Trees and shrubs of native flora in green areas of the South-East coast of the Crimea

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Abstract. The article examines species of native dendroflora in parks and other green areas of the South-Eastern coast of the Crimea. Those of them that are often used are considered, as well as rare one. The oldest woody aborigines in the parks of the region are identified, and their morphometric data are given. The work also considers neophytes of the Crimean flora (cedars, cypresses, pines), that emphasize the Mediterranean character of the local landscapes. Special attention we have paid to species with regional and state conservation status. Cultivating them in gardens and parks will serve as an additional measure to preserve them. We proposed species of native trees and shrubs with good ornamental properties and suitable for the soil and climatic conditions of the region. Thus, we expand their species diversity in cultural cenosis. Their physiognomic correspondence to local picturesque landscapes is important. Artificial green spaces play an important role in the conservation of biodiversity, as well as rare protected species of the Crimean flora. The preservation of artificial green zones should correspond with the general concept of nature protection in the region.

1. Introduction

The Crimea is attractive region for recreation [1]. The anthropogenic pressure on the natural complexes of the Crimea is increasing currently. So the problems of conservation and protection of its natural flora are becoming more and more actual. Especially it concerns the coastal area that is being developed most intensively for recreation. The fragments of forest vegetation are rapidly reducing under the anthropogenic pressure. Many species of native Crimean dendroflora are most susceptible to various threats, since in addition to reducing the areas of their natural growth, they are also subject to illegal logging, are used for crafts, etc. Such species as Juniperus excelsa M. Bieb., Pinus brutia Ten., Pistacia mutica Fisch. et C. A. Mey. are located at the northern boundary point of the range, therefore, vulnerable to changing environmental conditions [2]. In addition, recurrent forest fires pose a threat to their existence. The modern concept of preserving the biodiversity of flora involves both the protection of species in its natural censuses and in artificial plantations as an additional measure of its conservation. At present almost the entire Crimean coastal part has been transformed by humans, so artificial censuses, where a significant number of species of native dendroflora also grow are of great interest. This applies both to artificial forests and to various parks, and other green areas of
recreational complexes that occupy significant territories here. Using native flora species for landscaping is considered by many scientists in the world [3-6], in the Crimea in particular [7-8].

The aim of the work is to analyze the use of plants of native Crimean dendroflora in gardens and parks of the South-Eastern coast of the Crimea, suggest ways of enrichment, protection and rational use of native trees and shrubs in green areas of the region.

2. Materials and methods
The studied area is situated within the South-East Coast of the Crimea (SECC) region, and covers the coastal area from eastern outskirts of Alushta to Feodosia (Alushta, Sudak, and Feodosia administrative districts). Here the eastern variants of the Crimean sub-Mediterranean are presented. Unlike the western part, this area is less protected by the Crimean Mountains from northern air masses. Nevertheless, the dominant landscapes here have a Mediterranean character, distinguished by dryness and more continental features of climate. A more xerophytic character of vegetation has formed here. Forest formations dominate up to the Karadag mountain range, and to the east of the Karadag, steppe vegetation predominates. Southeastern Crimea belongs to the northeastern edge of a Mediterranean-type subtropical climate. The indigenous vegetation here belongs to the ancient Mediterranean flora. It was formed under the influence of subtropical climate, proximity of warm Black Sea and mountainous relief, determined the altitudinal zonation. Forest vegetation consists of summer green deciduous forests, evergreen coniferous forests and juniper woodlands. Such protected species grow here, as Juniperus excelsa (fragments along the entire coast on steep, predominantly southern slopes), Pistacia mutica (fragments along the entire coast and the lower forest belt), Pinus brutia (fragments in the coastal and lower forest belts on the slopes in the vicinity of the settlements of Novy Svet and Sudak).

A special landscape has formed here, which combines cities and towns, health resort and rest houses, parks, gardens and vineyards surrounded by sparse forests, rapidly reducing their areas under the recreation. We examined the green areas of cities and towns. We studied the species of native dendroflora of the Crimea, growing in artificial plantations, estimated state (good or bad growth) of trees and shrubs, measured the height and the diameter of trunk of the oldest trees. We paid special attention to species with a conservation status in the Red book of the Republic of Crimea (RBRC) and the Red book of Russian Federation (RBRF).

The investigation has been providing since 2002 year. We show the results of 2017–2020 period at present work.

3. Results
The dendroflora of artificial plantations of the SECC includes 229 species of woody plants. About a third of them (67 species, or 29.3%) belong to native flora of the Crimea [9]. Their frequency of occurrence is different. Some are massively used in various types of plantings, noted in all cities and towns, in various types of green areas. These species include coniferous trees – Juniperus excelsa, J. sabina L., Pinus brutia, P. nigra J.F. Arnold subsp. pallasiana (Lamb.) Holmboe, Taxus baccata L.; deciduous trees – Betula pendula Roth, Fraxinus excelsior L., Elaeagnus angustifolia L., Quercus pubescens Willd., Ulmus minor Mill.; deciduous shrubs – Cercis siliquastrum L., Cornus mas L., Cotinus coggyria Scop., Crataegus pallasii Griseb., Tamarix ramosissima Ledebed., T. tetrandra Pall. ex M. Bieb., and semi-evergreen shrubs – Pyracantha coccinea M. Roem., Ligustrum vulgare L.; lianas – Hedera helix L., Clematis vitalba L. All mass species are in good state, bloom, bear fruit, and fully display their ornamental features. Other species are rare. For example, trees: Arbutus andrachne L., Celtis australis L., C. glabrata Stev. ex Planch., Morus nigra L., Prunus mahaleb L., Sorbus graeca (Spach) Lodd. ex Schauer, S. torminalis (L.) Crantz., Tilia begoniafia Stev. Some shrubs are also rare, for example: Berberis vulgaris L., Colutea cilicica Boiss. & Balansa, Cornus mas L., Rhus coriaria L., Viburnum lantana L., Vitex angus-castus L. We found such single plants at green areas of recreational complexes, less often at streets of cities and settlements.
Neophytes of the Crimean flora are of great interest for green construction of the region, especially those who have firmly entered the culture of the Crimea under the "mediterranean influence". Representatives of the Mediterranean flora: *Cedrus atlantica* (Endl.) Manetti ex Carrière, *Cupressus sempervirens* L., *Prunus laurocerasus* L., *Spartium junceum* L. are widely used in all green construction sites. Such species as *Laurus nobilis* L., *Quercus ilex* L., *Viburnum tinus* L., *Rosmarinus officinalis* L. grow massively in the parks of the western part of the studied region (from Alushta to Sudak). To the east of Sudak, where in some winters temperatures reach –24°C, they are more or less damaged by frost.

There are many trees of rare, endemic and protected Crimean flora: *Juniperus deltoids* R.P. Adams, *J. excelsa*, *J. sabina*, *Pinus brutia*, *Pistacia mutica*, *Taxus baccata* at the territories of recreational complexes. They are in a good state. This is especially true for those parks that are located on the border with protected botanical sites in the Novi Svet (State Nature Reserve for the protection of *Juniperus excelsa* and *Pinus brutia*), in Kanaka Gully (State Nature Reserve for the protection of *Juniperus excelsa*). For a number of years we have been providing observations of 11 protected species of the Crimean flora growing in the arboretum of the Karadag Scientific Station (KSS) that located on the territory of the administrative zone of the Karadag Nature Reserve. They are: *Arbutus andrachne* L., *Crataegus pojarkovae* Kossych, *C. sphaenophylla* Pojark., *C. taurica* Pojark., *C. tournefortii* Griseb., *Juniperus excelsa*, *Juniperus deltoids*, *Juniperus sabina*, *Pinus brutia*, *Pistacia mutica*, *Taxus baccata*. All the studied plants in the arboretum are in good state (better than in natural conditions) through appropriate care for them (watering during the hottest time of the year, tilling the soil). They have the best taxation indicators: the height and diameter of the trunk. Give self-seeding *Crataegus sphaenophylla*, *C. taurica*, *Pinus brutia*, *Pistacia mutica*.

The identification and protection of the oldest trees of native flora in the Crimea is paid special attention [10]. Of great interest are the oldest plants (have reached 100 years age or more), we were able to note at the territory of the studied region. Below we present their taxation indicators (table 1). They all are in good state.

| Species | Location | Approximate height (m) | Stem diameter (cm) | Approximate age (years) |
|---------|----------|------------------------|--------------------|-------------------------|
| *Pinus brutia* | arboretum KSS | 16 | 67.0 | 100 |
| *Pinus brutia* | – // – | 18 | 63; 51; 34 | 100 |
| *Pistacia mutica* | – // – | 12 | 36; 36; 35; 31 | 200 |
| *Fraxinus excelsior* | park in the village of Malorechenskoye | 25 | 60.5 | > 150 |
| *Morus alba* | – // – | 24 | 95.0 | > 150 |
| *Pinus nigra* subsp. *pallasiana* | – // – | 35 | 91.0 | > 150 |
| – // – | – // – | 30 | 82.5 | > 150 |
| – // – | – // – | 32 | 72.5 | > 150 |
| – // – | – // – | 28 | 73.5 | > 150 |
| *Juniperus excelsa* | park in Kanaka boarding house | 7 | 85.0 | > 300 |
| *Juniperus excelsa* | – // – | 8 | 45.0 | > 300 |
| *Morus alba* | Feodosia, city hospital | 17 | 165.0 | > 150 |
4. Discussion

Plants of the Crimean native flora occupy a significant place in the culture phytocenoses of the SECC. In our opinion, this is due to a number of reasons. Historically, Crimean stamps were planted in a landscape style, where exotic trees and shrubs grew along with local plants. The combination of introduced and native flora accentuates and enriches the beauty of the surrounding landscapes. The inclusion to artificial landscapes the plants of natural flora that grew here before their creation are typical for many parks of the region. Exotic plants were planted to the natives already existing here. Another reason for the widespread use of native plants is their ecological properties and ornamental features. All plants of natural flora do not suffer from winter frost and summer drought, grow well and fully demonstrate their ornamental features. In conditions of increasing xerophytization of the climate, special attention should be paid to the most drought-resistant species that can grow without watering or need it only in case of extreme drought: *Pinus brutia*, *Juniperus excelsa*, *Cedrus atlantica*, *Pistacia mutica*, *Cotinus coggygria*, *Crataegus orientalis*, *C. pallasii*, *C. sphaenophylla*, *C. taurica*, *Pyrus elaeagnifolia* Pall., *Pyracantha coccinea*.

The ornamental features of trees and shrubs are of primary importance for garden and park landscapes. Plants of the Crimean flora have a number of such properties. Coniferous trees are attractive in all seasons of the year. Such species, as: *Cercis siliquastrum* L., *Tamarix ramosissima*, *T. tetrandra* are widely used as flowering plants. *Tamarix* sare often used to decorate embankments as they tolerate the proximity of the sea well. The assortment can be supplemented with the following species: *Prunus tenella* Batsch, *Berberis vulgaris* L., *Caragana frutex* (L.) K. Koch, *C. scythica* (Kom.) Poir., *Colutea orientalis* Mill., *Cornus mas*, *Crataegus germanica* (L .) O. Kuntze, *Prunus spinosa* L., *Sorbus umbellate* (Desf.) Fritsch. In the second half of summer and autumn, when the peak of flowering is passed, plants with ornamental fruits come to the fore in terms of decorative effect: *Pyracantha coccinea*, representatives of the genera *Cotoneaster*, *Crataegus*, *Sorbus*. In our opinion, aboriginal Crimean hawthorns are used insufficiently. They differ in a variety of fruits in shape, size and color. There are species with red (*Crataegus curvisepala*, *C. monogyna*, *C. karadagensis*), yellow (*C. pojarkoviae*), red-brown (*C. tournefortii*), black (*C. atrofusca*, *C. pentagyna*) fruits. Large-fruited species have a fruit size of 15-20 (*C. orientalis*, *C. tournefortii*) and 20-25 mm (*C. pojarkoviae*). The abundance of fruiting is usually very high (figure 1). An important feature of some species (*Crataegus curvisepala*, *C. sphaenophylla*, *C. taurica*, *C. monogyna*) is the duration of fruit preservation on branches. In warm winters, the fruits are preserved until the end of December – beginning of January of the following year. The branches of trees after leaf fall are covered with bright red fruits and look very attractive (figure 2).

![Figure 1. Fruiting of Crataegus tournefortii.](image1)

![Figure 2. General view of Crataegus sphaenophylla in winter (December).](image2)

Some species are distinguished by bright outstanding autumn foliage color: *Fraxinus angustifolia* Vahl, *F. excelsior*, *Cotinus coggygria*, *Paliurus spinia-christi* Mill. *Pyrus communis* L., *P. elaeagnifolia*, *Sorbus domestica* L., in some years – *Pistacia mutica*. The appearance and preservation of autumn foliage color largely depends on the weather conditions of the year.
Trees and shrubs of native flora can fulfill not only aesthetic functions. They also increase the healing effect of air environment that is very relevant in current challenges of COVID pandemic [11]. Many trees (pines, junipers and others) secrete phytoncides that have bactericidal effect. Various anti-tuberculosis and pulmonary health resorts are located in the Crimea.

Parks and other artificial green areas play an important role in the preservation of rare protected species of the Crimean flora. There are trees and shrubs in parks of recreational complexes of the studied region, which are protected at the state (RBRF) and regional levels (RBRC), and also have other protection statuses (table 2). In addition to the species listed in table 2, another 40 native species are listed in the Red List of Threatened Species (IUCN). Among them, 5 species have the status of Data Deficient; 34 species have the status of Least Concern and 1 species – Near Threatened.

### Table 2. Protected species of the Crimean flora in green areas of the region.

| No | Species | RBRF | RBRC | IUCN |
|----|---------|------|------|------|
| 1  | *Arbutus andrachne* L. | -    | + (3) | + (LC) |
| 2  | *Betula pendula* Roth. | -    | + (2) | + (LC) |
| 3  | *Crataegus meyeri* Pojark. | -    | + (3) | + (DD) |
| 4  | *Crataegus pojarkoviae* Kossych | -    | + (3) | - |
| 5  | *Crataegus taurica* Pojark. | -    | + (3) | - |
| 6  | *Crataegus sphaenophylla* Pojark. | -    | + (3) | + (NT) |
| 7  | *Juniperus excelsa* M.Bieb. | + (2a) | + (2) | + (LC) |
| 8  | *Juniperus oxycedrus* L. | -    | + (2) | + (LC) |
| 9  | *Juniperus sabina* L. | -    | + (3) | + (LC) |
| 10 | *Pinus brutia* Ten. | + (2a) | + (2) | + (LC) |
| 11 | *P. nigra* J.F. Arnold subsp. pallasiana (Lamb.) Holmboe | + (1) | - | + (LC) |
| 12 | *Pistacia mutica* Fisch.et Mey | + (3g) | + (3) | - |
| 13 | *Taxus baccata* L. | + (2a) | + (3) | + (LC) |
| 14 | *Tilia dasystila* Stev. | -    | + (3) | + (LC) |
| 15 | *Vitex angus-castus* L. | -    | + (3) | + (DD) |

Note: the protection status is indicated in parentheses. In the Red Book of the Russian Federation: 1 – species that is threatened with extinction; 2a – species that is declining in number; 3g – rare species. In the Red Book of the Republic of Crimea: 2 – species that is declining in number; 3 – rare species; In the IUCN Red List of Threatened Species: DD – Date Deficient; LC – Least Concern; NT - Near Threatened.

Cultivation of native flora species in arboretums and recreational complexes can serve an educational role. So, ecological tours are held on the territory of the arboretum of the KSS for a number of years. Visitors are introduced to various plants, including protected ones, which are marked in a special way. For this purpose, a special demonstration material has been developed, including the name of the plant, its origin, and the existing protected status. Such information provides visitors with special knowledge, allows them to distinguish rare and protected plants in nature, and does not harm them.

### 5. Conclusions

Since in recent years the territory of the eastern district of the Southern coast of the Crimea is in the zone of intensive recreational development, it is necessary to pay attention to the preservation of those parks that are the place of growth of many rare, valuable exotic and native species of woody plants. They need the protection status of the entire park complex, not its individual components. They should be included in the planned “ecological network” in the region. The preservation of park complexes in
the eastern South bank district should be in line with the general concept of nature protection in the region. The use of rare, red-listed species of native flora in park construction can serve as an additional way to preserve them.

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