ABS ACTA BIOLOGICA SIBIRICA
A journal on the biodiversity of Siberia and the adjacent lands

Acta Biologica Sibirica 8: 1–16 (2022)
doi: 10.14258/abs.v8.e01
http://journal.asu.ru

RESEARCH ARTICLE

Protection of rare and protected species of flora in large petrochemical projects

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Academic editor: A. Matsyura | Received 8 February 2022 | Accepted 9 March 2022 | Published 31 March 2022

http://zoobank.org/81FA9FA5-8C1F-47B5-BC28-375570309B04

Citation: Popova EI, Kozlov SI (2022) Protection of rare and protected species of flora in large petrochemical projects. Acta Biologica Sibirica 8: 1–16. https://doi.org/10.14258/abs.v8.e01

Abstract

The paper presents a comprehensive assessment of vegetation biodiversity at the construction site of the ZapSibNeftekhim production complex in the city of Tobolsk, Tyumen Region, Russia. In this paper, we (1) study the biogenic and salt composition of the soil; (2) label the revealed samples, (3) record the geographical coordinates; (4) use the method of translocation (transfer) of the rare and endangered flora representatives found at the construction site of the ZapSibNeftekhim and the associated facilities, as well as the removal of such species from the original habitat, and their transportation to new habitats. In total, 149 individuals of 13 flora species were transferred during the work: (1) *Malaxis monophyllos* L., (2) *Listera ovata* (L.) R. Br., (3) *Dactylorhiza maculata* (L.) Soo, (4) *Allium microdictyon* Prokh., (5) *Centaurea phrygia* L., (6) *Phegopteris connectilis* (Michx.) Watt, (7) *Polyporus badius* (Pers.) Schwein., (8) *Iris sibirica* L., (9) *Daphne mezereum* L., (10) *Lilium pilosiusculum* (Freyn) Miscz., (11) *Cinna latifolia* (Trev.) Griseb., (12) *Platant herabifolia* (L.) Rich., (13) *Heterodermia japonica* (M.Sato) Swinscow et Krog. In addition, we took into account all the biological characteristics of the transferred flora species and their environmental requirements during monitoring activities. Adaptation of almost all translocated specimens was successful. Research in this area contributes to a deeper understanding of the processes of anthropogenic transformation of floristic complexes and should be the basis for environmental monitoring of disturbed habitats. These studies allow approaching the solution of problems of rational use, conservation and restoration of life-support resources in ecosystems, integrity, productivity, and biodiversity of biological resources.

Keywords

Translocation, plant communities, transportation, monitoring, protected plants

Introduction

The city of Tobolsk (Tyumen region, Russia) is located about 100 km south of the border between the southern and middle taiga. This location determines the special natural environment surrounding the town, which has a great diversity of flora and fauna. Due to the geological features of the region, the extraction and processing of hydrocarbons by oil and gas companies have become the most important sectors of the economy. Hydrocarbons are processed at the facilities of SIBUR, the largest Russian petrochemical company. The production capabilities of SIBUR Tobolsk include a natural gas liquids (NGL) facility with a capacity of 6.8 million tonnes per year, a monomer and polymer manufacturing facilities for polypropylene production with a capacity of 500 thousand tonnes per year.

The construction of industrial facilities is always associated with the risk of damage to the natural environment in one way or another. Thus, a modern industrial enterprise must be evaluated not only in terms of efficiency and productivity, but also in terms of its interaction with the local community and the natural environment. In the context of the development of the oil and gas complex in Western Siberia, it is necessary to promote environmentally friendly projects that are currently being developed with the greatest possible preservation of the environment (Tsyganov 1983; Purschke et al. 2014; Jürgens & Bischoff 2017; Gerz et al. 2019).

The ZapSibNeftekhim project is one of the Russian largest petrochemical complexes, which involves the creation of capacities for the production of polymeric materials (polyethylene and polypropylene) with a total volume of two million tons per year. The project implementation will not only increase the advanced hydrocarbon processing in Western Siberia and meet the growing demand for polymers in the domestic market, but also prevent pollutant emissions from burning unprocessed associated petroleum gas.

The location of the industrial site of the complex was determined by the geographical proximity to the sources of raw materials and the reserves of production infrastructure assets of operating enterprises, which allowed to create high capacity units for advanced processing of raw materials. The new petrochemical complex being built by the SIBUR group will become part of the Tobolsk industrial site, which already includes the monomer and polymer production enterprises of Tobolsk-Neftekhim and Tobolsk-Polymer. Currently, these enterprises annually produce more than half a million tons of polymers. With ZapSibNeftekhim, this volume will increase significantly.

Constant monitoring of the ecological situation at industrial sites and the preservation of rare habitats with endangered flora species located near the planned construction sites are one of the main priority tasks of scientific research in this area. It is extremely important to spread the opinion about the possibility of harmonious coexistence of the developing modern industrial production with the surrounding environment through the organization and implementation of various environmental projects (Bykov 1983; Bauer et al. 2017; Haapalehto et al. 2017).

The ever-increasing scale and rate of withdrawal of territories during construction, development of deposits, laying of communications actualizes the problem of preserving rarities of the flora, the populations of which live in the withdrawal zone. For non-mobile organisms (plants, fungi, lichens), the transplantation method is used, usually in the Botanical Gardens. However, for the conservation of biodiversity at the genetic level of its organization, such methods are unsuitable. The most modern, most environmentally friendly and economical way is translocation, i.e. transplantation (resettlement) from native (wild) habitats to reserve safe wild habitats.

Plant relocation activities have a long history. As research and experimentation expanded, the corresponding terminological apparatus expanded. The development and improvement of terminology are actively continuing now. Introduction (biological) - deliberate or accidental relocation of individuals of any species of animals and plants outside the natural range to new habitats for them. In other words, introduction is the process of introducing alien species into an ecosystem.

Introduction is the entry of new species into culture outside of their natural range. It includes both naturalization and acclimatization, but the distinction between these two concepts is very conditional, since outside the habitat of the introduced species, it is impossible to select areas with a similar combination of environmental conditions for naturalization of this species. With any transfer of a plant from its distribution area to a new area, it must, to one degree or another, adapt to the new growing conditions. The introduction is the initial stage of acclimatization.

Naturalization is different when a species is transferred to similar conditions or biocenoses, its adaptation in this case lies within the potential range and capabilities of the genome, and acclimatization - with transfer to significantly different conditions, for adaptation to which requires a change in the structure of the genome of the population of the species. Introduction is an introduction to the culture of both local and non-regional species. Spontaneous resettlement is adventisation, the extreme expression of which is naturalization. The acclimatization is the adaptation of an animal or plant to a different climate, different from the climate of its homeland. Introduction and acclimatization are closely related. Introduction from distant countries is inevitably accompanied by adaptation (adaptation) to a new climate, i.e. acclimatization (Novikov 2002; Ribeiroet al. 2019; Ma et al. 2020).

The reintroduction is the restoration of a species to habitats or areas that were once part of its historical range and where it has been destroyed or disappeared. Reintroduction as a process opposite to introduction, i.e. return (special, intentional) of planted species to natural habitats.

The introduction can save the species diversity of flora, but it cannot preserve its gene pool and, consequently, biodiversity. Indeed, the preservation of the formed over centuries, manifested and potential genotypic wealth in full outside natural conditions is impossible, just as it is impossible to protect one species without protecting other species functionally related to it in nature.

The most environmentally friendly and biologically justified is the method of rescuing rare and protected species of flora, the populations of which are in the construction zone - this is the method of translocation. Translocation of rare and endangered plant species to new localities can also be justified from a microevolutionary standpoint. The appearance in a new place due to translocation of individuals from other populations can enrich the gene pool of local populations of the same rare and endangered species, but growing in safe areas (Bowd et al. 2018; Shovon et al. 2020; Gray et al. 2021).

The research objects are flora representatives at the construction site of the ZapSibNeftekhim complex located in the city of Tobolsk, Tyumen Region, Russia. Flora species were rescued and transferred from the construction site to safe areas.

One way to preserve the biodiversity of rare plant species is to transfer them to a protected area. Many scholars agree that the search for optimal habitats is crucial for successful translocation since plant survival largely depends on favorable living conditions. Researchers from different countries investigate the matter of transplantation of rare and protected species. Within this work, only vascular plants, fungi, and lichens are subjected to translocation.

Therefore, the most environmentally friendly, biologically reasonable, and economical method the conservation of rare and endangered flora species, the populations of which accidentally ended up in the construction zone, namely the use of the translocation method.

Based on the foregoing, the paper aims to preserve the rare and protected flora species found at the construction site of the ZapSibNeftekhim complex and its associated facilities.

Material and methods

Site selection

The construction site of the ZapSibNeftekhim complex has an area of 460 hectares and is located north of the production sites of the existing facilities of Tobolsk-Neftekhim LLC, Tobolsk-Polymer LLC, and the Tobolsk Thermal Power Plant (Tobolsk, Tyumen Region, Russia).

On the north side, the site is surrounded by forest; from the north-west by a gas distribution station; from the west by a motor road and Tobolsk-Neftekhim LLC; from the south by a motor road, the railway tracks of Sibur-Trans CJSC, and forest; from the south-east by the repair and testing ground of Federal State Unitary Enterprise SG-Trans [FSUE SG-Trans]; from the east by a motor road and the treatment facilities of Tobolsk-Neftekhim LLC.

The nearest residential areas of the city of Tobolsk are located approximately 8.5 km south-west of the construction site. The nearest settlements are more than two km away from the designed enterprise site, namely, in the western direction – the village of Mikhailovka (2.2 km), the village of Sokolovka (3.8 km), and the village of Denisovka (3.1 km); in the northeastern direction – the village of Chukmanka (3.8 km), and the village of Verhniye Aremzyany (6.8 km).

The shape of the site is close to rectangular, with one side 2.9 km and another side 1.7 km. Along the eastern border and in some places along the western border, there is a water drawdown ditch, which currently is 0.5 m deep and 1–3 m wide. The northern border of the site passes through the forest.

The site is forested, sporadically swampy, has an inclined, sloping surface, and the lowest elevations within the site are in the southern part, along the road with the lowest point in the south-east corner.

The site selected for the complex is optimal in terms of compliance with Russian legislation requirements regarding the location of such production facilities. Considering the wind rose and the distance to the borders of the designated conservation area "Abalaksky Natural-Historical Complex," the selected construction site is the most favorable of all alternative options.

To select geobotanical test sites and describe the vegetation, the author followed the generally accepted phytosociological methods and approaches widely used in geobotanical studies. In accordance with the geobotanical research methodology, the description of ground vegetation communities was used as the main method at the field stage of the study.

The species composition of vascular plants at geobotanical sites was identified at the time of the description. To determine the abundance, the Drude scale was used – a system of point-based ocular estimate grades used for assessment of the abundance of the species: soc (socialis) – plants close in on the above-ground part, completely; cop^3 (from copiosa – copious) – very copious; cop^2 – copious; cop^1 – fairly copious; sp (sparsae) – absentmindedly; sol (solitaries) – thin, scattered; un (unicum) – occurs singly.

To determine the degree of transformation of flora and individual plant communities, we evaluated the synanthropization index – the share of synanthropic species in relation to the total number of species (Burda, 1991).

Assessment of the degree of synanthropization was carried out according to the method of R.I. Burda. The percentage is calculated by the formula (1):

$$X=S_{sp}/S_t\times100\% , \quad (1)$$

where S_{sp} – the number of synanthropic species; S_t – the total number of species on the site.

Assessment of the degree of synanthropization according to the five-point system of R. I. Burda (1991): 1 point – the content of synanthropic species at the site is no more than 1%, i.e. they are sparsely interspersed in the general background of vegetation; 2 points – the content of synanthropic species on the site is no more than 10%. Found among several plants that form a mass admixture to the background; 3

points – the content of synanthropes on the site is no more than 30%. Here they are found among many species, making up a significant part of the general background; 4 points – the content of synanthropes on the site is no more than 50%, i.e. their dominance is evident. Synanthropes make up the bulk of the vegetation; 5 points – the content of synanthropes on the site is more than 50%.

Translocation

The transplant was carried out by the Tobolsk Complex Scientific Station of the Ural Branch of the Russian Academy of Sciences [TCSS UB RAS]. The work on translocation must be preceded by the preparation of the plants, fungi, and lichens subject to transfer that involves (1) precise coordinate referencing of the species subject to translocation at the site using a GPS navigator (Garmin); (2) labeling the plants, mushrooms, and lichens prepared for translocation, so that they can be easily detected from a distance (it prevents them from accidental damaging during the operation) (Fig. 1); (3) search for the most suitable and shortest transport routes to the prepared vehicle (bypassing any swamps, windbreaks, etc.); (4) marking the routes of removal using signs to facilitate movement and land navigation.

The description of vegetation was carried out during the growing seasons according to the methodological approaches and methods, accepted in phytocoenology and widely used in geobotanical studies (Cherepanov 1981; Kharitintsev 1994; Petrova 2004; Naumenko 2004).

Figure 1. Labeling the plants (*Centaurea phrygia* L.).

Using the method of translocation, we paid particular attention to preserving the integrity of the root system of the transplanted species to prevent them from mechanical damage, and preserve them in the initial period, in the original optimal neighborhood of the habitual environment, as well as the roots of the nearest representatives of the flora (Kulikov 2010; Ilminskikh 2014). This method allows to save all consortium connections in the part of pedobiology and exclude possible mechanical damage to the root system. When removing, any shaking leading to vibration of the root system is minimized, because it is detrimental for intergrown root hairs with soil microparticles (Ryabinina and Knyazev 2009).

Above-ground (litter) fungi to be translocated have similar requirements and limitations as vascular plants. There are no rare, endangered, and protected species of this group at the industrial site. Xylotrophic (wood-destroying) fungi, whose mycelium is not in the soil, but in wood, require completely different translocation techniques.

Epigeneous (above-ground) lichen species also differ from litter fungi and vascular plants in terms of translocation methods. Another thing is epiphytic lichens growing on the bark of trees and shrubs. Since, unlike xylotrophic fungi, epiphytic lichens do not enter into trophic relations with forophytes (the supporting tree), there is no need to remove any part of the tree's wood during translocation. It is sufficient to remove a portion of the tree bark with the lichen thallus located on it and attach it with lichen to another suitable forophyte in a safe place.

A specific site for protected plant transplantation was chosen. To make the right choice, we considered the opacity, configuration, size, and depth of places for new locations. Also, during the work, we took into account all biological characteristics of the transferred flora species and their ecological requirements (phytocoenotic environment, illumination of forest areas, soil moisture, topography). After the translocation, we irrigated and labeled the plants and carried out photographic fixation. Furthermore, we recorded the geographic coordinates on the GPS-navigator "Garmin." Based on Google Earth satellite photos, we developed maps of rare and endangered species along the right-hand path of the power line, where the locations of species marked by the Garmin GPS Navigator were plotted.

Results

We also assessed biodiversity in the territory of the ZapSibNeftekhim construction project. Based on the assessment results, we sent an appeal to the SIBUR management (the company implementing the project), initiating to preserve (transfer) the rare and endangered flora species (vascular plants, mushrooms, and lichens) that were found in the area.

In total, 149 specimens of 13 species of flora were transferred during the research: (1) *Malaxis monophyllos* L. (un), (2) *Listera ovata* (L.) R. Br. (un), (3) *Dactylorhiza maculata* (L.) Soo (un), (4) *Allium microdictyon* Prokh. (sol), (5) *Centaurea* *phrygia* L. (sol), (6) *Phegopteris connectilis* (Michx.) Watt (sol), (7) *Polyporus badius* (Pers.) Schwein. (un), (8) *Iris sibirica* L. (un), (9) *Daphne mezereum* L. (un), (10) *Lilium pilosiusculum* (Freyn) Miscz. (sol), (11) *Cinna latifolia* (Trev.) Griseb. (un), (12) *Platant herabifolia* (L.) Rich. (un), (13) *Heterodermia japonica* (M.Sato) Swinscow et Krog (un) (Table 1).

As a result of the research, we decided to preserve the floral forms growing in the project territory. Besides, we agreed to carry out all of the work on clearing the construction site only after completing the translocation works.

One of the main points of the project was the development of the translocation method, which includes the following sections: (1) carrying out agrochemical and ecotoxicological analysis of soils of present and future habitats of floristic species; (2) preparation of plants for transfer (coordinate referencing, labeling, etc.); (3) removal of the transferred flora forms from the original habitat; (4) transportation and transplantation to new habitats.

Preparatory work stages preceded the transfer of floristic species: (1) study of the nutrient and salt composition of the soil; (2) study of the phytocoenotic environment both in the habitats of identified rare and protected flora species and in new localities. During the work, we took into account all biological features of the transferred flora species and their environmental requirements (phytocoenotic environment, illumination of forest areas, soil humidity, terrain type, etc.).

Table 1. Rare and endangered flora species found at the construction site of the ZapSib-Neftekhim complex

Species of flora transferred	**Status, category in the Red Book of the Tyumen Region**	**Number (pcs.)**
Endangered species listed in the Red Book of the Tyumen region		
Malaxis monophyllos L.	Status II. Category: threatened species	4
Listera ovata (L.) R. Br.	Status II. Category: threatened species	2
Dactylorhiza maculata (L.) Soo	Status II. Category: threatened species	1
Allium microdictyon Prokh.	Status II. Category: threatened species	17
Centaurea phrygia L.	Status III. Category: rare species	106
Phegopteris connectilis (Michx.) Watt	Status III. Category: rare species	8
Polyporus badius (Pers.) Schwein.	Status III. Category: rare species	2
Rare species		
Iris sibirica L.	None	1
Daphne mezereum L.	None	1
Lilium pilosiusculum (Freyn) Miscz.	None	2
Cinna latifolia (Trev.) Griseb.	None	2
Platanthera bifolia (L.) Rich.	None	1
Heterodermia japonica (M. Sato) Swinscow et Krog	None	2

The chemical composition of soil samples taken in the localities of rare plant species is the most similar to the chemical composition of the soil samples taken in the places proposed for plant transplantation.

As a result, we transferred all discovered representatives of rare and protected flora species from the construction site of the ZapSibNeftekhim complex to a safe area. The required permission was obtained from the Department of Subsoil Use and Ecology of the Tyumen Oblast to carry out the activities on the transfer of protected species of flora.

The flora specimens transferred by the translocation method were located at seven monitoring sites in the Tobolsk and Uvat districts of the Tyumen Region, Russia. The area was mapped, and the GPS coordinates of all transplanted specimens were specified.

Malaxis monophyllos (L.) Sw. is a perennial herb with a thickened pseudobulb (tuber). Stems 8-30 cm tall, slender. Leaves in the lower part of the stem (one, rarely two) are long, 5-10 cm, 3-5 cm wide, broadly elliptic, with a long stalk-enclosing petiole. The second leaves are much smaller. The flowers are pale green, on twisted stalks, in sparse racemes 3-14 cm long.

This plant blooms for a very long period. Translocation is best done during blooming, as new aerial buds form in autumn. Therefore, it is undesirable to disturb the plant at this time. In addition, the seeds will spill out at a new locality, which is especially important for this species with almost exclusive seed reproduction. New locality coordinates: N 58˚44.861', E 68˚46.427'.

The plant of *Listera ovata* (L.) R. Br. is a perennial herb with a short thick rhizome. Stem near the middle with 2 almost opposite leaves, glabrous and thicker below the leaves, shortly glandular pubescent above, with 1-3 small reduced leaves. Leaves narrowed towards the base, sessile, with a stalk-enveloping base. Flowers on strongly twisted, glandular-hairy legs, green. The perianth is folded in a helmet, the outer ones are ovoid, the inner ones are linearly oblong.

Propagates mainly vegetatively, from roots and rootstalks. Therefore, the root system should not be damaged during translocation. In terms of time, translocation is optimal either during blossoming or immediately after blossoming, because the complex processes of laying buds for the winter begin later. New locality coordinates: N 58˚44.808', E 68˚45.918'.

Dactylorhiza maculata (L.) Soo. is a perennial herb with palmate compressed root tuber. The stem is dense, 25-50 cm tall, with 2-6 broadly keeled leaves deviated from the stem, of which the lower one is 5-10 cm long, the next 2 are larger – 6-15 cm long, the uppermost linear, bracts often slightly sinuous, not reaching the base of the inflorescence. The leaves are dark green above, often with round, large, sometimes merging brown spots, bluish-green below, one-color. The inflorescence is spicate, dense, multi-flowered, up to 10 (12) cm long.

It is advisable to transfer this plant during or immediately after blossoming, since later in autumn, complex processes of laying new flowers in the bud begin; transplantation during blossoming or blossom fading will allow the plant to disperse its seeds at a new locality, which is essential, especially considering that the seed propagation method is practically the only one in this species. New locality coordinates: N 58˚17.968', E 68˚29.077'.

Platanthera bifolia (L.) Rich. is a herbaceous plant 20–50 cm high with two undivided root tubers. Some grow up to 60 cm. Each year a new replacement tuber grows. Basal leaves – two, rarely one or three, located almost opposite, narrowed at the base into a petiole. The flower is a rare cylindrical spike, reaching 20 cm in length.

Should be transferred during blossoming or a little later, since in the fall a replacement (new) tuber is laid, from which a new blossoming shoot is formed the next year, and after cracking the ripened seeds they disperse at the original locality, and the seed propagation of the specimen transferred to the new locality will be reduced to zero. New locality coordinates: N 58˚17.971', E 68˚29.081'.

Allium microdictyon Prokh can also be found in the forest. It is a plant up to 70 cm tall, with a stem half covered with leaf sheaths. The bulbs are conical and cylindrical, with a diameter of up to one and a half centimeters. On an oblique rhizome there can be from one to several bulbs. The leaves are smooth, lanceolate or oblong-elliptical, flat with a well-defined blade, 10 to 20 cm long and 8 cm wide, tapering into a long (3-7 cm) stalk. The inflorescence at the end of the stem is shaped as a thick spherical umbrella. The flowers are borne on equal pedicels, which are two to three times longer than the perianth. It is a rare species that can be found on the western boundary of the distribution area. Species with disjunctive distribution. It is listed in the Red books of Tyumen (2004) and Sverdlovsk (2008) regions as category 2 (Fig. 2).

Transplanting *Allium microdictyon* Prokh is impractical before blossoming. The best time for that is right after blossoming, since later the generative shoots and the leaves, wither, and seeds are scattered from the capsules, which will deprive the transplanted specimens of the possibility of seed renewal at a new locality. New locality coordinates: N 58˚44.898', E 68˚45.567'.

Lilium pilosiusculum (Freyn) Miscz – perennial bulbous plant up to 80 cm tall. The bulb is golden yellow, ovoid, and consists of tiled scales. Stem green or with red spots, pubescent, with whorled lower and alternate upper elliptical leaves.

Translocation of *Lilium pilosiusculum* (Freyn) Miscz is desirable after blossoming as this will save the seeds of the plant for possible germination in a new locality. Also, in autumn, the processes of formation of accessory buds are actively taking place, and the plant should not be disturbed at such a crucial stage of its ontogenesis. The new locality coordinates: N 58˚44.572', E 68˚44.680'.

Iris sibirica L. – a perennial plant that forms dense tussocks. The flowers are large (7-8 cm), light blue with purple veins, collected in 2-3 at the top of a high (60-110 cm) peduncle.

Transplanting of *Iris sibirica* L. is best done with well-developed but not yet ripe fruits. New locality coordinates: N 58˚17.286', E 68˚28.521'.

Cinna latifolia (Trev.) Griseb. – rhizome perennial. Stems are 40 to 130 (up to 200) cm tall, erect. Leaf blades up to 15 mm wide, with a prominent white midrib, rough along the edges and midrib; tongue from 3 to 9 mm.

Figure 2. *Allium microdictyon* Prokh.

When transplanting *Cinna latifolia* (Trev.) Griseb. it is necessary to ensure that generative stems fall into the composition of the separated parts. The root system is shallow, allowing one to take a 20 cm thick layer of soil with plants. New locality coordinates: N 58˚44.911', E 68˚45.573'.

Daphne mezereum L. – a sparsely branched low wintergreen shrub with a shallow root system. It is characterized by slow development.

Daphne mezereum L. is the only arboreal representative of all transplanted species. Translocation is best done after blossoming before the fruit ripens: ripe berries easily slough. New locality coordinates: N 58˚43.039', E 68˚41.017'.

Centaurea phrygia L. – perennial herb, 30 to 130 cm tall, covered with winding hairs. The stem is simple or branched, ribbed. Leaves 5-15 cm long, from oblong-ovate to broadly, dentate. The flowers are pink or purple.

Centaurea phrygia L. is often located in groups due to vegetative propagation; it forms clones. The plant can be transplanted before blossoming to engage seed propagation. New locality coordinates: N 58˚17.984', E 68˚28.934'.

The plant of *Phegopteris connectilis* (Michx.) Watt has long creeping rootstalks, due to which vegetative propagation occurs with the formation of close clone groups. The root system of this fern is periblastic; the fronds (leaves) are very delicate, brittle. The new locality coordinates: N 58˚15.055', E 68˚28.938' (Fig. 3).

Since *Heterodermia japonica* (M.Sato) Swinscow et Krog grows on a crust in the lower part of old aspen trunks. Such a place is the best for its nutrition. It is essential to carefully remove a part of the crust in its entire thickness (up to cambium) from the original forophyte. Thallus small-lobed rosette-shaped, up to 15 cm in diameter, tightly attached to the substrate. Attached with rizin. The lobes are 1–2 mm wide, flat or slightly convex, dichotomously branched. On the tips of the blades or on their lateral branches, there are lip-shaped or capitate sorals. There are long cilia at the tips of the lobes. In the new locality, old, inclined aspen (an analog of the original forophyte) is selected. New locality coordinates: N 58˚17.286', E 68˚28.723'.

Polyporus badius (Pers.) Schwein. is a type of mushroom belonging to the Polyporaceae family. In young specimens, the cap is smooth, shiny, light gray-brown; in mature specimens it is dark chestnut, with a bright orange-red sinuous edge.

Figure 3. *Phegopteris connectilis* (Michx.).

To save *Polyporus badius* (Pers.) Schwein. it is necessary to carry the trunk with mycelium and fruit bodies to a new safe locality. For better contact of the trunk with the soil, after delivery to the new locality, the top of the soil with the grass stand must be removed in the direction that the trunk was initially laid. It is better to select a specific place in areas where there are fallen aspen trees for the possibility of rapid reproduction of the fungus and infection of other logs. New locality coordinates: N 58˚44.911', E 68˚45.573'.

Near the site there are taiga sections with *Tilia cordata* Mill. This tree species is common in Europe, but in Siberia it can be found only in the Tyumen Region and partially in the Khanty-Mansiysk Autonomous Okrug. *Tilia cordata* Mill. has category III – rare species. The trees can grow up to 30 m in height. In the understory they can be found in bushlike form. The leaves are petiolate, round-heart-shaped, serrate along the edge, acuminate, 3-9 cm long, bearded with reddish hairs in corners of veins. The inflorescence is composed of cymes combining 2-4 flowers. *Tilia cordata* Mill. is considered a relict species for the southern taiga forests of Western Siberia. It was widespread in warmer geological periods and significantly reduced its range in cold periods. At present, *Tilia cordata* Mill. thrives and reproduces well in the polydominant taiga.

Another interesting rare plant can be found in pine forests: *Calluna vulgaris* (L.) Hull. Category III – rare species. It is an evergreen shrub of 15-50 cm tall, with woody, ascending and branching stems. The leaves are opposite, sessile, pressed, boat-shaped, small (1.7-2.3 mm long), sagittate at the base. The flowers are reclined or drooping, form almost one-sided tufts ending in leafy tops. The flowering season of heather lasts from July to late September. Dried heather flowers do not fall, giving the impression that the plant blooms until late autumn.

The species transferred to new places (localities) should be regularly monitored, keeping records of their stay in the new place. The observation system of living organisms in nature (*in situ*) or their populations and entire communities is called monitoring. At new localities, the transferred species were monitored to determine their survival rate. To assess if the reintroduction work was successful, primarily, we took into account the following indicators: the percentage of surviving specimens; plant vigor; the time required for the transition of plants to blossoming and seed setting; seed viability; the presence of seedlings and juvenile plants. The monitoring results showed that the adaptation of almost all the translocated specimens was successful.

Discussion

Biological diversity is the basis for maintaining the ecological balance and sustainable development of the region's biota. In this regard, the problem of preservation and reproduction of rare and endangered species of organisms in natural habitats is relevant. Specially protected natural areas are one of the most effective forms of nature protection activity, which allows preserving biological and landscape diversity.

It is noted that not many researchers studied the environmental conditions to select the places of transplantation, while the number of studied factors is usually limited. It is proposed to compare plant communities between the donor population and potential sites. This transplantation stage should be performed at an early stage of the site selection process.

Some authors note that the translocation of rare and endangered plant species to new localities can be justified from microevolutionary positions. In modern mass anthropogenic insularization (fragmentation leading to isolation of populations) of landscapes, populations of many species are fragmented, which prevents panmixia (unhindered exchange of genetic material), resulting in undesirable inbreeding (closely related crossbreeding) (Shumilova 1962; Gritsch et al. 2016; Macdonald et al. 2019). The appearance of specimens from other populations at a new place due to translocation can enrich the gene pool of local populations of the same rare and endangered species growing in safe areas (Sloan et al. 2016; Arestova and Arestova 2017).

Many researchers note that among modern theories, methods, and models for the conservation of plant genetic resources, the conservation of *ex situ* species (in culture, mainly in botanical gardens, specialized greenhouses, etc.) and *ex situ* on a farm (preserving the gene pool in homesteads, and farm gardens, monastery gardens and collections of experienced gardeners) prevail. Such studies and practical work are carried out in many European countries (Switzerland, Belgium, France, Great Britain) (Lazareva 2006). Genetic research has a leading position: the creation of genebanks, cryo-collections, germplasm, as well as work with meristems. *In situ* works (in the wild) are less developed, although they are also carried out mainly on the basis of National Parks and nature reserves (Romanova 2005; Rozno and Kavelenova 2007).

The transfer (translocation) of rare and endangered flora species of flora is significantly complicated by the lack of publications on similar (analogous) types of biodiversity conservation activities.

Replicating the positive experience of translocation will make it possible to use this technique for other specially protected natural areas. In the established order and, if necessary, in specially protected natural areas, measures should be taken to restore the disturbed balance in ecosystems.

Conclusion

We managed to make a scientifically substantiated transfer of rare and endangered flora species to a safe area from the construction site of the ZapSibNeftekhim complex to new habitats similar in terms of environmental conditions.

The work was carried out during the season favorable for transfer. We took into account (1) the stage of ontogenesis of the transferred plants, (2) all biological features of the transferred flora species, and (3) their environmental requirements.

As a result of the study, we developed methods and approaches to translocate vascular plant species. Plants were prepared for transfer (coordinate referencing, labeling, etc.), and the translocated specimens were removed from the original habitats. The implemented project showed the effectiveness of translocation methods and approaches to preserve rare and endangered flora species in the territories designated for economic activities.

Methods and approaches of translocation of vascular plant species have been developed. The preparation of plants transferring (coordinate binding, labeling, etc.), removal of the translocated individuals from the original habitat and their transportation to new safe areas was performed. A system for monitoring the state of translocated plants was developed, and a high level of survival of plants after translocation to new habitats was noted.

During the intensive economic development of the territory, the translocation method for rare and endangered species can become an effective mechanism for maintaining biodiversity and sustainable development of regions. Sharing of positive translocation experience will allow using this technique for other similar projects.

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