

DRIVING FACTORS AND SPATIAL PATTERNS OF SHRUBIFICATION: A CASE STUDY OF ALDER THICKETS IN THE SOUTHERN TUNDRA OF WESTERN SIBERIA

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Abstract. The shrub expansion of the tundra is one of the key processes transforming Arctic ecosystems under climate warming. Alder thickets play a significant role in this process. However, their phytocenotic structure and associated soil changes in the southern tundra of Western Siberia remain poorly understood. The aim of this study was to identify the spatial patterns of vegetation distribution within an isolated alder thicket in the typical tundra and to quantitatively assess its phytocenotic diversity in comparison with the surrounding tundra communities. The study was performed in August 2021 in the Pur-Taz interfluve. We made 37 geobotanical relevés and 32 soil pits were dug, along 8 transects from the tundra to the center of the alder thicket. The structure of the vegetation cover was analyzed using multivariate methods, including clustering and Principal Coordinates Analysis. The relationship between vegetation and soil-topographic factors was assessed using Redundancy Analysis (RDA). Cluster analysis revealed 7 distinct phytocenotic clusters. These clusters form a gradient: from dwarf shrub-moss-lichen tundra to the formed core of the alder thicket, through an ecotonal peripheral zone. Phytocenotic diversity was highest within the ecotone. In the core area, dominate a *Calamagrostis lapponica* (or *Carex globularis*), while the moss-lichen cover is almost absent. RDA revealed a statistically significant relationship between vegetation and key environmental factors, including projective cover of lichens and tall shrubs, as well as soil thixotropy. The shrubification process is accompanied by soil transformation: a reduction in the thickness of the peat horizon, but an increase in the humus horizon and the depth of root penetration into the soil. For the first time for alder thickets in the southern tundra of Western Siberia, the spatial phytocenotic structure has been quantitatively described and its close relationship with a complex of soil-topographic factors has been proven. The RDA results showed that the vegetation change from the tundra to the alder thicket core is associated with a shift in ecological parameters. The first gradient (RDA1) separates tundra plots with lichens and thixotropic soils from the central alder zone with a more pronounced humus horizon. The second gradient (RDA2) separates clusters within the thicket based on microrelief: in depressions, sedges and *Betula nana* dominate, while on convex areas with a sparser shrub layer, *Calamagrostis lapponica* dominates, accompanied by deep penetration of fine roots.

Keywords: tundra shrubification, alder thickets, phytocenotic diversity, multivariate analysis, cluster analysis, Yamalo-Nenets Autonomous Okrug

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