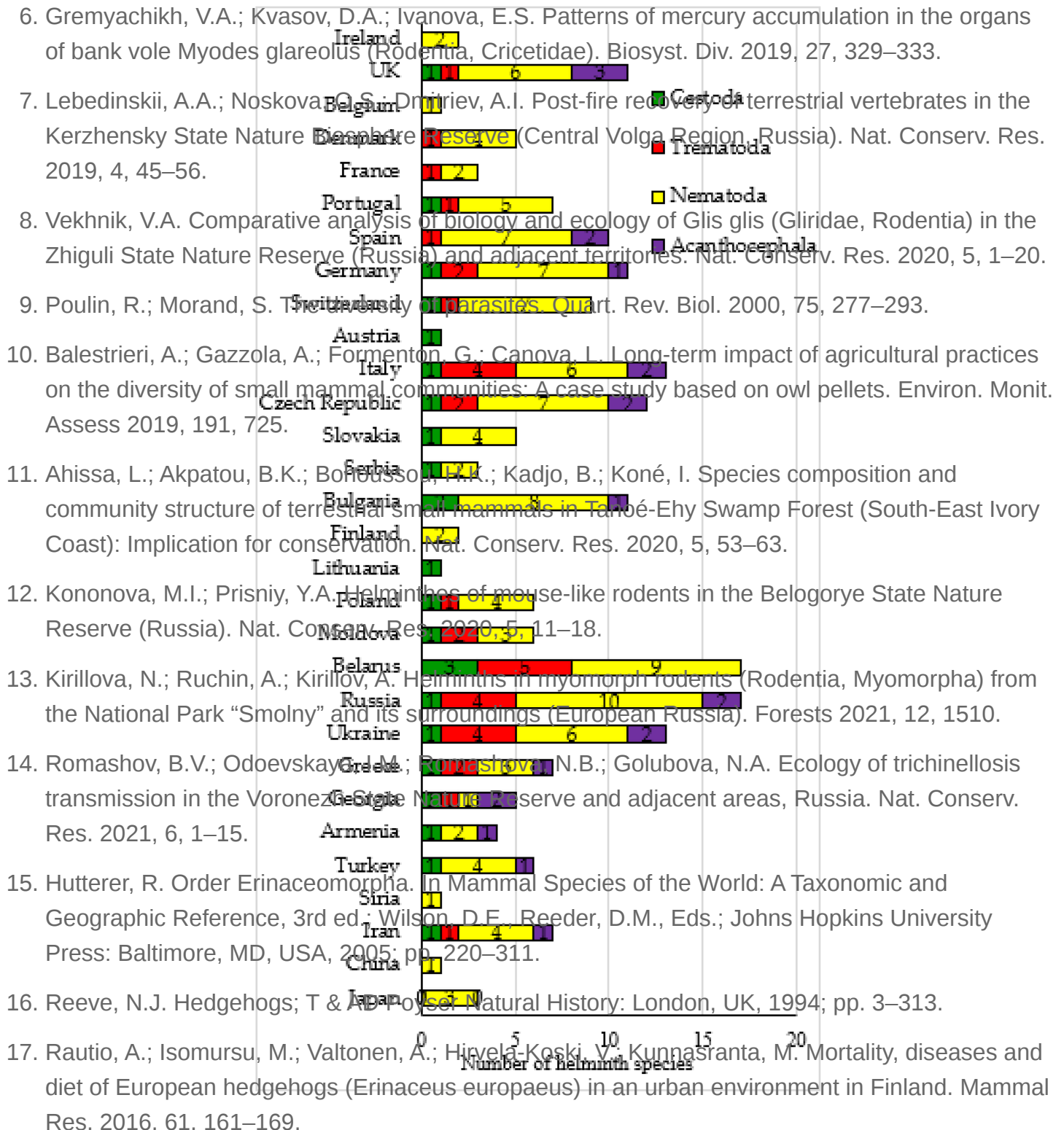
3. Comparative Analysis of the Helminth Fauna of *Erinaceus spp.*

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2. Rudovskaya, M.V.; Aleksandrov, A.N.; Podshivalina, V.N.; Soboleva, A.S.; Glushenkov, O.V. The helminth fauna of *Erinaceus* spp. in Palaearctic includes 54 species: 14 trematodes, 8 cestodes, 27 nematodes and 7 acanthocephalans. Among all the studied species of hedgehogs *E. europaeus* (35 species) and *E. roumanicus* (26) have the richest helminth faunas. A significantly smaller number of parasite species was found in *E. concolor* (12) and *E. amurensis* (4). The greatest richness of the helminth fauna in hedgehogs was in Russia and Belarus, where 17 species of parasites were found in each country (**Figure 1**). Thirteen species of parasites were found in hedgehogs both in Italy and in Ukraine. Twelve species of parasitic worms were recorded in *E. concolor* in the Longtepapamonitoring ofred ibis species numbers inMagdalen Nature Reserve in, 1980–2021. *Proc. Mordovia State Nat. Res.* 2021, 29, 319–325.

3. Bashinskiy, I.V. Beaver impact on water coverage of forest-steppe territories (Penza region, European Russia). *Nat. Conserv. Res.* 2021, 6, 88–97.

4. Gaidysh, I.S. The species composition and abundance of terrestrial small mammals in the Finnish-Russian Friendship Nature Reserve. *Nat. Conserv. Res.* 2021, 6, 127–136.



- Figure 1.** Species richness of helminths in hedgehogs of *Erinaceus* genus in Palearctic region.
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- The African and Middle Eastern hedgehogs are relatively less diverse in helminths, for example, in Iran, where seven species of parasites were registered in each country. Six species of parasitic worms were noted in hedgehogs in Moldova, Turkey and Poland (in each country); five helminth species – in Denmark, Slovakia and Georgia. Four species of parasites were found in *E. concolor* from Armenia. Three helminth species were noted in hedgehogs in Western Yugoslavia. *Biosistematika* 1983, 9, 71–78.
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Comparative analysis of the helminth species composition in *Erinaceus* spp. from different countries showed, on the one hand, the originality of the parasite faunas of each hedgehog species, on the other, the similarity of the and the northern white-breasted hedgehog during the Late Quaternary in Europe. *J. Zool.* 2007, 273, 82–89.

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hybridization between west European and northern white-breasted hedgehogs (*Erinaceus europaeus* and *E. roumanicus*) in Moscow Region. *Biol. Bull.* 2009, 6, 760–765.

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A high similarity in the helminth fauna of hedgehogs from countries far from each other was noted only when comparing the parasites of one species of hedgehogs (in *E. europaeus* from Finland and Ireland – 0.67). As a rule,

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The diet and lifestyle of hedgehogs affect their helminth species composition. Hedgehogs get most of their helminths through food. Hedgehogs are omnivorous animals. But invertebrates are important food sources, including beetles (adult and larvae), earthworms, caterpillars, and moth larvae, slugs, and snails. [34][35][36]

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The revealed helminth fauna confirms the omnivorous diet of *Erinaceus* hedgehogs. Hedgehogs get all species of trematodes and cestodes (except parasite larvae), acanthocephalans, as well as most species of nematodes (except nematodes with a direct life cycle) by eating invertebrates, which are intermediate and paratenic hosts of helminths.

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4. Conclusions

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The helminth fauna of the Northern white-breasted hedgehog *Erinaceus roumanicus* was studied for the first time in the Republic of Mordovia (Russia). In total, nine species of helminths in hedgehogs were found. Of them, four

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