Alien species of the *Apiaceae* family in the flora of Khabarovsk Territory (the Russian Far East)

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Abstract. The results of studying alien species of the *Apiaceae* family in the flora of the Khabarovsk Territory are presented. According to our data, 13 alien species of this family, including the invasive species *Pastinaca sylvestris*, are now widespread in the territory of the region. They differ in the degree of naturalization, phytocenotic confinement, and the intensity of settlement.

1. Introduction

The introduction and dispersal of alien species is currently a significant part of global natural changes and often leads to significant losses of biological diversity and economic importance of ecosystems prone to biological invasions. While disseminating, alien species transform the structure and disrupt the functioning of ecosystems, homogenize the structure of the biota, displace native species, and carry various diseases. In recent years, studies in the theory of predicting biological invasion and regulation of the number of alien species are among the paramount areas of ecological research all over the world.

The appearance and distribution of alien plant species in the south of the Russian Far East is associated with the beginning of its development in the early 19th century. At present, the adventive fraction of the flora of Khabarovsk Territory includes 474 species of vascular plants from 274 genera belonging to 62 families, which is 18.8% of the flora of the region [1]. The purpose of this study was to analyze the distribution and degree of naturalization, as well as to forecast the further distribution of alien species of the *Apiaceae* family in Khabarovsk Territory.

2. Methodology

To prepare this paper the author used the data from own field studies carried out during the last 20 years in all areas of Khabarovsk Territory, materials from the Herbariums of leading scientific institutions of Russia (LE, MHA, MW, VLA, KHA), and analyzed the published data on this group of species.

3. Results and comprehensive consideration of the issue

The *Apiaceae* family in the flora of Khabarovsk Territory is represented by 34 genera, of which 11 are represented only by alien species. They consist of 55 species, including 13 alien ones. To characterize the flora, not only the number of alien species is important, but also how widely they have spread in the region, how firmly they have become part of disturbed or indigenous communities, and how high their
activity is. The highest indicators according to these criteria indicate biological invasion, which poses an ecological and economic threat and requires control over the dissemination of these species.

The data characterizing the invasive status of alien species of the Apiaceae family in Khabarovsk Territory are summarized in Table 1. For each species, the degree of naturalization is indicated as indicators from N⁰ to N⁹; distribution in 17 administrative districts of Khabarovsk Territory; activity on a five-point scale, based on the ratio of occurrence, abundance and vitality. According to the method of introduction, three groups were distinguished: accidentally introduced – xenophytes, migrants from culture – ergasiophytes and xeno-ergasiophytes, when both methods of introduction take place.

Table 1. Indicators of invasive status of alien species of the Apiaceae family in Khabarovsk Territory

| Plant name                    | Invasive status | Degree of naturalization | Number of districts | Activity | Introduction method | Introduction time |
|-------------------------------|-----------------|--------------------------|---------------------|----------|---------------------|------------------|
| Pastinaca sylvestris          | very high       | N⁸                       | 8                   | 5        | xenophyte           | mid 20th century  |
| Carum carvi                  | very high       | N⁸                       | 16                  | 5        | xenophyte           | mid 20th century  |
| Pimpinella saxifraga         | high            | N⁶                       | 4                   | 3        | xenophyte           | mid 20th century  |
| Aegopodium podagraria        | middle          | N⁴                       | 2                   | 2        | ergasiophyte        | 2010–2015        |
| Eryngium planum              | low             | N³                       | 2                   | 1        | xeno-ergasiophyte   | mid 20th century  |
| Conium maculatum             | low             | N⁳                       | 1                   | 1        | xenophyte           | mid 20th century  |
| Daucus carota L.             | low             | N²                       | 1                   | 1        | xenophyte           | mid 20th century  |
| Turgenia latifolia           | low             | N¹                       | 1                   | 0        | xenophyte           | mid 20th century  |
| Caularis platycarpus         | low             | N¹                       | 1                   | 0        | xenophyte           | 2015             |
| Anethum graveolens           | very low        | N¹                       | 17                  | 1        | ergasiophyte        | early 20th century|
| Coriandrum sativum           | very low        | N¹                       | 4                   | 1        | ergasiophyte        | early 20th century|
| Levisticum officinale        | very low        | N⁰                       | 1                   | 0        | ergasiophyte        | early 21st century|
| Astrantia major L.           | very low        | N⁰                       | 1                   | 0        | ergasiophyte        | 2015             |

All the alien species of the Apiaceae family found in Khabarovsk Territory can be classified into three groups. The first group includes the three most aggressive species: Pastinaca sylvestris, Carum carvi, Pimpinella saxifraga, and one potentially aggressive species, Aegopodium podagraria. The distribution of these species is shown in Figure 1.

Figure 1. Distribution of species with a high invasive status in the administrative districts of Khabarovsk Territory

a. Pastinaca sylvestris  
b. Pimpinella saxifraga  
c. Carum carvi  
d. Aegopodium podagraria
P. sylvestris Mill. – forest parsnip is a wild form of cultivated parsnip P. sativa L. At present, the wild form is considered a subspecies of cultivated parsnip - P. sativa L. subsp. sylvestris (Mill.) Roug et Camus (The Plant List). Parsnips have been cultivated as a valuable food and medicinal plant since ancient times. It is not possible to establish clear signs that distinguish cultivated forms from plants from natural communities; therefore, it is difficult to characterize the boundaries of the natural range of the species. The wild form grows everywhere in Europe, the Caucasus, in Asia Minor in meadows and along river banks. In Russia, the species is indigenous in the European part, in Crimea, Ciscaucasia, Dagestan, and Western Siberia [2].

Apparently, it was brought to the territory of the Russian Far East (RFE) from Eastern Siberia, where it is an archaeophyte and is one of the plants introduced to Siberia during the period of active development of this region by the Russians (from the end of the 16th to the first half of the 18th centuries). Currently it is widespread in Primors and Khabarovsky Territories, Sakhalin, Amur and Jewish Autonomous Regions. The beginning of active dispersal of P. sylvestris was noted in the second half of the last century in Primors Territory. At the same time, the first collections were made in Khabarovsky Territory. First, a large focus was formed in the transport and industrial center of the region – Khabarovsky city, from where in 2007–2010 it began to spread to the southern regions of the region. Parsnip forms many kilometers of strips along the federal highway M60 Khabarovsk – Vladivostok, populating mainly the roadside and ditches. Along the highway outside these habitats, parsnip locally grows on open areas with disturbed vegetation, but here it forms large, almost monodominant thickets. A little later, in 2017, mass settlement dissemination began to the northeast along the Khabarovsky – Komsomolsk-on-Amur highway. There, parsnip inhabits similar habitats, also forming strips over many kilometers. Currently, an important deterrent to the dissemination of parsnips along major highways is the cleaning of the roadside area, especially before the beginning of fruiting. This is how it usually happens, since by the time of flowering and fruiting, the height of the plants is 1.5-2.0 m. Nevertheless, on these highways, which are more than 200 km long within the Territory, parsnips are recorded annually. The second important main route of dissemination is the railway, which also has a general direction to the south and north-east of the region. Here the dissemination of parsnips is less intensive. Most of the railroad runs through flat boggy landscapes, where there are few ecotopes suitable for parsnips. Usually, small localities are confined to railway stations. At present, the largest outbreak is still the city of Khabarovsky, where parsnip, along with numerous small groups of plants mainly along the railway, on the roadsides, wastelands of the industrial zone and low-rise buildings, forms large thickets in the green areas of the city.

C. carvi L. – common caraway, has long been introduced into cultivation and cultivated as an essential oil plant. It has been cultivated in Russia since the beginning of the 19th century. The natural range covers Europe, Asia, North Africa. In Russia, the natural range is limited to Eastern Siberia. In all regions of the RFE it is invasive. It was first discovered in 1911 in the vicinity of Vladivostok, later it was indicated as a rarity for Primorsk Territory, Kamchatka and Amur Region. In the second half of the last century, it began to actively spread in Khabarovsky Territory and is now found in all regions. The highest degree of naturalization is manifested in the coast of the Tatar Strait (Sovetskaya Gavan, Vanino, De-Kastri, Nikolaevsk-on-Amur, etc.), this is one of the most abundant plants on lawns, ruderalized meadows, railway slopes, roadsides [3].

P. saxifraga Ledeb. – common burnet saxifrage, its natural range covers Europe, the Caucasus, South-West Asia, Kazakhstan. In Russia, the border of distribution is Eastern Siberia, in the RFE it is alien. Until the middle of the last century, collections were known in Kamchatka and the south of Primorsk Territory. At the end of the last century, it was discovered in Khabarovsky Territory. All finds are mainly confined to the sea coast and the mouth of the Amur river (Vanino, Sovetskaya Gavan, Nikolaevsk-on-Amur). Here, common burnet saxifrage dominates in meadow communities along the railroad and on dry slopes along the Amur bank [3].

A. podagraria L. – the cultivated form is variegata – common variegated runny, a popular ornamental plant, a European-West Siberian species. In the south of the region it is grown as a ground
cover plant. It spreads quickly, forming stable local thickets along ditches, roadsides, forest edges not far from cultivation sites [1].

The second group is represented by low-active species, which are currently not widespread over the territory of the region, but the possibility of further dispersal cannot be ruled out.

*Cuminum maculatum* L. – Spotted hemlock, its natural range is Europe, the Caucasus, Central Asia, Mongolia, Western China, Western Siberia. In the RFE it was found in 1962 in Primorsk Territory. In Khabarovsky Territory in the middle of the last century it was noted as a common species, *en masse* found in weedy places in Ulchsky District (Nechaev, 1970, MNA). Nowadays, it is very rare, sometimes it is grown in vegetable gardens as a medicinal product.

*Eryngium planum* L. – Erythematous flat-leaved, natural range: Europe, Georgia, Kazakhstan, Western China, Mongolia, Siberia. There are several known locations in the RFE. Since 1932, it several times gathered in Primorsk Territory. In Khabarovsky Territory, it has been growing like a weed for several decades in the arboretum of the city of Khabarovsk, does not show a tendency to dissemination. In 2006, several plants were found on the side of the road in Nikolaevsk district, Mago settlement [3]. Occasionally it is grown as decorative plant for dry bouquets.

*Turgenia latifolia* (L.) Hoffm. – broad-leaved turgenia, natural range: Europe, North Africa, Transcaucasia, Iran, Southwest Asia, Kazakhstan. In the RFE it was collected in the last century in Kamchatka and Khabarovsky Territory [4], Primorsky Territory [5].

*Caulis platycarpos* L. – natural range: Europe, North Africa, Southwest Asia, Transcaucasia, Iran, Iraq, Afghanistan, Kyrgyzstan, Turkmenistan, Kazakhstan. In the RFE it can be found in Amur Region, as well as in Khabarovsky Territory in single collections (Antonova, 2018).

*Daucus carota* L. – Common carrot is a wild relative of the cultivated carrot *Daucus carota* subsp. *sativus* (Hoffm.) Arcang. Natural area: Europe, Southwest and West Asia. In the RFE, in Khabarovsky Territory, it is very rarely found as a weed plant (Antonova, 14.08.2018, Komsomolsk-on-Amur).

The third group is represented by species that are cultivated and can be found near their places of cultivation, but due to their biology, the likelihood of further naturalization is very small.

*Anethum graveolens* L. – common dill. Homeland is the Mediterranean. Cultivated in all districts of the Territory, occasionally observed not far from the places of cultivation.

*Coriandrum sativum* L. – coriander, or cilantro, home is the Mediterranean, from where it was brought to many countries, where it was cultivated as a spice and ran wild. In the RFE, it was found at the beginning of the last century in garbage places in the Korean settlements of Primorsk Territory. Occasionally observed along roadsides in summer cottages in the southern regions of the region.

*Levisticum officinale* Koch – garden lovage, a European-Caucasian species. Cultivated as a food plant, in the south of the region it is occasionally observed in abandoned gardens.

*Astrantia major* L. – great masterwort, a European species, cultivated as an ornamental plant. It was encountered several times in abandoned flower beds in Khabarovsk (Antonova, 21.08.2015, Komsomolsk-on-Amur).

4. Conclusions

Thus, the alien flora of Khabarovsky Territory is represented by 13 species of the *Apiaceae* family. Four species are actively spreading over the territory of the region, and with an increase in anthropogenic load, further expansion of their range will occur. Monitoring of the invasive species *Pastinaca sylvestris* is necessary; its spread can lead to ecological and economic problems.

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