

Conference Paper

Biodiversity Conservation in Botanical Gardens: The Collection of Pinaceae Representatives in the Greenhouses of Peter the Great Botanical Garden (BIN RAN)

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Abstract

The work researches the role of botanical gardens in biodiversity conservation. It cites the total number of rare and endangered plants in the greenhouse collection of Peter the Great Botanical garden (BIN RAN). The greenhouse collection of *Pinaceae* representatives has been analysed, provided with a short description of family, genus and certain species, presented in the collection. The article highlights the importance of *Pinaceae* for various industries, decorative value of plants of this group, the worth of the pinaceous as having environment-improving properties. In the greenhouses there are 37 species of *Pinaceae*, of 7 geni, all species have a conservation status: CR -- 2 species, EN -- 3 species, VU- 3 species, NT -- 4 species, LC -- 25 species. For most species it is indicated what causes depletion. Most often it is the destruction of natural habitats, uncontrolled clearance, insect invasion and diseases.

Keywords: biodiversity, botanical gardens, collections of tropical and subtropical plants, Pinaceae plants, conservation status

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Received: 25 October 2019

Accepted: 15 November 2019

Published: 25 November 2019

Publishing services provided by
Knowledge E

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Selection and Peer-review under
the responsibility of the
AgroSMART 2019 Conference
Committee.

1. Introduction

Nowadays research of biodiversity is believed to be one of the overarching goals for the modern world. Already the second World Congress of Botanical gardens in 2004 declared a new International programme of plant protection, setting 16 objectives for gardens. One of the most important is conservation of endangered plants in accessible collections of botanical gardens. All over the world botanical gardens have become the centres of complex nature conservation, there are several examples when endangered species have survived as culture only as a result of the activities of botanical gardens.

It can hardly be argued that botanical gardens serve to connect nature and society. Botanical gardens are not only places where rare and endangered plants are preserved, but this is the site for education: here it is possible to learn about a large number of very different plants from across the globe. A visitor to botanical gardens can see all the

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wealth of nature, here a person gets the information about all the presented species and starts to realise the worth of every plant, even if just a weed.

Undoubtedly, Botanical gardens contribute considerably to biodiversity conservation. There is a range of policy papers, regulating this process: «Convention on Biological Diversity» (2006), «Global Strategy for Plant Conservation» (Global strategy..., 2002), «International programme of botanical gardens for plant conservation» (2000) and «Strategy of Russian botanical gardens for biodiversity conservation» (2003).

Now in botanical gardens of the planet there are almost 4 million plants of 80 thousand species, i.e. approximately 30% of the world flora [3]. The objectives of making collections in botanical gardens at present tends to reflect environment-oriented policies.

The activities, aimed at biodiversity conservation, involve not only preservation of plants *ex situ*, but researching the specific features of their growth, establishing the causes of their depletion in natural habitats, searching for the most efficient ways of reproduction and reintroduction of these species. The task of promoting ecological awareness among people of the world is hardly less important. This mission has to be fulfilled by botanical gardens in cooperation with educational institutions, voluntary organisations, and mass media, which increases public awareness of the problem of declining biodiversity, and every person will understand what kind of contribution can be made by individuals to the common cause.

2. Methods and Materials

The research object is the greenhouses' collection of Peter the Great Botanical garden (BIN RAN). The collection of *Pinaceae* has been revised. Plants of this group grow in subtropical greenhouses. The taxonomy has been checked with the help of the joint encyclopedic online-project The Plant List [9], the same source has provided the data concerning the number of geni and species of *Pinaceae*. The conservation status is assigned, according to The IUCN Red List of Threatened Species [8].

3. Results

At present the greenhouse complex of Peter the Great Botanical garden contains more than 13 thousand taxons of tropical and subtropical plants of which, according to the data of 2010, 1500 species are rare and endangered. These are the representatives of *Cactaceae*, various other succulents, ferns, cycas, orchids.

The garden has accumulated considerable practical knowledge of growing rare plants. There is a great number of various experimental projects of vegetative reproduction, and pollination.

Many «Red Book» plants bloom and fruit well in greenhouses, yielding sound seeds. The Peter the Great Botanical garden successfully utilizes agricultural engineering to grow plants, reproduction via sowing seeds and herbaceous cutting.

The experimental reintroduction of *Cycas micholitzii* Dyer has been carried out with the help of seedlings, grown from the seeds, harvested in the greenhouses [1].

Our team has revised the representatives of Pinaceae in the greenhouses. There are 255 pinaceous species in the world flora, mainly growing in the northern hemisphere. Certain species can be found high in the mountains, as well as north of the Arctic circle. The only species in the southern hemisphere is *Pinus merkusii* Jungh. & de Vriese, growing in South-East Asia.

The representatives of *Pinaceae* -- evergreen, or foliage plants, mostly large trees, rarely small trees or bushes. Leaves are acicular, cataphyll, or narrow lanceolate from 1--3 to 45 cm, growing separately in a spiral; on the species with shoots of two types, the brachyblasts can have single leaves, or bundles of 2--50. Cones are formed by spirally growing seeds and cover scales. When ripening, cones increase in size and get woody. Every genus has its own typical shape and size of cones from 2,5--3 cm to 50 cm.

Pinaceae are important for economy. They contain resins, sterols, essential oils, tanning materials and vitamins. This wood is a source of raw pulp for paper production, and it is also widely used in building.

Seeds of certain *Pinaceae* species-- are edible. The pinaceous are popular as decorative plants, today there are hundreds of their varieties. However, the representatives of this family can do more than just serve as a decoration in a park or garden, they also improve the environment, as they contain bioactive volatile substances, reducing the number of pathogens in the air.

The intensive industrial exploitation of the pinaceous, destruction of natural habitats have led to depletion of these plants. At present 224 species of *Pinaceae* are included in the list of IUCN.

According to the table, it can be seen that most species (25) have the conservation status LC. Generally, there are 7 geni out of the existing 11: *Tsuga* (Endl.) Carrière -- 2 species, *Pinus* L. -- 24 species, *Picea* A. Dietr. -- 4 species, *Abies* Mill. -- 3 species, *Keteleeria* Carrière -- 1 species, *Cedrus* Trew -- 2 species, *Pseudolarix* Gordon -- 1 species.

The greenhouses of Peter the Great Botanical garden grow 37 species of *Pinaceae*, and all of them have a conservation status.

The genus of *Abies* includes 48 species, in the greenhouses there are 3. They are presented by evergreen cone-shaped trees. Cones are erect, elongated and egg-shaped, almost cylindrical, when ripen fall apart up to the central axis. They grow in the northern temperate zone, as well as in North Africa and the Himalayas.

TABLE 1: IUCN categories of threat.

Conservation status	Abbreviation
Extinct	EX
Extinct in the Wild	EXW
Critically Endangered	CR
Endangered	EN
Vulnerable	VU
Near Threatened	NT
Least Concern	LC
Data Deficient	DD
Not Evaluated	NE

Abies pinsapo Boiss. -- most forests of this species are situated in the protected regions of Spain and Morocco. In 2006 these conservation areas were included in the first International Mediterranean biosphere reserve of UNESCO. In Spain this species is protected at the regional level as well. The major threat -- is fire, diseases and pest which are especially active in dry years.

Abies firma Siebold & Zucc. in the wild can only be found on the islands of Honshu, Shikoku, Kyushu and Yaku at the height of 50--1900 m. The main threat -- wood cutting, as this species is actively used to produce wood.

Abies nordmanniana (Steven) Spach, the natural habitat of this fir is the mountains of the eastern Black Sea region. The wood has high value, in Europe it is grown as a «Christmas tree».

The genus *Cedrus* includes 3 species, the greenhouses grow 2. Cedars -- are evergreen tall and broad-crowned trees, cones are erect, from egg-shaped to elongated-oid or cylindrical, ripen within 2--3 years, then fall apart. They can be found in the mountains of Southern and Eastern Mediterranean, the Western Himalayas.

Cedrus libani A. Rich. was historically used to build ships and temples. Many forests of this cedar species are under protection. Lebanon limits its use due to high demand

for products, made from cedar wood. In 1994–1996 Turkey introduced plantations of *Cedrus libani* (Khuri), small groves can also be found in Syria.

Cedrus deodara (Roxb. ex Lamb.) G. Don grows in Afghanistan, India, Nepal, Pakistan at the height of 1200–3200 m above the sea level. It is highly valued as tough and long-lived wood, it is also used to produce cedar oil. Now one of the threats for this species is pest: caterpillars, ticks and fungi [6].

Genus of *Keteleeria* includes 3 species, greenhouses grow 1. These are tall trees with a pyramidal crown which becomes umbrella-like with age. Cones are erect, egg-shaped, cylindrical, ripen within the 1st year and dropped off completely. Natural habitat includes China and the island of Formosa.

Keteleeria fortunei (A. Murray bis) Carriere grows in China. Wood is used in building and as firewood. This species is presented in a few protected regions. It declines as a result of deforestation [11].

Genus of *Picea* has 40 species, greenhouses grow 4. These are evergreen top-shaped plants. Acicular leaves remain on trees. Cones are pendulous or spaced apart, from egg-shaped to elongated and cylindrical. It is wide spread in the north of the temperate zone, approximately half of species grow in Western and Central China.

Picea alcoquiana (Veitch ex Lindl.) Carrier -- endemic species of Japan. It disappears as a result of wood cuttings. Wood of this kind is used to produce paper pulp, furniture and musical instruments. It has been introduced in Europe and the USA, but has not become wide spread [10].

Picea koyamae Shiras. -- endemic in Central Honshu, unsustainable cutting has led to the decline in the number of species. Some habitats are under protection [4].

Picea retroflexa Mast. is wide spread in Western China. Depletion is also caused by forest clearance, at present cutting is banned, some parts of the population are situated on the territory of the natural reserve.

Picea likiangensis (Franch.) E.Pritz. grows in Bhutan and China. Tree felling has resulted in the drop of number by 30 %. Chinese government has forbidden logging in Western China.

Genus of *Pinus* includes 130 species, greenhouses grow 24. These are evergreen trees, rarely bushes. Acicular leaves grow in bundles of 2–5, rarely 6–8. Cones are rounded, egg-shaped or cylindrical. Ripening starts from the 2nd year, as a rule. They grow from the Arctic circle to Guatemala, the West Indies, North Africa, Indonesia. Here we cite the species that are under the most serious threat.

TABLE 2: Species of Pinaceae, having the conservation status, presented in the collection of Peter the Great Botanical garden.

Conservation status	Number of species	Species
CR	2	<i>Picea koyamae</i> <i>Pinus torreyana</i>
EN	3	<i>Abies pinsapo</i> <i>Picea retroflexa</i> <i>Pinus radiata</i>
VU	3	<i>Cedrus libani</i> <i>Picea likiangensis</i> <i>Pseudolarix amabilis</i>
NT	4	<i>Keteleeria fortunei</i> <i>Picea alcoquiana</i> <i>Pinus gerardiana</i> <i>Tsuga caroliniana</i>
LC	25	<i>Cedrus deodara</i> <i>Abies firma</i> <i>Abies nordmanniana</i> <i>Pinus armandii</i> <i>Pinus brutia</i> <i>Pinus bungeana</i> <i>Pinus caribaea</i> <i>Pinus cubensis</i> <i>Pinus densa</i> <i>Pinus devoniana</i> <i>Pinus echinata</i> <i>Pinus edulis</i> <i>Pinus halepensis</i> <i>Pinus parviflora</i> <i>Pinus pinaster</i> <i>Pinus pinea</i> <i>Pinus ponderosa</i> <i>Pinus roxburghii</i> <i>Pinus sabiniana</i> <i>Pinus tabuliformis</i> <i>Pinus taiwanensis</i> <i>Pinus thunbergii</i> <i>Pinus canariensis</i> <i>Pinus montezumae</i> <i>Tsuga diversifolia</i>

Pinus gerardiana Wall. ex D. Don grows in the Western Himalayas. It has edible, oil-saturated seeds. In some areas wood is used for building and joinery. The major threats are tilling of wild land, grazing, wood cutting and unsustainable harvesting of seeds. Some parts of the population are situated in the protected areas. This species is rare in gardening [5].

Pinus radiata D. Don in the wild can be found in the Pacific coastal region of California, as well as two islands off the Mexican coast. It is used to produce paper pulp, in building: joinery, veneer, furniture; as an ornamental plant. It is endangered because of -- grazing (goats), cutting, competition with other trees and an invasive pathogen [2].

Pinus torreyana Parry ex Carriere grows in California. Wood is not used, two isolated populations are under protection. Depletion of natural habitat, caused by urban sprawl, fire, pest and diseases are the main reasons for decreasing numbers of this species.

Genus of *Tsuga* has 10 species, greenhouses grow 2. These are evergreen trees, often tall, branches are drooping at the tip. Their natural habitats are in North America, East Asia, spread from the Himalayas to Japan.

Tsuga caroliniana Engelm. -- is a rare species, preserved as small isolated populations in the Southern Appalachians. Often it suffers from *Adelges tsugae* Annand -- hemipteran insects [7].

Tsuga diversifolia (Maxim) Mast. -- endemic of Japan. Wood is used in building, joinery and for making furniture.

Pseudolarix -- monotypical genus, *Pseudolarix amabilis* (J.Nelson) Rehder -- endemic of China. It is a tall tree of 30-40 m. Linear leaves fall in autumn. Cones are erect and egg-shaped. It is rare in the wild, it can be found in primary forests. The main threat is depletion of natural habitat. Very few populations are situated within protected areas.

4. Conclusion

Botanical gardens play a key role in biodiversity conservation. The collection of Peter the Great Botanical garden (BIN RAN) has 1500 rare and endangered species, among which there are various succulents, ferns, cycas, orchids. Revising the collection of *Pinaceae* has shown that all species of this group, grown in the greenhouses, have a conservation status. Overall, there are 37 species of *Pinaceae*, 2 have the conservation status of CR, 3 species -- EN, 3 species -- VU, 25 species -- LC. The family of *Pinaceae* has great economic value: these plants are used in wood chemical, paper-and-pulp, paint-and-varnish, textile, leather and food processing industries, as well as medicine. Many species are decorative plants, what is more, they have environment-improving properties.

The main threats for *Pinaceae* include: depletion of natural habitats as a result of urban sprawl, tilling of wild land, unsustainable logging. Recently these plants often suffer from pest and diseases which may be attributed to climate change and introduction of invasive species.

In this regard, the importance of collections, growing rare and endangered plants in botanical gardens, has become evident. Any botanical garden -- is the centre of integrated nature protection. Here species are not only preserved, but studied, the specific features of their growth and reproduction are researched, reasons for decline

in numbers are established, plans for introduction and reintroduction are developed and realised. Botanical gardens organize educational activities for communities, promoting among visitors the awareness of the variety of plants, growing on the planet.

Acknowledgment

This work is completed as part of the state commission on the planned topic «Collections of living plants of V.L. Komarov Botanical Institute (history, current state, perspective use)», number AAAA-A18-118032890141-4.

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