

ANALYSIS OF VASCULAR PLANT SPECIES COMPOSITION OF DUMPS AND QUARRIES IN THE REPUBLIC OF KARELIA

E. E. Kostina^{a,#}, A. M. Kryshen^a, and N. V. Genikova^a

^a Forest Research Institute of the Karelian Research Centre RAS
Pushkinskaya Str., 11, Petrozavodsk, 185910, Russia

[#]e-mail: kostina@krc.karelia.ru

DOI: 10.31857/S000681362112005X

The analysis of the vascular plant species composition recorded was carried out on the lands disturbed during the extraction of minerals (dumps of empty rock and quarries) on the territory of the Republic of Karelia. In total, 152 vascular plant species were identified, including 120 (79.0%) native and 32 (21.0%) adventive. Among the adventive species, xenophytes predominate according to the way of introduction, and epiphytes predominate according to the degree of naturalization. Apophytes (48 species, 31.6%) are represented mostly by forest and meadow species (18 each). According to the way of plant dispersion, the group of diplochorous species is represented by the largest number – 61 species (40.1%), and anemochorous species – 38 (25%). Among them, *Calamagrostis epigeios*, *Chamaenerion angustifolium*, *Tussilago farfara*, *Betula* spp., *Pinus sylvestris*, *Salix* spp., etc. are the most widespread in disturbed areas. The restoration of plant cover is much more successful if the mineral substrate is enriched with organic matter (peat, solid household waste), which is also a source of plant germs. In such places, after 20 years, the species number and the plant projective cover is about 40% higher than on the mineral substrate. The processes of natural overgrowth are also determined by the presence of nearby sources of introduction of plant propagules.

Keywords: disturbed lands, quarry, overburden dumps, biodiversity, ecological-coenotic composition, revegetation

ACKNOWLEDGEMENTS

Our gratitudes due to V.A. Kharitonov, A.N. Pekkoef for their assistance in collecting the material, and also to E.P. Gnatyuk and A.V. Kravchenko for their assistance in identifying the plant species.

The research was funded through the state research programme of the Karelian Research Centre of the Russian Academy of Sciences (Forest Research Institute of the KARC RAS).

REFERENCES

- Batalov A.A., Mart'yanov N.A., Kulagin A.U., Goryukhin O.B. 1989. Lesovosstanovlenie na promyshlennyykh otvalakh predural'ya i Yuzhnogo Urala [Reforestation on industrial dumps of the Urals and the southern Urals]. Ufa. 140 p. (In Russ.).
- Borgegård S.O. 1990. Vegetation development in abandoned gravel pits: effects of surrounding vegetation, substrate and regionality. – J. Veg. Sci. 1: 675–682.
- Chaudhuri S., Pena-Yewtukhiw E.M., McDonald L.M., Skousen J., Sperow M. 2011. Land use effects on sample size requirements for soil organic carbon stock estimations. – Soil Sciences. 176 (2): 110–114. <https://doi.org/10.1097/SS.0b013e31820a0fe2>
- Chibrik T.S., Yel'kin Yu.A. 1991. Formirovanie fitotsenozov na narushennykh promyshlennostyu zemlyakh (biologicheskaya rekultivatsiya) [Formation of phytocenoses on the lands disturbed by industry: (biological reclamation)]. Sverdlovsk. 220 p. (In Russ.).
- Denshchikova T.Yu. 2015. Suktsessionnyye protsessy v rastitel'nosti Tsentral'nogo Predkavkazya [Succession processes in vegetation of the Central Caucasus]. Stavropol. 94 p. (In Russ.).
- Druzhinina O.A., Myalo E.G. 1990. Okhrana rastitel'nogo pokrova krainego severa: problemy i perspektivy [Protection of the vegetation cover of the Far North: problems and perspectives]. Moscow. 176 p. (In Russ.).
- Ekologicheskkiye osnovy i opit biologicheskoi rekultivatsii narushennykh promishlennost'yu zemel'. 2011. [Ecological bases and experience of biological reclamation of lands disturbed by industry]. Yekaterinburg. 267 p. (In Russ.).
- Ellenberg H. 1974. Zeigerwerte der Gefasspflanzen Mitteleuropas. Göttingen. 97 s.
- Ellenberg H. 1996. Vegetation Mitteleuropas mit den Alpen. In ökologischer, dynamischer und historischer Sicht. Stuttgart. 1095 s.
- Fedorets N.G., Sokolov A.I., Kryshen A.M., Medvedeva M.V., Kostina E.E. 2011. Formirovanie lesnykh soobshchestv na tekhnogennykh zemlyakh severa-zapada taezhnoy zony Rossii [Forming forest ecosystems on technogenic substrates in the North-West of the Russian boreal zone]. Petrozavodsk. 130 p. (In Russ.).
- Genikova N.V., Gnatiuk E.P., Kryshen A.M., Ryzhkova N.I. 2014. Formation of the composition of plant communities in an anthropogenically fragmented landscape at the southern-middle taiga interface. – Trudy KarNTC RAN. 2: 27–35 (In Russ.).

- Gnatiuk E.P., Kryshen A.M. 2005. Methods for investigating coenofloras (example of plant communities in harvested forest areas in Karelia). Petrozavodsk. 68 p. (In Russ.).
- Goryukhin M.V. 2018. Areas of potential use of waste not flooded quarries of minerals in the Jewish autonomous region. — Regional problem. 21 (3): 49–54 (In Russ.). <https://doi.org/10.31433/1605-220X-2018-21-3-49-54>
- Gosudarstvennyi doklad o sostoyanii okruzhayushchei sredy Respubliki Karelia v 2019 godu. 2020. [State report on the state of the environment of the Republic of Karelia in 2019]. Petrozavodsk. 248 p. (In Russ.). <http://ecology.gov.karelia.ru/>
- Kapel'kina L.P. 2014. Transformation of tundra ecosystems in oil development industrials of the North of Russia. — Theoretical and applied ecology. 1: 49–52 (In Russ.).
- Kapitonova O.A., Selivanov A.E., Kapitonov V.I. 2017. Structure of plant communities of the initial stages of succession on anthropogenic sandy outcrops of the Forest-Tundra and Northern Taiga of West Siberia. — Siberian ecological journal. 24 (6): 731–745 (In Russ.). <https://doi.org/10.15372/SEJ20170606>
- Klassifikatsiya zemel' narushennikh pri dobyche stroitel'nykh materialov v Karelii. 1980. [Classification of land disturbed during the extraction of construction materials in Karelia]. Vol. 3. Petrozavodsk. 124 p. (In Russ.).
- Koronatova N.G. 2000. Zarastanie peschanykh kar'erov v zone severnoi taigi [Overgrowing of sand pits in the Northern taiga zone]. — In: Materialy II Vseros. konf. "Problemy regionalnoi ekologii". Vol. 8. Novosibirsk. P. 201–202 (In Russ.).
- Koronatova N.G. 2004. Razvitiye pochvenno-rastitel'nogo pokrova na peschanikh kar'yerakh v severnoi taiga Zapadnoi Sibiri [Development of soil and vegetation cover on sand pits in the Northern taiga of Western Siberia]: Abstr. ... Diss. Kand. Sci.]. Novosibirsk. 23 p. (In Russ.).
- Koronatova N.G., Milyayeva E.V. 2011. Succession of phytocenoses during overgrowth of quarries in the Northern taiga subzone of Western Siberia. — Sibirskiy ekologicheskiy zhurnal. 18 (5): 697–705 (In Russ.).
- Kostina E.E. 2012. Osobennosti formirovaniya lesnikh soobshchestv v peschano-graviinykh karyerakh Karelii [Features of formation of forest communities in sand and gravel pits of Karelia]. — Izvestia of Samara Scientific Center RAS. 14 (1): 1284–1287 (In Russ.).
- Kostina E.E. 2013. Osobennosti struktury napochvennogo pokrova v peschano-graviinykh karyerakh Respubliki Kareliya. — In: Trudy XIII S'yezda Russkogo bot. ob-va i konf. "Nauchn. osnovy ohrany i rac. ispol'zovaniya rastit. pokrova Volzhskogo bassejna". Vol. 2. Tol'yatti. P. 241–243 (In Russ.).
- Kostina E.E. 2018. Formirovaniye vidovogo sostava rastitel'nosti na narushennoi territorii v tayozhnoizone (na primere peschano-graviinogo kar'yera) [The formation of the species composition of disturbed areas in the taiga zone (on the example of sandy-gravel pit)]. — In: Trudy XIV S'yezda Russkogo bot. ob-va i konf. "Botanika v sovremennom mire". Vol. 2. Makhachkala. P. 71–73 (In Russ.).
- Kostina E.E. 2020. The distribution of *Lupinus polyphyllus* Lindl. on the dumps of the Kostomuksha mining and processing plant and in the sand and gravel quarry (Republic Karelia, Russia). — Trudy Karelskogo Nauchnogo Tsentra RAN. 12: 35–41 (In Russ.). <https://doi.org/10.17076/eco1310>
- Krasavin A.P. 1982. Okhrana prirodi pri razrabotke ugol'nikh metorozhdenii [Nature protection in the development of coal deposits]. Lyubertsy. 162 p. (In Russ.).
- Kravchenko A.V. 2007. Synopsis of the flora of Karelia. Petrozavodsk. 403 p. (In Russ.).
- Kryshen A.M. 2006. Plant communities of logging areas in Karelia. Moscow. 262 p. (In Russ.).
- Kryshen A.M., Gnatiuk E.P., Genikova N.V., Ryzhkova N.I. 2016. Comparative analysis of ecological coenetic groups in the structure of partial floras of anthropogenically fragmented territory. — Bot. Zhurn. 101 (5): 489–516 (In Russ.). <https://doi.org/10.1134/S0006813616050021>
- Kryshen A.M., Genikova N.V., Gnatiuk E.P., Presnukhin Iu.V., Tkachenko Iu.N. 2018. Reforestation series of pine forest communities in eastern fennoscandia on sandy automorphic soils. — Bot. Zhurn. 103 (1): 5–35 (In Russ.). <https://doi.org/10.1134/S0006813618010015>
- Kucherov I.B., Milevskaya S.N., Naumenko N.I., Sennikov A.N. 1998. O bogatstve lokal'noi flory zapovdnika "Kivach" i predelah shirotnogo rasprostraneniya vidov v Zaonezhskoy Karelii [About the richness of the local flora of the Kivach reserve and the limits of the latitudinal distribution of species in Zaonezhskaya Karelia]. — In: Izuchenie biologicheskogo raznoobraziya metodami sravnitelnoi floristiki. St.-Petersburg. P. 119–150 (In Russ.).
- Kulagin A.A., Habirova L.M. 2016. Technogenic impact of sandy-gravel mixture on the landscape of Chesnokovsky deposit in the republic of Bashkortostan. — Izvestiya Orenburgskogo gosudarstvennogo agrarnogo universiteta. 1 (57): 121–123 (In Russ.).
- Landolt E. 1977. Okologische Zeigerwerte zur Schweizer Flora. Veroff. Geobot. Inst. ETH. Zurich. 64: 1–208.
- Levina R.E. 1957. Sposoby rasprostraneniya plodov i semyan [Methods of distribution of fruits and seeds]. Moscow. 358 p. (In Russ.).
- Likhanova I.A., Zheleznova G.V. 2012. Vegetation restoration at sand-pits in the suburbs of Syktyvkar during forest recultivation. — Izvestiya of Samara Scientific Center RAS. 14 (1): 1485–1488 (In Russ.).
- Manakov Yu.A., Strel'nikova T.O., Kupriyanov A.N. 2011. Formirovaniye rastitel'nogo pokrova v technogennikh landshaftakh Kuzbassa [Formation of vegetation cover in the technogenic landscapes of the Kuznetsk Coal Basin]. Novosibirsk. 167 p. (In Russ.).
- Marianna L. Ramenkaya (life and scientific activity, selected works, translations). 2015. Apatites. 204 p. (In Russ.).

- Mironova S.I. 2000. Tekhnogennye suksessionnye sistemy rastitel'noti Yakutii (na primere Zapadnoi i Yuznoi Yakutii) [Technogenic successional system of vegetation in Yakutia (by the example of the Western and southern Yakutia)]. Novosibirsk. 152 p. (In Russ.).
- Nachal'nyye stadii formirovaniya biogeotsenozov na tekhnogennikh zemlyakh Evropeiskogo Severa. 1999. [Initial stages of formation of biogeocenoses on technogenic lands of the European North]. Petrozavodsk. 74 p. (In Russ.).
- Nitsenko A.A. 1969. On the study of ecological structure of vegetation cover. — *Bot. Zhurn.* 54 (7): 1002–1013 (In Russ.).
- Plantarium: open on-line atlas and key to plants and lichens of Russia and neighbouring countries. 2007–2021. <http://www.plantarium.ru/>
- Ramenskaya M.L. 1983. Analysis of flora in the Murmansk region and Republic of Karelia. Leningrad. 216 p. (In Russ.).
- Razrabotka metodov lesomelioratsii tekhnogennikh pustoshei Evropeiskogo Severa. 1993. [Development of methods of forest reclamation of technogenic wastelands of the European North]. Petrozavodsk 294 p. (In Russ.).
- Řehouňková K., Prach K. 2008. Spontaneous vegetation succession in gravel-sand pits: a potential for restoration. — *Restoration Ecology*. 16(2): 305–312.
- Serebryakov I.G. 1962. *Ecologicheskaya morfologiya rastenii* [Ecological morphology of plants]. Moscow. 378 p. (In Russ.).
- Skousen J., Zipper C., Burger J., Barton C., Angel P. 2011. Selecting materials for mine soil construction when establishing forests on Appalachian mine sites. — *Forest Reclamation Advisory*. 8: 1–6.
- Sokolov A.I. 2016. Povysheniye resursnogo potentsiala tayozhnykh lesov lesokul'turnym metodom [Increasing the resource potential of taiga forests by the forest culture method]. Petrozavodsk. 178 p. (In Russ.).
- Sumina O.I. 2012. Polyvariant model of vegetation primary succession on heterogeneous territory with a various habitats set (by the example of forest-tundra quarries). — *Successes of Modern Natural Sciences*. 11 (1): 112–116 (In Russ.).
- Sumina O.I. 2013. Formirovanie rastitelnosti na tekhnogennikh mestoobitaniyakh Krainego Severa Rossii [Vegetation formation in technogenic habitats of the Far North of Russia]. St.-Petersburg. 340 p. (In Russ.).
- Sumina O.I. 2014. Primary successions on quarries as a full-scale model for study of terrestrial ecosystems development. — *Theoretical and applied ecology*. 1: 40–44 (In Russ.).
- Tsyganov D.N. 1983. *Fitoindikatsiya ekologicheskikh rezhimov v podzone khvoino-shirokolistvennikh lesov* [Phytoindication of ecological regimes in the subzone of coniferous and broad-leaved forests]. Moscow. 196 p. (In Russ.).