Xylotrophs in spruce stands of the Kologrivsky Forest Nature Reserve, Russia

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Abstract. The purpose of the study is to study the species composition of xylotrophic fungi in spruce stands of the Kologrivsky Forest Nature Reserve (Kostroma region, Russia). On the territory of the nature reserve, 20 species of pathogenic fungi were found parasitizing on the trunks of living and dead trees. Dead wood (57%) is the main substrate for fungal fruiting bodies. Producing tree trunks use about 28% of xylophytes as a substrate, dry-standing – 15%.

1 Introduction

In forest ecosystems, autotrophic organisms are distinguished, which accumulate phytomass, and heterotrophic, whose function is the decomposition of organic matter. Among heterotrophs, typical inhabitants of forests are xylotrophs (wood-destroying fungi) that grow on the trunks and roots of living and dead trees, deadwood and stumps [1;3;8]. Dendropathogenic fungi are capable of causing rot diseases of tree species. The defeat of forest stands by fungal organisms leads to their weakening, death and drying of trees, the formation of windfalls and windbreaks, contributes to the loss of ecological, resource, aesthetic, sanitary and hygienic functions by the forest stand [9-11]. Many researchers attach particular importance to the role of wood-destroying fungi in the food chain. Being decomposers, xylotrophs mineralize wood residues, thus splitting complex organic substances into elements of mineral plant nutrition, contributing to an increase in soil fertility. Wood-destroying fungi can cause stem and root rot of trees, causing damage to forestry [2]. The rate of wood destruction is significantly affected by the amount of wood waste and the activity of xylotrophic fungi. Wood rotting is a process widespread in nature, which affects the wood of both dead and producing tree trunks. The purpose of the study is to study the species composition of xylotrophic fungi in spruce stands of the Kologrivsky Forest Nature Reserve.

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2 Methods and Materials

The object of the study is xylotrophic fungi in spruce stands of the Kologrivsky Les Reserve [3]. The reserve is located in the taiga zone of the European part of Russia (Kostroma region) and consists of two unconnected clusters (Kologrivsky and Manturovsky). Since 2020, the nature reserve has been the core of the Kologrivsky Forest Biosphere Reserve [4-7].

Collection of fungal fruiting bodies was carried out on permanent trial plots of the Kologrivsky cluster of the nature reserve with a complete enumeration of trees, the results of which determined the main stand indicators. The selection of specimens of fruiting bodies of xylotrophic fungi with a small amount of substrate was carried out from standing trees and deadwood at various stages of decomposition. The collected field materials were labeled and numbered.

The subsequent identification of sporocarps of parasitic fungi was carried out under laboratory conditions using a determinant according to the appearance of the fruiting body, its size, shape, color, structure, and consistency of the mycelial filaments that form the pulp.

3 Results and Discussion

European spruce (Picea abies L.), Finnish spruce (Picea ×fennica (Regel) Kom.), European white birch (Betula pubescens Ehrh.) and Silver birch (Betula pendula Roth) dominate in the forest stands of the studied plots. Associated species are small-leaved lime (Tilia cordata L.) and aspen (Populus tremula L.). Most forest stands are mature and overmature. The young generation of the forest is represented by European spruce (Picea abies L.), Finnish spruce (Picea ×fennica (Regel) Kom.), European white birch (Betula pubescens Ehrh.), Silver birch (Betula pendula Roth), small-leaved lime (Tilia cordata L.), aspen (Populus tremula L.), and Norway maple (Acer platanoides L.). The undergrowth is represented by mountain ash (Sorbus aucuparia L.), in small quantities there are cinnamon rose (Rosa majalis Herm.), hairy apple rose (Rosa Villosa L.), dog-rose (Rosa canina L.), black currant (Ribes nigrum L.), Nordic currant (Ribes spicatum E. Robson), alder buckthorn (Frangula alnus L.) and fly honeysuckle (Lanicera xylosteum L.). When studying the living ground cover, 66 species of flowering plants belonging to 38 families were identified. The most represented families are Heather (Ericaceae) - 11%, Roses (Rosaceae) - 7%, Cereals (Poaceae) - 7%, Legumes (Fabaceae) - 5%, Ranunculaceae (Ranunculaceae) - 5% and Rushes (Juncaceae) - 5%. Of the plant species, the most common are bilberry (Vaccinium myrtillus L.), Lysimachia europaea (Trientalis europaea L.), May lily (Maianthemum bifolium L.), wood-sorrel (Oxalis acetosella L.).

In the spruce forests of the Kologrivsky Forest Nature Reserve, Picea abies L., Picea ×fennica (Regel) Kom., Betula pendula Roth, Betula pubescens Ehrh., Tilia cordata L., and Populus tremula L. are most damaged by dendropathogenic fungi. The growing trunks of Picea abies L. and Picea ×fennica (Regel) Kom. are parasitized by Climacocystis borealis (Fr.) Kotl. et Pouzar and Heterobasidion parviporum Niemelä & Korhonen. On dead trees, such species of xylotrophic fungi as Climacocystis borealis (Fr.) Kotl. et Pouzar and Fomitopsis cajanderi (Karst.) Kotl. Et Pouzar. Spruce tree waste is inhabited by Ischnoderma benzoinum (Wahlenb.: Fr.) P. Karst., Phellinus viticola (Schwein. in Fr.) Donk, Onnia tomentosa (Fr.) P. Kaest., Trichaptum abietinum (Dicks.: Fr.) Ryvarden, Fomitopsis rosea (Alb. & Schwein.) P. Karst. and Phellinus nigrolimitatus (Romell) Bourdot et Galzin.
Phellinus igniarius (L.:Fr.) Quel., Inonotus obliquus (Pers.:Fr.) Pilat, are found on the trunks of growing Betula pendula Roth and Betula pubescens Ehrh. Trees and Fomes fomentarius (L.:Fr.) Fr. also found on dead trees. Piptoporus betulinus (Bull.:Fr.) P. Karst., Cerrena unicolor (Bull.:Fr.) Murrill, Stereum subtomentosum Pouzar, Ganoderma lipsiense (Batsch) G.F. Atk. and Trichaptum pargamenum (Fr.) G. Cunn. found on dead birch wood.

On dead wood of Tilia cordata L., fruiting bodies of Bjerkandera adusta (Willd.:Fr.) P. Karst and Stereum subtomentosum Pouzar, which is also found on aspen (Populus tremula L.) deadwood, were found. In addition, Trametes ochracea (Pers.) Gilb. Et Ryvarden found on aspen waste.

According to the results of the study, 20 species of xylotrophic fungi were identified. Their distribution by families is shown in figure 1.

An analysis of the occurrence of fruiting bodies of wood-destroying fungi in the permanent sample plots revealed the predominance of the following species: Stereum subtomentosum Pouzar, Bjerkandera adusta (Willd.: Fr.) P. Karst., Phellinus chrysoloma (Pers.: Fr.) Donk, Fomes fomentarius (L.: Fr.) Fr. (figure 2), Climacocystis borealis (Fr.) Kotl. et Pouzar, belonging to the families Stereaceae, Phanerochaetaceae, Hymenochaetaceae, Polyporaceae and Fomitopsidaceae, respectively.

![Fig 1. Distribution of xylotrophic species by families.](image-url)
4 Conclusion

Considering the distribution of wood-destroying fungi according to their attachment to the substrate, one can note the predominance of species that destroy dead wood (57%). Producing tree trunks use about 28% of xylophytes as a substrate, dry-standing - 15%. A distinctive feature of *Climacocystis borealis* (Fr.) Kotl. et Pouzar and *Fomes fomentarius* (L.: Fr.) Fr. is the ability to damage both living and dead trees. The results of this study can be applied in assessing the sanitary condition of forest plantations.

References

4. I.G. Krinitsyn and A.V. Lebedev 2019 Ecological characteristics of the habitats of cenopopulations of Linden heart-shaped and Norway spruce of the Kologrivsky Forest Nature Reserve, Russia. Prirodoobushroistvo 3 121-126
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References
4. I.G. Krinitsyn and A.V. Lebedev 2019 Ecological characteristics of the habitats of cenopopulations of Linden heart-shaped and Norway spruce of the Kologrivsky Forest Nature Reserve, Russia. Prirodoobustrojstvo 3 115-121
7. A.V. Lebedev, I.G. Krinitsyn and V.V. Gostev 2022 Taxonomical structure of the flora of vascular plants of the forest nature reserve "Kologrivsky les". Prirodoobustrojstvo 3 115-121
8. M. Pavlik 2019 Educational project on cognition and use of wood-destroying fungi at the technical university in zvolen (Slovak Republic). Anul XXIII 43 47-51
13. L.A. Oznobikhina and A.M. Ermakova 2022 Organization of environmentally friendly production as the basis for the development of the municipal district. IOP Conference Series: Earth and Environmental Science 990 012179
16. A.M. Ermakova 2022 Environmental protection as a mechanism for the sustainable development of the region. IOP Conference Series: Earth and Environmental Science 990 012144