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Article

Soil mesofauna in pine forests of the Volga-Kama Reserve

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Abstract. The results of studies in soil mesofauna at pine forests of Saraly and Raifa sectors of Volga-Kama Reserve are presented in paper. These sectors are located in different landscape zones. The research was conducted in pine forests of the Volga-Kama Natural Biosphere Reserve in 2012–2022. Standard soil-zoological samples were taken in each plot twice a season during three consecutive years. A total of 624 samples were taken and 2870 invertebrates were counted. The taxonomic structure of the mesofauna of both sectors of the Reserve was similar and included 23 and 21 large taxa, in Saraly and Raifa sectors, respectively. Isopodes, Dermaptera and Silphidae were absent in the Raifa sector. The abundance of mesofauna varied approximately within the same limits and averaged 74 specimens per square meter, that was twice as high as the data for the region as a whole. The trophic structure of mesofauna was mostly similar, in all pine forests predators and in most cases saprophages predominated, less phytophages, but they also played the significant role in the pedobiont community. The structure of pedobiont communities differed significantly both in zonal aspect and by the location of the community in a particular.

Keywords: soil invertebrates, pine forests, abundance, taxonomic composition, trophic structure

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Научная статья**Почвенная мезофауна сосновых лесов
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Аннотация. В работе приведены результаты исследований почвенной мезофауны сосняков Саралинского и Раифского участков Волжско-Камского заповедника, расположенных в разных ландшафтных зонах. Исследования выполнялись в 2012–2022 гг., в течение двух–трех последовательных лет в каждом плоте дважды в сезон брали стандартные зоологические пробы. Общее количество проб составило 624, было зарегистрировано 2870 беспозвоночных. Таксономическая структура мезофауны обоих участков заповедника сходна и включает 24 и 21 крупный таксон в Саралинском и Раифском участках соответственно. В Раифском участке отсутствовали Isopoda, Dermaptera и Silphidae. Численность мезофауны варьирует примерно в одинаковых пределах и составляет в среднем 74 экз./м², что вдвое выше данных по региону в целом. Трофическая структура мезофауны в большей степени сходная, во всех сосняках преобладают хищники и в большинстве случаев сапрофаги; фитофагов меньше, но они также играют значимую роль в сообществе педобионтов. В то же время структура и население сообществ педобионтов статистически значимо отличается как в зональном аспекте, так и по месту положения сообщества в конкретном локалитете.

Ключевые слова: почвенные беспозвоночные, хвойные леса, обилие, таксономический состав, трофическая структура

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Introduction

Determining the potential distribution of soil biodiversity with respect to its density and richness, including its constituent species, is a prerequisite for assessing, conserving and protecting soil biodiversity and the soil functions it defines (Salako et al., 2022). The bulk of terrestrial ecosystem biodiversity is represented by soil fauna (FAO et al., 2020). Moreover, most ecosystem services provided by terrestrial habitats are based on soil functions (Adhikari and Hartemink, 2015), with almost all soil functions arising from processes caused by soil organisms.

Soil biodiversity plays a crucial role in pedogenesis and soil functioning, including chemical and physical processes, enabling essential ecosystem functions such as nutrient cycling, biomass production, water or pest regulation (Brussaard et al., 1997; de Vries et al., 2013). Soil animals are particularly abundant and represent about 25% of all animal species on Earth (Decaëns et al., 2006). Several classifications of soil animals have been proposed in order to describe and understand their ecological importance to soils (Hedde et al., 2022). The present study summarized the results of monitoring the soil mesofauna of coniferous forests of the Volga-Kama State Natural Biosphere Reserve). It includes the following groups of soil invertebrates: earthworms – inhabitants of litter and soil, processing litter and passing soil through the body, participating in the process of humification, enriching soil with microelements, useful microflora; predatory millipedes drupes and earthlings, consumers of the 2nd and higher order, they regulate the number of invertebrates; saprophilous millipedes and woodlouses, participating in mineralization of dead plant organic matter; plant-eating mollusks – slugs; larvae of phytophagous beetles – click beetles (wireworms), weevils, cockchafers, consumers of the 1st order.

Soil ecosystems in pine forests in protected areas are among the most valuable objects of protection, and the current assessment of their condition is an important scientific and technical task of the reserves of the Russian Federation (Emets, 2014). Diagnosis of the soil ecosystems state belongs to the number of complex and underdeveloped scientific and technical problems, and the indication of the soil ecosystems health with the help of various groups of soil invertebrates is one of the most promising directions.

In the modern period, the issue of preserving the biological diversity of forests and maintaining their sustainability is acute, which is impossible without a thorough knowledge of the peculiarities of their functioning and is a priority area of research of ecologists in Russia and abroad (Konakova and Kolesnikova, 2011; Trube, 2010). The integrity and functioning of soil mesofauna contribute to the sustainable development of these biocenoses. This task is of particular importance in specially protected natural areas.

Information on invertebrates of the Volga-Kama State Natural Biosphere Reserve (hereinafter referred to as VKR) and the surrounding area is known since the XIX century from the first surveys of E. Eversmann, K.E. Lindemann, M.D. Ruzsky; in the early XX century, clarifications and additions were made by G.G. Jakobson, N.F. Mayer (Akhmetzyanova et al., 2003). With the organization of VKZ in 1960¹, the number of studies increased by the efforts of its staff. They mainly concerned collections of separate groups of insects. The fauna and population of soil mesofauna of the Volga-Kama Reserve, especially its forest-steppe Saraly sector, have been poorly studied and are fragmentary in nature. Preliminary results of these studies have been published earlier in conference proceedings (Gordienko et al., 2013; 2016a, b).

¹ Notes on the history of the reserve. Web page. URL: <https://vkgz.ru/ru/zametki-po-istorii-zapovednika> (accessed: 30.01.2024).

The aim of the present work was to conduct an inventory of pedobionts in coniferous biotopes of the Volga-Kama Reserve and to reveal zonation and locality impact on their community structure formation in VKR coniferous biotopes.

Material and methods

The studies were conducted on the territory of the Volga-Kama State Natural Biosphere Reserve. The territory of Reserve consists two parts (sectors): Raifa sector is located in the subtaiga subzone of the boreal landscape, Saraly sector – in broad-leaved forest subzone of the subboreal northern semihumid landscape zone (Ermolaev et al., 2007). Field sampling was carried out in 2012–2022.

The abundance of soil mesofauna was counted in pine biotopes of 4 quarters of the Saraly sector and 8 quarters of the Raifa sector (Table 1). Pedobionts were counted using the standard soil-zoological method – soil plots 25×25 cm² and 15–20 cm deep, in the layer of the highest occurrence of animals (Byzova et al., 1987). Soil sample were collected on site using the manual disassembly method. In total, 624 samples were taken and 2870 invertebrates were counted. The samples were taken twice a season in each biotope during one year in each of the quarters of the Raifa sector and three consecutive years in the quarters of the Saraly sector.

Statistical processing of data was carried out in Excel 2007 (12.0), Statistica 8. Multivariate discriminant analysis of data with dependent variables “zonality” and “locality” was performed.

Results and discussion

The taxonomic composition of soil mesofauna communities of pine forests of the Raifa sector was represented by 3 types – Annelida, Mollusca and Artropoda, 6 classes – Clitellata, Gastropoda, Arachnida, Chilopoda, Diplopoda, Insecta, 14 detachments – Haplotaxida, Pulmonata, Araneae, Opiliones, Geophilomorpha, Lithobiomorpha, Julida, Blattodea, Hemiptera, Neuroptera, Coleoptera, Lepidoptera, Hymenoptera, Diptera (in total of 21 taxonomic groups, 11–16 at each sampling point) (Table 2). Insects (Insecta), predatory millipedes Chilopoda (Lithobiidae), millipedes Diplopoda, earthworms Lumbricidae and spiders Arachnidae dominated there. Among insects, beetles (Coleoptera) – Elateridae and Staphilinidae were numerous.

The abundance of pedobionts in the Raifa sector of the Reserve varied within 37–104 specimens/m², on average 75.2 specimens/m². In quarter 25, two plots were surveyed, differing in light, grass cover and stand density; in the more lighted and warmed forest plot of that quarter, the abundance of soil mesofauna was 2.8 times higher (Table 2).

In the Saraly sector we recorded 3 types – Annelida, Mollusca and Artropoda, 7 classes – Clitellata, Gastropoda, Isopoda, Arachnida, Chilopoda, Diplopoda, Insecta, 16 orders – Haplotaxida, Pulmonata, Araneae, Geophilomorpha, Lithobiomorpha, Julida, Polydesmida, Polyzoniida, Blattodea, Dermaptera, Hemiptera, Neuroptera, Coleoptera, Lepidoptera, Hymenoptera, Diptera (in total 24 taxonomic groups 12–22 at each collection point) (Table 3). Insecta insects, predatory litter-dwelling millipedes Lithobiidae, spiders Arachnidae and earthworms Lumbricidae also dominated there. Beetles (Coleoptera) Elateridae, Curculionidae weevils and Diptera diptera were numerous among insects. 21 taxonomic groups were common to the Saraly and Raifa sectors.

The abundance of soil mesofauna in the Saraly sector of the Reserve was similar to that in the Raifa sector (Table 3), varying within the same limits of 33.8–102.8 specimens/m² (mean value 73.4 specimens/m²). General abundance of pedobionts in the studied quarters of the Reserve is presented in Fig. 1. Its values exceeded the average values of pedobiont abundance in pine forests in the Republic of Tatarstan (Kadastr..., 2014).

The results of trophic structure assessment are presented in Fig. 2. The ratio of trophic groups varied in the pine forests of the Raifa sector of the Reserve, with saprophages (30.5–56.3%) and predators (25.2–52.5%) predominating in most cases (quarter 162, 156, 63, 47, 25-1, 58), except for two (quarter 25-2 and 154), where they yielded to phytophages (45.9–64.6%). The predatory group of invertebrate mesofauna was abundant in all pine sites studied (20.7–52.7%). On average, the proportion of saprophages and predators in that sector of the Reserve was similar (36.8% and 37.4%, respectively), phytophages were slightly less (21.4%). The predominance of predators in the community of mesofauna pedobionts is characteristic of pine forests (Kadastr..., 2014).

Table 1. Description of studied areas of the Volga-Kama Reserve.

No	Sector, quarter	Year of study	Designation in the text	Coordinates	Plant association
1	Raifa, KB. 154	2012	154	N 55.937123 E 48.862850	Pinetum pteridosum
2	Raifa, KB. 63	2014	63	N 55.889277 E 48.727539	Pinetum hylocomioso-herbosum
3	Saraly, KB.24	2014–2016	24	N 55.312076 E 49.247264	Pinetum acero-plataniosum
4	Saraly, KB.42	2014–2016	42	N 55.289442 E 49.246432	Pinetum cladoso-herboso-hylocomiosum
5	Raifa, KB. 47	2015	47	N 55.890454 E 48.711775	Pinetum vaccinoso-bryoso-herbosum
6	Raifa, KB. 25	2016	25-1	N 55.9099 E 48.7328	Pinetum pteridoso-vaccinoso-herbosum
7	Raifa, KB. 58	2017	58	N 55.889291 E 48.686413	Pinetum vaccinoso-rubus-saxatiliosum-bryoso-herbosum
8	Saraly, KB.32	2017–2019	32	N 55.304379 E 49.239163	Pinetum cladinoso-calamagrostiso-herbosum
9	Saraly, KB.46	2017–2019	46	N 55.287621 E 49.249408	Pinetum hylocomioso-cladinosum
10	Raifa, KB. 162	2018	162	N 55.929016 E 48.865744	Pinetum pteridium-convallariosum
11	Raifa, KB. 156	2018	156	N 55.9325 E 48.859444	Pinetum convallarioso-pteridosum
12	Raifa, KB. 25	2022	25-2	N 55.912222 E 48.740833	Pinetum oxalioso-herbosum

In the Saraly sector of the Reserve, the results for the trophic group in the pedobiont community were similar to those in the Raifa sector. There, predators (20.8–48.4%), saprophages (13.4–52.5%) and slightly less phytophages (12.4–33.9%) also dominated.

Multivariate analysis of the data according to the dependent variables “locality” and “zonality” revealed the following:

– all pine forests differed from each other in terms of pedobiont population structure (Wilks' Lambda: 0.26, approx. $F(143.5100) = 6.01$, $p < 0.0000$), except quarters 63 and 47, 25 and 162;

– in general, pedobiont communities of the two sectors of the Reserve were also statistically significantly different (Wilks' Lambda: 0.83964, approx. $F(11.612) = 10.626$, $p < 0.0000$).

One important detail should be noted: when assessing the contribution of individual variables to discrimination, Wilks'-Lambda as a measure of sample cohesion had much lower value in the case of the dependent variable “locality” than with the variable “zonality” (Tables 4, 5). This suggests that specific conditions in each individual study plot have a greater influence on the formation of soil cenosis structure than the influence of landscape habitat zone.

The Square Mahalanobis Distance (an indicator of differences in the community structure) was low and ranged from 1.17–7.06, indicating sometimes insignificant differences in the structural organization of the pedobiont community. The greatest differences were observed between the communities in quarters 58 and 154 located at opposite ends of the Reserve (in the southwest and northeast, respectively). Closely located pine forests of quarters 47 and 63 of the Raifa sector did not differ in the mesofauna structure. The Square Mahalanobis Distance between the Raifa and Saralinsk sectors communities was low (0.79). The latter indicated small but statistically significant differences in the pedobiont communities of the pine forests of the two plots, if we consider the latter as a whole.

Table 2. Numbers of mesofauna in coniferous biotopes of Raifa sector of the Reserve (specimen per m²).

Taxon	Quarter								Mean	%
	25-1	25-2	47	58	63	154	156	162		
Geophilomorpha	0.5	6.5	1.5	4	5	1	0.5	1	2.5	3.3
Lithobiomorpha	19	4.5	13	17	14.5	3	10	14	11.9	15.8
Diplopoda	25	1	11	19	8.5	2	18	13	12.2	16.2
Insecta all	42	22	42.5	35.5	38.5	32	22	17	31.4	41.8
Blattodea	2	0.5	1.5	0.5	2	0.5	1.5	0	1.1	1.4
Hemiptera	3.5	0.5	6	1.5	2.5	0	1.5	1	2.1	2.7
Neuroptera	0.5	0	0	0	0	0	0	0	0.1	0.1
Coleoptera all	30.5	17	31.5	28.5	22	28	14.5	12	23.0	30.6
Carabidae	5	0	4	11	1.5	1	3.5	1	3.4	4.5
Staphylinidae	8.5	1	4.5	7.5	5.5	0.5	1.5	4	4.1	5.5
Tenebrionidae	0	0	0	0	0	0	0.5	0	0.1	0.1
Melolonthinae	2	2.5	3.5	1	0	15	1.5	0	3.2	4.2
Geotrupinae	0	0	0	0	0	0	0.5	0	0.1	0.1
Cantharidae	0	0	0	0	0.5	0	0	0	0.1	0.1
Elateridae	13.5	7.5	17	6.5	13	5.5	7	7	9.6	12.8
Curculionidae	1.5	6	2.5	2.5	1.5	6	0	0	2.5	3.3
Hymenoptera	1	1.5	0	1.5	0.5	0	0	1	0.7	0.9
Diptera	3.5	1	2	2.5	10.5	3	2.5	2	3.4	4.5
Lepidoptera	1	1	0.5	0.5	1	0	0.5	1	0.7	0.9
Others	0	0.5	1	0.5	0	0.5	1.5	0	0.5	0.7
Araneae	12	2	6.5	9	2	3	1.5	10	5.8	7.6
Opiliones	0	0	0.5	1.5	0	0	0	1	0.4	0.5
Mollusca	0	0	0	0	0.5	0	0	0	0.1	0.1
Lumbricidae	4	1	23.5	18	23	0	15.5	3	11.0	14.6
Total	102.5	37	98.5	104	92	41	67.5	59	75.2	100.0
Saprophagous	34.5	3.5	38	40	44	5.5	38	18	27.7	36.8
Phytophagous	18	17	23.5	10.5	16	26.5	9.5	8	16.1	21.4
Predators	45.5	14	30	50	29	8.5	17	31	28.1	37.4
Mixed group	4.5	2.5	7	3.5	3	0.5	3	2	3.3	4.3

Table 3. Number of mesofauna in coniferous biotopes of Saraly sector of the Reserve (specimen per m²).

Taxon	Quarter				Mean	%
	24	32	42	46		
Isopoda	0.1	0.0	0.0	0.0	0.05	0.0
Geophilomorpha	9.4	0.0	0.0	0.0	2.4	3.2
Lithobiomorpha	14.6	5.8	21.0	10.0	12.8	17.5
Diplopoda	7.9	0.0	10.2	2.4	5.1	7.0
Insecta all	22.1	17.3	49.4	57.5	36.6	49.8
Dermaptera	0.6	0.0	0.0	0.0	0.1	0.2
Blattodea	1.1	0.0	0.0	0.0	0.3	0.4
Hemiptera	2.4	0.5	3.0	0.4	1.6	2.2
Neuroptera	0.3	0.2	0.4	0.2	0.3	0.4
Coleoptera all	14.0	11.5	30.2	18.5	18.6	25.3
Carabidae	2.6	0.0	2.2	1.3	1.5	2.1
Silphidae	0.1	0.0	0.0	0.0	0.05	0.0
Staphylinidae	2.0	0.4	0.4	0.2	0.7	1.0
Tenebrionidae	0.0	0.5	4.8	3.6	2.2	3.1
Melolonthinae	0.4	0.4	2.4	0.0	0.8	1.1
Geotrupinae	0.1	0.0	0.0	0.0	0.05	0.0
Cantharidae	0.1	0.0	0.0	0.0	0.05	0.0
Elateridae	7.1	2.2	14.0	4.4	6.9	9.4
Curculionidae	1.4	8.0	6.4	9.1	6.2	8.5
Hymenoptera	0.1	0.0	0.0	0.2	0.1	0.1
Diptera	2.6	3.8	10.8	35.8	13.3	18.0
Lepidoptera	0.4	0.4	0.2	0.2	0.3	0.4
Others	0.6	0.9	4.8	2.2	2.1	2.9
Araneae	8.4	10.0	11.6	4.0	8.5	11.6
Mollusca	0.1	0.0	0.2	0.0	0.1	0.1
Lumbricidae	19.3	0.7	10.4	1.3	7.9	10.8
Total	82.0	33.8	102.8	75.1	73.4	100.0
Saprophagous	31.3	4.5	31.4	39.5	26.7	36.3
Phytophagous	10.1	11.5	28.0	17.3	16.7	22.8
Predators	37.4	16.4	35.6	15.6	26.3	35.8
Mixed group	3.1	1.5	7.8	2.7	3.8	5.1

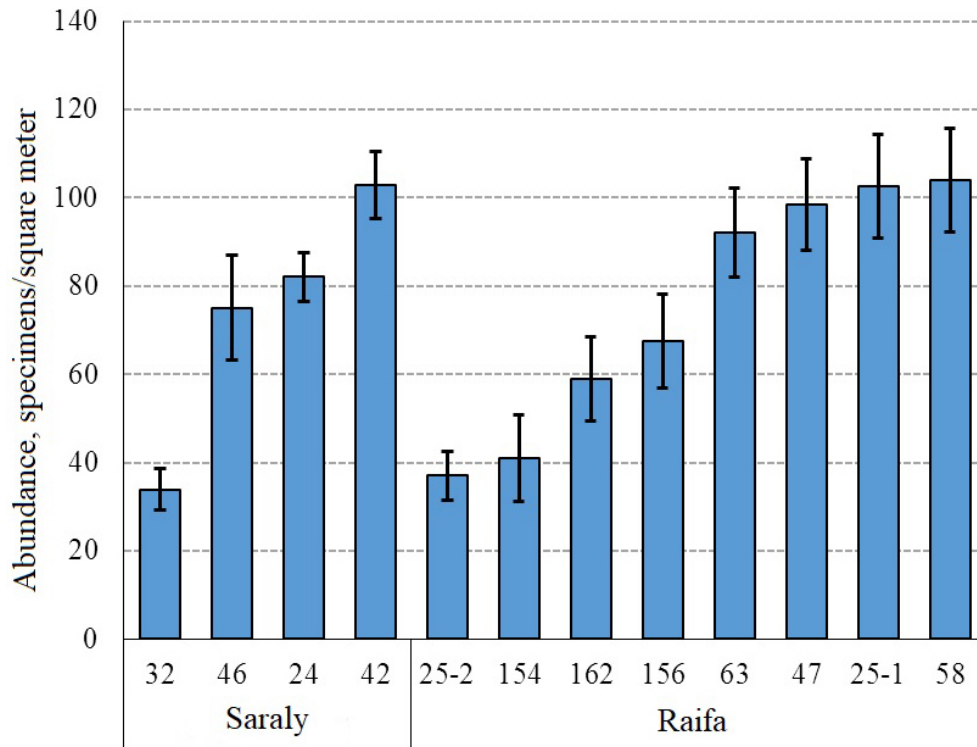


Fig. 1. Total abundance of mesofauna in coniferous biotopes of Raifa and Saraly sectors of the Reserve.

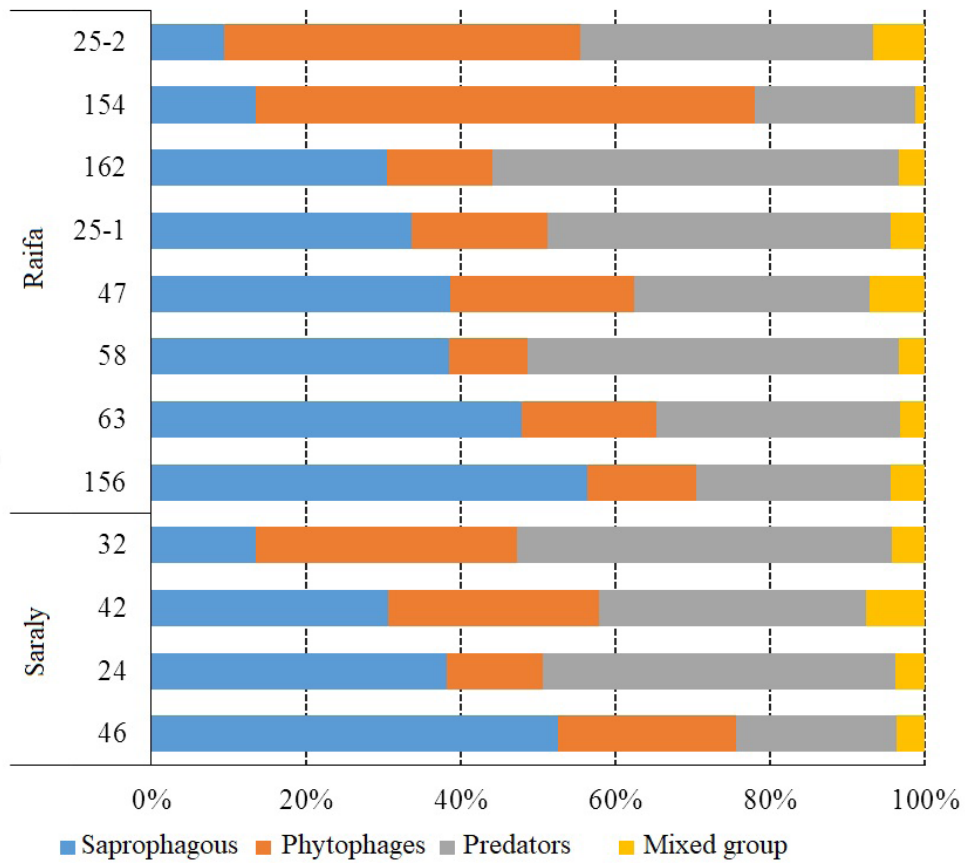


Fig. 2. The ratio of trophic groups in the mesofauna community of Raifa and Saraly sectors of the Reserve.

When planning our work, we assumed that the structure and population of pedobionts of the mesofauna of the pine forests of both sectors differ since they are located in different landscape zones, but the structure of the pedobiont population should not differ much in the different pine forests under study since this is one type of biotope. Our assumptions were not fully realized. It turned out that zonality plays a lesser role in the spatial distribution of soil invertebrates of pine biotopes, and local features of their habitat are of decisive importance. But zonality cannot be completely ruled out, it is part of a complex of factors influencing pedobionts of coniferous forests.

In this respect, we support the point of view of a number of researchers - soil zoologists - that soil animals respond to a complex of interacting factors (temperature of soil layers, hydrothermal coefficient, pH, organic carbon and total nitrogen, sodding, succession stages) (Ananina et al., 2023; Luzyanin et al., 2023). Therefore, the conditions of a particular habitat (it was in our case designated as a locality) play a crucial role in determining the specificity of the mesofauna community.

According to some researchers, the species diversity of soil invertebrates decreases as one moves from south to north within the taiga zone. For example, for Western Siberia, it was revealed that in the direction from the southern taiga to the northern taiga there is a trend of decreasing diversity of soil mesofauna (Mordkovich et al., 2014) and the soil fauna of pine forests becomes poorer than that of spruce forests (Striganova and Poryadina, 2005). Similar trend was observed in our studies, with a slight increase in the diversity of large taxa in the broadleaf-forest subzone (Saraly sector) compared to the taiga subzone (Raifa sector of the Reserve). However, there is another opinion that pedobiont abundance increases to the north, for example, in taiga forests of Central Siberia the level of abundance of soil invertebrates reached 200–400 specimens/m² (Rybalov, 2002; Rybalov and Vorobyova, 2002), similar results were obtained in boreal forests of European northeast Russia (Kolesnikova and Konakova, 2019). This is significantly higher than the values of pedobiont abundance recorded in our work.

According to literature data, the abundance of pedobionts in forests varies greatly depending on humidity, soil type and its acidity, undergrowth (plant fall), herbage, and zonality. Poverty of group and species diversity in pine forests is explained by low soil fertility under these vegetation formations (Kadastr..., 2014). In Komi taiga forests, the abundance and species diversity of invertebrates are determined primarily by the nature of plant fall and soil type (Konakova and Kolesnikova, 2011). The

Table 4. Contribution of individual taxa to discrimination with the dependent variable 'locality'.

	Wilks' – Lambda	Partial – Lambda	F-remove – 11.600	p-level	Tolerance	1–Tolerance (R-Square)
Lumbricidae	0.32	0.82	11.6	0.000	0.96	0.04
Diplopoda	0.3	0.9	6.3	0.000	0.88	0.12
Geophilomorpha	0.32	0.83	11.1	0.000	0.97	0.03
Melolonthinae	0.3	0.9	6.2	0.000	0.21	0.79
Insecta	0.29	0.93	4.4	0.000	0.66	0.34
Carabidae	0.29	0.92	4.8	0.000	0.36	0.64
Elateridae	0.29	0.92	4.5	0.000	0.14	0.86
Staphylinidae	0.3	0.89	6.9	0.000	0.33	0.67
Araneae	0.28	0.95	2.8	0.002	0.97	0.03
Lithobiomorpha	0.28	0.95	2.8	0.002	0.94	0.06
Hemiptera	0.28	0.96	2.4	0.006	0.96	0.04
Coleoptera	0.29	0.93	4.2	0.000	0.04	0.96
Curculionidae	0.29	0.94	3.8	0.000	0.1	0.9

Table 5. Contribution of individual taxa to discrimination with the dependent variable “zonality” (Raifa and Saraly sectors).

	Wilks' – Lambda	Partial – Lambda	F-remove – 1.612	p-level	Tolerance	1–Tolerance (R-Square)
Staphylinidae	0.88	0.95	32.9	0.000	0.33	0.67
Diplopoda	0.86	0.97	16.5	0.000	0.82	0.18
Araneae	0.85	0.99	8.4	0.004	0.96	0.04
Melolonthinae	0.88	0.95	29.4	0.000	0.2	0.8
Insecta	0.85	0.99	5.7	0.017	0.66	0.34
Elateridae	0.87	0.96	24	0.000	0.13	0.87
Carabidae	0.86	0.97	18.5	0.000	0.34	0.66
Coleoptera	0.86	0.97	16	0.000	0.03	0.97
Curculionidae	0.85	0.98	10.6	0.001	0.1	0.9
Lithobiomorpha	0.84	1	2.6	0.10	0.9	0.1
Geophilomorpha	0.84	1	2.4	0.12	0.97	0.03

diverse species composition and high density of soil invertebrates in wet pine forests (complex and floodplain forests) compared to dry pine forests are due to higher soil moisture, thick litter with a large amount of species-diverse leaf litter (Nagumanova, 2005).

Our results suggest that the abundance of pedobionts in the Volga-Kama Reserve is lower compared to pine forest communities in northern Russia. Such data may well be explained by the fact that pine forests in the Urals and Western Siberia are located in the zone of higher moisture content, which plays a major role in maintaining the abundance of soil mesofauna.

It is also important to take into account the temporal aspect. According to the studies of M.M. Aleynikova, the number of mesofauna pedobionts in pine forests of the Raifa sector of the Volga-Kama Reserve amounted to 25 specimens/m² (Aleynikova et al., 1964; 1972). Thus, in comparison with the data of more than half a century ago, the abundance of mesofauna in the studied areas of the Reserve has significantly increased. In our opinion, this has little to do with the protection measures implemented in the Reserve. The soil fauna is quite stable to external influences. Positive shifts in the number of pedobionts of the Reserve are rather connected with successional processes. Under anthropogenic impact, fluctuations in mesofauna abundance are associated with changes in the composition of the grass layer, which under the influence of recreation acquires many weedy and meadow plant species, attracting various herbivorous insects. Thus, the mesofauna communities of pine forests in protected areas were comparable to those of the suburban area of Kazan city in terms of mesofauna abundance and revealed a relatively high density of soil invertebrates (25–130 specimens/m²) (Gordienko and Sabantsev, 2012; Gordienko and Sukhodolskaya, 2011; Sabantsev and Gordienko, 2014). The communities in pine forests within the city were characterized by an increased content of invertebrate animals in soil (91–161 specimens/m²), and no close dependence of pedobiont abundance on the degree of anthropogenic load was revealed.

Conclusions

1. The abundance of pedobionts of the two sites was similar and not high, corresponded to the indicators of the Voronezh Reserve and was twice as high as the average values for the Republic of Tatarstan. Taxonomic composition was rather diverse and similar – 11–16 taxa in Raifa and 12–22 taxa in Saraly sectors.

2. The trophic structure was also practically the same: predators and saprophagous species predominated in most biotopes in both Saraly and Raifa sectors of the Reserve. Phytophages were somewhat inferior in the community of mesofauna pedobionts.

3. The multivariate analysis of mesofauna data showed statistically significant differences in the structure of the soil invertebrate community both in zonal and local aspects.

4. The predictions made at the beginning of the article about the greater influence of zonality on the structure of mesofauna communities were partially confirmed: the structure of pedobiont communities was determined by the complex of conditions in each specific habitat.

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