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Current state and ecological features of *Hippophae rhamnoides* L. cenopopulations in Northern Kazakhstan

Hippophae rhamnoides L. (sea buckthorn) is an important resource for agriculture, landscaping, and medicine due to its beneficial properties, high winter hardiness, and adaptability to various soil conditions. These factors make the study of the current state and ecological-cenotic characteristics of sea buckthorn populations in Northern Kazakhstan particularly relevant. The research conducted in the North Kazakhstan and Kostanai regions covers eight key populations of *H. rhamnoides* and their plant communities. The study found that sea buckthorn thrives and can be successfully used for reclamation in technogenically disturbed areas with moderate moisture. Sea buckthorn forms a shrub layer in forests and creates thickets on the edges of birch groves. In flatland landscapes, sea buckthorn dominates plant communities, particularly in dry steppe and meadow conditions, indicating ecological and phytocenotic plasticity. The species composition of the studied communities involving sea buckthorn depends on the ecological and cenosis conditions of their habitats. The herbaceous layer is predominantly composed of mesoxerophytic species. The studied sea buckthorn populations are mainly composed of pre-generative and generative individuals and require further monitoring and research.

Keywords: Hippophaer hamnoides L., North Kazakhstan, plant communities, populations, herbaceous layer, phytocenotic conditions.

Introduction

Currently, there is heightened attention to issues of food security and sustainable use of genetic resources [1, 2], which includes ensuring the conservation and rational use of agro-biodiversity in their habitats.

Sea buckthorn, known for its beneficial properties for the body [3, 4], is well adapted to harsh soil and climatic conditions, as evidenced by its ability to thrive in poor, sandy, and rocky soils, as well as withstand extreme temperatures and severe frosts. Additionally, its resistance to drought and saline soils contributes to its spread in arid and semi-arid regions [5].

These adaptive characteristics render sea buckthorn (*Hippophae rhamnoides* L.) particularly valuable for ecosystem restoration and agricultural utilization in regions with harsh climates. Sea buckthorn is a deciduous shrub predominantly distributed across Asia and North America, with occurrences in Europe, particularly along riverbanks in Finland, Sweden, Poland, and Germany [6–8].

In the countries of the former Soviet Union, the range of *H.rhamnoides* is characterized by a discontinuous nature. Sea buckthorn is found in almost all mountainous areas that border the southern edge of the CIS, including the Caucasus, the mountains of Central Asia, Kazakhstan, and Siberia. At low and medium elevations in these regions, it forms extensive thickets, thrives well, and produces abundant seed yields, which allows us to consider these territories as key areas for this species.

The range of sea buckthorn in Kazakhstan [9] covers the following floristic regions: 11. Eastern Sary-Esik, 12. Zaisan, 18. Balkhash — Alakol, 22. Altai, 23. Tarbagatai, 24. Dzhungarsky Alatau, 25. Zailiysky Kunghey Alatau, 25a. Ketmen Terskey Alatau, 27. Kyrgyz Alatau, 28. Karatau, 29. Western Tien Shan.

The North Kazakhstan region is characterized by a rather harsh sharply continental climate with hot summers and frosty winters. The diversity of geomorphological, climatic, and soil-vegetation conditions in North Kazakhstan determines the variety of landscapes, which correspond to well-defined natural zones in the latitudinal direction — forest-steppe, steppe, and semi-desert (desert steppes and grass-covered deserts).

A significant part of the region consists of flat steppes, with hilly fragments covered by pine forests. To the south, it borders the Kazakh Upland [10]. This region is also known for its mining activities, with several iron ore deposits being mined via open-pit methods. These operations lead to changes in geological landscapes and increase the areas of disturbed land that are prone to erosion. Treshchevskaya et al. (2018)

[11] note that sea buckthorn (Hippophae rhamnoides) is the most promising species for the reclamation of waste heaps.

Sea buckthorn (*H.rhamnoides*) is indifferent to soil conditions and can thrive on chestnut soils that are poor in nutrients and have significant salinity; however, it is very sensitive to the physical properties of the soil, preferring well-aerated substrates [12].

Thus, *H. rhamnoides* represents a valuable resource for agricultural use, landscaping, and medicine, owing to its beneficial properties, winter hardiness, and adaptability to soil conditions. This underscores the relevance of studying the current status and ecological-cenotic characteristics of *H.rhamnoides* populations in Northern Kazakhstan.

Experimental

Field botanical studies were conducted in the autumn-spring period of 2023-2024 in the territory of the State National Nature Parks “Borovoe” and “Kokshetau” in the North Kazakhstan region, as well as in the forests of the Kostanay region in Northern Kazakhstan. The research was carried out on 8 key plots measuring 10x10 m, 10x15 m, and 20x20 m [13]. Field expedition studies were conducted using a route reconnaissance method with the help of a GPS navigation device, specifically the GPS Garmin Montana 750i. The mathematical processing of the research results was carried out according to the methodology of G.N. Zaytsev [14].

The surveyed routes encompassed a variety of habitats where the studied species were found, including pine and birch forests of different forest type groups, forest edges, clearings, glades, areas along roads, and more. The collected herbarium of encountered species was identified using floristic compilations [15]. Additionally, the taxonomic status of the species was determined and verified using the international web system POWO [16]. Geobotanical descriptions included: coordinates, geographical location, absolute elevation, micro relief; description of the community involving sea buckthorn (name and species composition of the community, origin, number of shrubs, density, height, age, trunk diameter, phenophase, condition); for the herbaceous layer: projected cover, grassiness, abundance according to Drudae [17–19], height and phenophase, placement according to Bykov [20]. Age states were identified according to the methodological guidelines of L.B. Zaugolnova and O.V. Smirnova (1978) [21-22]. Taxonomic characteristics used in forestry and forest geobotany were noted. An analysis of the spatial distribution of individuals was conducted. Shrub counting was carried out across the entire sample plot using a complete count method. Their species, height, and frequency of occurrence were determined. The plant community was identified based on the proportion of dominants.

Descriptions of communities with *H. rhamnoides* L. are given in ascending order of the absolute height of their place of growth.

Results and Discussion

Plot 1. *Pine-sea buckthorn-herbaceous community.* Sea buckthorn grows in the lower part of the quarry pit (quarry location from the 1980s) on the boundary of compartment 62 of the Prigorodny Forest District, Kostanay Forestry. The area of the site is approximately 30 hectares. It is a forest-steppe zone. Coordinates: N 53°09'06.22", E 063°38'55.24", 147 meters above sea level. Sea buckthorn is in a tree-like life stage with a single trunk (average height — 4-5 meters; trunk diameter — 5 cm). Within the 10x10 meter sample plots, the number of sea buckthorn plants totals 20 units. The average distance between trees is 2-3 meters. The tree stand is represented by *Pinus sylvestris* L. (average height — 4–6 meters), *Ulmus pumila* L. (average height — 5-6 m), *Acer negundo* L. (average height — 6 m), *Populus* sp. (average height — 5-6 m). The shrub tier is not rich and is represented by *Lonicera tatarica* L. Regeneration is good. Succession is observed. The substrate is sandstone.

The cenoflora consists of *Pinus sylvestris* L, *Ulmus pumila* L., *Acer negundo* L., *Betula pendula* Roth, *Elaeagnus angustifolia* L., *Hippophae rhamnoides* L., *Lonicera tatarica* L, *Salix* × *fragilis* L., *Euphorbia virgata* Waldst. ex Kit., *Achillea millefolium*L., *Polygonum aviculare*L., *Veronicaincana* L., *Koeleria cristata (L.) Pers., Artemisia dracunculus* L, *Artemisia sericea* Weber ex Stechm., *Plantago media* L., *Vicia sepium* L., *Vicia cracca* L., *Medicago falcata* L., *Lathyrus pratensis* L., *Cirsium setosum* (Willd.) Bes, *Phleum phleoides* (L.). Karst., *Poa angustifolia* L., *Agropyron pectinatum* (M.Bieb.) Beauv., *Calamagrostis epigeios* (L.) Roth, *Melilotus officinalis*(L.) Lam., *Potentilla humifusa* Willd. ex Schltdl., *Helictotrichon desertorum* (Less.) Nevs.

Plot 2. *Pine-sea buckthorn-herbaceous-sedge community*, 175 meters above sea level. The population of H. rhamnoides L. is located along the Big Chebachye Lake on the northwestern lakeside terrace, 500 meters from the lake, within the Borovsky Forestry area, GNP "Borovoe". The area of the compartment is 27 hectares. It is a lake-alluvial plain. Coordinates: N 53°06'69,66, E 070°18'79,61. Within the 10x15 meter sample plots, there are about 70 sea buckthorn shrubs. The tree stand consists of Scots pine (*Pinus sylvestris* L., average height 6–8 m) and a few silver birches (*Betula pendula* Roth., average height 6 m). The shrub tier is represented by *H. rhamnoides* L. and *Crataegus sanguinea* Pall. The height of the sea buckthorn shrubs averages 2-3 meters. Trunk diameters range from 1 cm to 10 cm. The age of the shrubs is 15–20 years. The age spectrum of *H. rhamnoides* L. includes generative and pre-generative individuals of the species. Regeneration is present. Five forms of sea buckthorn are described, differing in the morphometric characteristics of the fruits. *Thymus serpyllum* L. is found in the herbaceous tier.

Plot 3. *Sea buckthorn-willow-onobrychis-herbaceous community* with pines. This plant community is located within the Kostanay Forestry area of the Prigorodny Forest District, at the boundary of compartment 66. The area of the community is 20 hectares. Coordinates: N 53°09'28.57", E 63°41'24.06", 181 m above sea level. Within the 20x20 meter sample plot, sea buckthorn is diffusely distributed, with the shrubs being 20 years old. Sea buckthorn is predominantly represented by generative individuals. Regeneration is good (35 saplings). The distance between sea buckthorn shrubs is 3–5 meters. The average trunk diameter is 10 cm. The tree stand consists of *Pinus sylvestris* L., *Betula pendula* Roth., and *Salix × fragilis* L.

The herbaceous layer includes the following species: *Euphorbia virgata* Waldst. ex Kit., *Achillea millefolium* L., *Koeleria cristata (L.) Pers.*, *Artemisia dracunculus* L., *Artemisia sericea* Weber ex Stechm., *Carex polyphylla* Kar. & Kir., *Dianthus versicolor* Fisch. ex Link, *Astragalus onobrychis* L., *Onobrychis arenaria*(Kit.) DC., *Onobrychis viciifolia* Scop., *Plantago media* L., *Vicia sepium* L., *Vicia cracca* L., *Medicago falcata* L., *Lathyrus pratensis* L., *Cirsium setosum* (Willd.) Bes, *Phleum phleoides* (L.) H.Karst., *Poa angustifolia* L., *Agropyron pectinatum* (M.Bieb.) Beauv., *Agropyron kazachstanicum* (Tzvelev) Peschkova, *Calamagrostis epigeios* (L.) Roth, *Plantago media* L., *Veronica incana* L.

Plot 4. *Elaeagnus-sea buckthorn-herbaceous community*. *Hippophae rhamnoides* thickets were found in the Prigorodny Forest District of Kostanay Forestry, Compartment 68. The area of the plot is 11.8 hectares. It is a lowland meadow. The site is seasonally inundated by meltwater during the spring. Coordinates: N 53°10'10.05", E 63°42'61.98", 190 m above sea level.

Within the 10x10 meter sample plots, approximately 50 sea buckthorn shrubs are present. The shrub layer includes *Elaeagnus angustifolia* L., *H. rhamnoides* L., *Lonicera tatarica* L., and *Salix × fragilis* L. The height of the sea buckthorn shrubs averages 3–5 meters. Trunk diameters range from 1.5 cm to 15 cm. The age of the shrubs is 15–20 years. The cenopopulation of *H. rhamnoides* comprises immature, generative, and post-generative individuals. Regeneration is good.The cenoflora consists of the following species: *Elaeagnus angustifolia* L., *Hippophae rhamnoides* L., *Lonicera tatarica* L, *Salix × fragilis* L., *Euphorbia virgata* Waldst. ex Kit., *Achillea millefolium* L., *Koeleria cristata (L.) Pers., Artemisia dracunculus* L, *Artemisia sericea* Weber ex Stechm., *Polygonum aviculare* L., *Dianthus versicolor* Fisch. ex Link, *Astragalus onobrychis* L., *Sedum telephium* L., *Vicia sepium* L., *Vicia cracca* L., *Medicago falcata* L., *Lathyrus pratensis* L., *Cirsium setosum* (Willd.) Bes, *Phleum phleoides* (L.) H. Karst., *Poa angustifolia* L., *Agropyron pectinatum* (M. Bieb.) Beauv., *Agropyron kazachstanicum* (Tzvelev) Peschkova, *Calamagrostis epigeios* (L.) Roth, *Plantago media* L., *Trifolium repens* L.

Plot 5. *Sea buckthorn-herbaceous community*, 196 meters above sea level. Prigorodny Forest District, Kostanay Forestry. Located at the edge of an old quarry. Coordinates: N 53° 10' 94.84", E 063° 43' 44.40".

Within this plot, sea buckthorn is distributed in clumps (thickets), with shrub ages ranging from 10 to 15 years. Sea buckthorn is predominantly represented by generative individuals. Regeneration is good, with 35 saplings present. The distance between sea buckthorn shrubs ranges from 1 to 3 meters. The average trunk diameter is 5 cm. Dominant species of the herbaceous layer include: *Artemisia dracunculus* L, *Artemisiasericea* Weber ex Stechm., *Vicia sepium* L., *Achillea millefolium*L., *Phleum phleoides* (L.) H. Karst., *Lathyrus pratensis* L., *Medicago falcata* L., *Euphorbia virgata* Waldst. ex Kit. et al.

Plot 6. *Sea buckthorn-bluegrass-strawberry community*. Coordinates: N 53°24'25.51", E 68°01'77.19", 290 m above sea level. (GNP "Kokshetau", Aiyrtausky Branch, Syrymbet-Tyukhtinsky Forestry, Compartment 28. The area of the plot is 0.01 hectares. It is a floodplain meadow. Sea buckthorn is diffusely distributed in the shrub life form. The species is 15–20 years old. The ontogenetic spectrum is incomplete. The tree stand consists of *Betula pendula* Roth (average height = 8 m), *Sorbus aucuparia* L. (average height = 6 m), and occasionally *Malus baccata* (L.) Borkh. (average height = 5 meters). The shrub layer is

exclusively represented by *H. rhamnoides* L. The herbaceous layer includes: *Fragaria viridis* (Duchesne) Weston (cop1), *Fragaria vesca* L. (cop3), *Euphorbia virgata* Waldst. ex Kit., *Plantago urvillei* Opiz, *Vicia cracca* L., *Urtica urens* L., *Bromopsis inermis* (Leyss.) Holub, *Melica nutans* L., *Calamagrostis neglecta* (Ehrh.) Gaertner, Meyer et Schreber, *Agrostis gigantean* Roth, *Elytrigia repens* (L.) Nevski, *Achillea millefolium* L., *Artemisia sericea* Weber ex Stechm., *Stellaria graminea* L., *Convolvulus arvensis* L., *Artemisia sericea* Weber ex Stechm., *Ranunculus polyanthemos* L., *Koeleria cristata* (L.) Pers.

Plot 7. *Birch-shrub-herbaceous community*. Coordinates: N 52°53'36.42", E 68°58'63.03", 349 m above sea level. The cenopopulation of *H.rhamnoides* is located on the left bank of a spring stream in the understory of a birch grove west of the settlement of Bayterek. Within the 10x15 meter sample plots, approximately 45 sea buckthorn shrubs are recorded. Regeneration is satisfactory. The tree stand consists of silver birch (*Betula pendula* Roth, average height = 9 meters). The shrub layer is diverse and includes *H. rhamnoides* L., *Rosa canina* L., and *Cerasus* sp. The height of the sea buckthorn ranges from 1 to 3 meters, with trunk diameters of 5–10 cm. The age of the shrubs is 15–25 years. The herbaceous tier consists of: *Artemisia dracunculus* L, *Artemisia sericea* Weber ex Stechm., *Polygonum aviculare* L., *Dianthus versicolor* Fisch. ex Link, *Astragalus onobrychis L., Sedum telephium L., Vicia sepium* L., *Vicia cracca* L., *Medicago falcata* L., *Lathyrus pratensis* L., *Cirsium setosum* (Willd.) Bes, *Phleum phleoides* (L.) H. Karst. and other forest-meadow species.

Plot 8. *Birch-sea buckthorn community*. The cenopopulation of *H. rhamnoides* is located on the right bank of a spring stream at an elevation of 349 meters above sea level. Coordinates: N 52°53'29.46", E 68°58'30.59', 349 v above sea level. The birch grove is situated west of the settlement of Bayterek. In this plot, sea buckthorn is represented in a tree-like life form, reaching up to 5 meters in height; with trunk diameters of 8–15 cm. Regeneration is excellent. The ontogenetic spectrum is complete. The sea buckthorn fruits exhibit distinct morphometric characteristics. The tree stand of the plant community is represented by *Betula pendula* (average height = 6–8 meters). The understory consists of *H. rhamnoides*, *Rosa canina* L., and *Ribes aureum* Pursh. The cenoflora of the herbaceous layer includes: *Euphorbia virgata* Waldst. ex Kit., *Achillea millefolium* L., *Koeleria cristata* (L.) Pers., *Artemisia dracunculus* L., *Artemisia sericea* Weber ex Stechm., *Carex polyphylla* Kar. &Kir., *Plantago media* L., *Vicia sepium* L., *Vicia cracca* L., *Medicago falcata* L., *Cirsium setosum* (Willd.) Bes, *Phleum phleoides* (L.) H. Karst., *Poa angustifolia* L., *Agropyron pectinatum* (M. Bieb.) Beauv., *Agropyron kazachstanicum* (Tzvelev) Peschkova.

In the habitats of *Hippophae rhamnoides* with adequate soil moisture and aeration, the herbaceous layer is dominated by *Fragaria viridis, Fragaria vesca, Euphorbia virgata, Plantago urvillei, Calamagrostis epigeios*, and other typical forest and meadow herbaceous species (Plots 2, 3, 4, 6, 7). In drier ecological and cenotic conditions, the abundance of xerophytic and mesoxerophytic species increases (*Artemisia dracunculus, Artemisia sericea, Polygonum aviculare, Dianthus versicolor*, etc.) (Plots 1, 5, 8).

Research has shown that *Hippophae rhamnoides* thrives and is successfully reintroduced in industrially disturbed areas with medium-steppe moisture. However, the herbaceous cover in these areas is not rich in species and is significantly sparse.

Conclusion

Thus, we found and studied 4 populations in the North Kazakhstan region, and 4 populations of *H.rhamnoides* were also found in the Kostanay region.

H.rhamnoides serves as an understory species in birch and pine forests, forming a shrub layer in tree plantations and occasionally creating impenetrable thickets at forest edges. Under such conditions, it exhibits high morphometric values of its fruits. In plain landscapes, sea buckthorn is primarily a dominant species in plant communities and is associated with dry-steppe and meadow ecological and cenotic conditions. In the cenopopulations of sea buckthorn we studied, generative and pre-generative individuals predominated, with post-generative individuals being rare. Sea buckthorn primarily regenerates vegetatively and successfully contributes to the process of afforesting disturbed lands. The data we obtained indicate that the studied populations of sea buckthorn are young and require further stationary research and regular monitoring of their current condition.

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Солтүстік Қазақстанның *Hippophae rhamnoides* L. ценопопуляцияларының қазіргі жағдайы және экологиялық ерекшеліктері

Hippophae rhamnoides L. (итшомыр шырғанағы) жемісінің пайдалы қасиеттерімен, әртүрлі топырақ жағдайларына бейімделу қабілетімен белгілі, аязға жоғары төзімділігі мен ауылшаруашылығында, ортаны көгалдандыруға және медицинада пайдалануда құнды ресурс. Аталған факторларға байланысты Солтүстік Қазақстан жағдайында шырғанақ популяциясының қазіргі жағдайы мен экологиялық-ценотикалық ерекшеліктерін зерттеу өзекті. Солтүстік Қазақстан және Қостанай облыстарында жүргізілген зерттеу итшомыр шырғанағының (*H. rhamnoides*) негізгі сегіз популяциясын және олардың өсімдіктер қауымдастықтарын қамтиды. Жүргізілген жұмыстардың

нәтижесінде итшомыр шырғанағы орта далалық ылғалдылығы бар техногендік бұзылған аймақтарда жақсы өсетіні және қалпына келетіні анықталды. Итшомыр шырғанағы қарағай ормандарында бұталы қабат түзіп, қайың тоғайларының шетінде қалың тоғай құрайды. Құрғақ далалы және шалғынды жағдайдағы жазық ландшафттарда итшомыр шырғанағы өсімдіктер қауымдастығында доминантты түр ретінде таралған, бұл олардың экологиялық-фитоценотикалық икемділігін көрсетеді. Итшомыр шырғанағының қатысуымен зерттелген қауымдастықтардың түрлік құрамы олардың тіршілік ету ортасының экологиялық және ценотикалық жағдайларына байланысты. Шөп қабатының негізінде мезоксерофильді түрлер басым болды. Итшомыр шырғанағының зерттелген популяциясы негізінен прегенеративті, генеративті дарақтардан тұрады және одан әрі бақылаумен зерттеуді қажет етеді.

Кілт сөздер: *Hippophae rhamnoides* L., Солтүстік Қазақстан, өсімдіктер қауымдастығы, популяция, шөпті деңгей, фитоценотикалық жағдайлар.

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Современное состояние и экологические особенности ценопопуляций *Hippophae rhamnoides* L. Северного Казахстана

Hippophae rhamnoides L. (облепиха крушиновидная) представляет собой важный ресурс для сельского хозяйства, озеленения и медицины благодаря своим полезным свойствам, высокой зимостойкости и способности адаптироваться к различным почвенным условиям. Эти факторы делают особенно актуальным изучение современных состояний и эколого-ценотических особенностей популяций облепихи крушиновидной в условиях Северного Казахстана. Исследование, проведенное в Северо-Казахстанской и Костанайской областях, охватывает восемь ключевых популяций облепихи (*H. rhamnoides*) и их растительные сообщества. В результате данной работы выявлено, что облепиха крушиновидная успешно растет и рекультивируется на техногенно-нарушенных территориях при среднестепном увлажнении. Облепиха формирует кустарниковый ярус в лесах и образует заросли на опушках березовых рощ. В равнинных ландшафтах облепиха доминирует в растительных сообществах, преимущественно в сухостепных и луговых условиях, указывающая на их эколого-фитоценотическую пластичность. Видовой состав изученных сообществ с участием облепихи зависит от эколого-ценотических условий их местобитаний. В основе травяного яруса преобладают мезоксерофильные виды. Изученные популяции облепихи состоят преимущественно из прегенеративных, генеративных особей и требуют дальнейшего мониторинга и исследований.

Ключевые слова: *Hippophae rhamnoides* L., Северный Казахстан, растительные сообщества, популяция, травянистый ярус, фитоценотические условия.

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