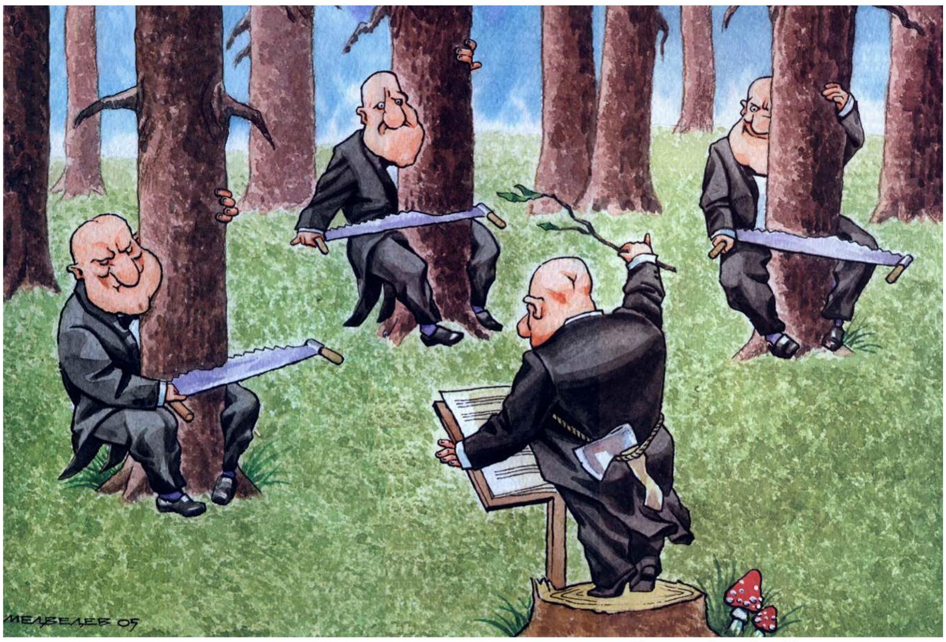
Vladimir Usoltsev

Forest Arabesques, or Sketches of Our Trees' Life



Caring for the Forest:
Research in a Changing World

Ministry of Education and Science of the Russian Federation
Ural State Forest Engineering University
Radomska Szkoła Wyższa w Radomiu, Polska

On the occasion of
Ural State Forest Engineering University's
85th Anniversary

Vladimir Usoltsev

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Translated from Russian by Tatiana Wells

The monograph describes some distinctive biological and ecological features of our forest trees in layman's terms (in a popular form). It gives consideration to all the tree species such as larch, pine, spruce, fir, cedar, birch, aspen, oak, linden, willow; that are mostly represented in the Russian forests.

The book is intended for professionals as forest scientists, botanists, students and graduate students and for wildlife enthusiasts.

The research was performed under the Department of Management and Foreign Economic Activities of Companies as a part of the science topics of the Institute of Economics and Management of the Ural State Forest Engineering University.

On the front book cover there is a picture by Alexander Medvedev that was taken for the article "Siberian Forest"by A. Chernobylets, A. Verkhozin and D. Polin ("Expert-Siberia"Magazin, Issue 10, 2005).

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Content

Introduction

The forest is a benefit, a meaning which
we will comprehend with its vanishing from the Earth.
L. Leonov «Russian Forest»

In the context of the ever increasing environmental and biospheric role of forests on one hand and steady growth of anthropogenic influence on them on the other hand, the main purpose of this book putting it in the words of my colleague professor N. A. Babiĉ (2006) is "the development of the attitude towards the care of every plant, even if it's poisonous, of every animal, although it is dangerous, of every bird even if it's a flesh-eater". Therefore the motto of IUFRO XX World Congress (1995) "Caring for the Forest: Research in a Changing World"is placed on the book cover.

The goal of the author is to capture the attention of the readers caring about Russian nature's uniqueness, value and even the mystery of ourwood species, keeping in mind the thinking by K. Lorenz (1970) who said,"In the end it is every scientist's duty to popularize to general public what he works on" (p. 13). Following this thinking every specialist is caught between Scylla and Charybdis, or is on the horns of dilemma to merge two difficulty-combining courses meaning relevance and apprehensiveness for the general audience and non-trivial approach for professionals. In consideration of the aim the author, to an extent, possibly omits dendrological, forest typological and other identifications of wood species that are binding on botanists and foresters but hard taken by non-specialists. In that regard the structure of the book is played off as a combination of unique sketches, or arabesques.

The term "arabesque" has a long history and has changed its meaning. Originally it meant medieval oriental pattern (**Fig. 1**). According to The Brockhause and Efron Encyclopedic Dictionary, "Arabesques are an odd or grotesque decor of the Renaissance, in those cases when they fall into over grotesque design". M. Yampolskiy (2007) clears "Arabesques, or grotesques, first draw attention during the opening of the Emperor Nero's palace, The Domus Aurea in the Renaissance. Fragments of the wall painting were discovered there; abstract ornamental motifs joined with ligatures of odd lines played the main role. The vignettes that connected different figurative pieces added compositional unity between the wall paintings and the ceiling pieces (p. 347)".

Fig. 1. Arabesque motif. Glazed ceramic. Turkey. (http://ec-dejavu.ru/a/arabesque_2.html).

In the Renaissance, arabesques fulfilled the role of "decorative fusion of pieces in whole", and served as "an impulse to restore the unity and hence the meaning," and also as "a form of a mystic revelation of the whole and invisible links" (Yampolskiy, 2007. P. 348, 350). M. Yampolskiy associates this phenomenon with the concept of "representation"that shifts the focus from an artist's skills to his semi-mythical ability to see images that appear in front of his internal vision of imagination (**Fig. 2**). Johann Wolfgang von Göthe in his article "On the arabesques" (Von Arabesken," 1789) published in "Der Teutsche Merkur" journal connects the concept of arabesques with the phenomenon of ornamental grotesque of antiquity (Dezhurov, 1993).

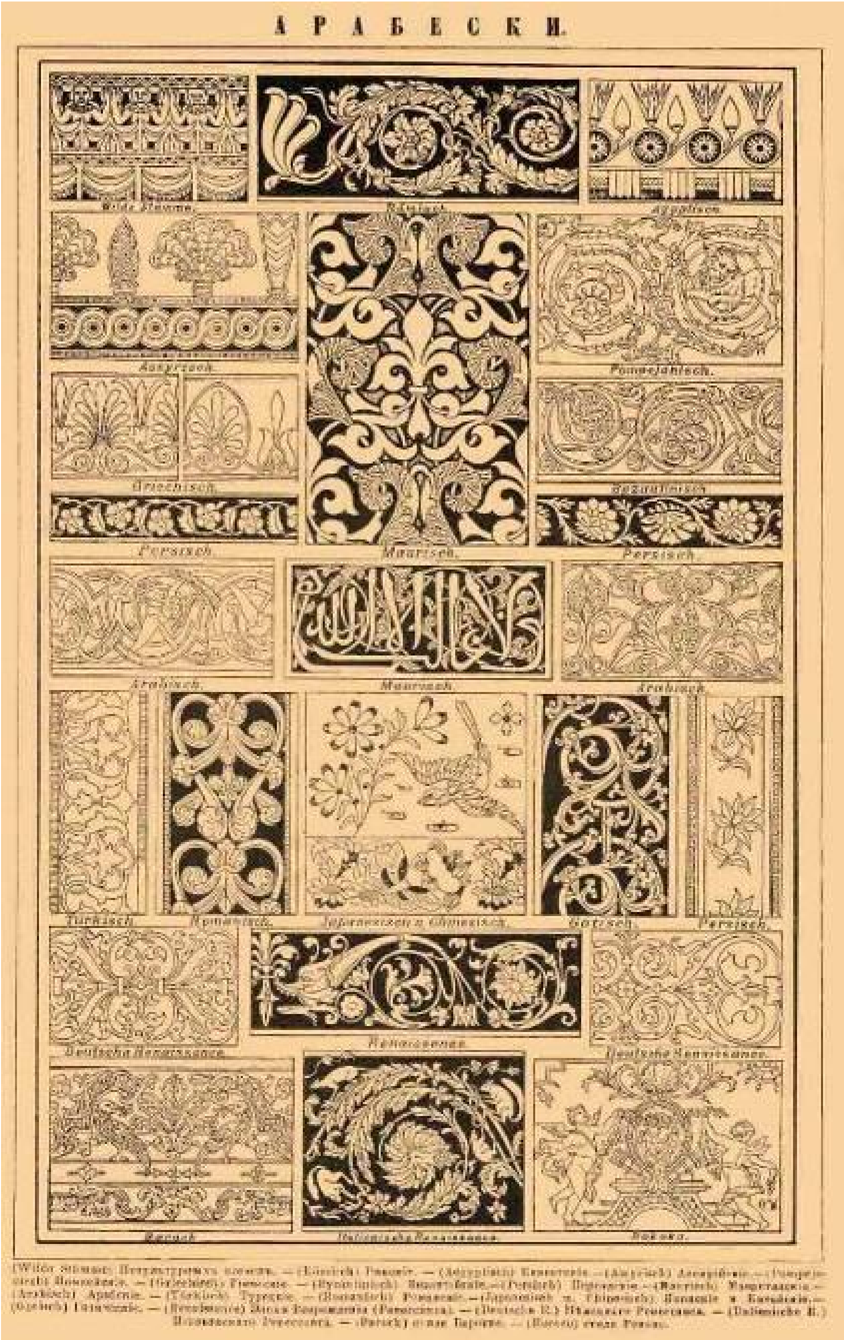


Fig. 2. Arabesques. Illustration from Brockhaus and Efron Encyclopedic Dictionary (1890—1907).

Immanuel Kant (1966) found arabesques as the best image of “free beauty”independent from the comprehension of an object; and he used life flowers as an example. Russian writer Nikolay Gogol (1835) represented his book “Arabesques”as a mixture of miscellaneous materials such as journalism, esthetics, and prose. However M. Yampolskiy (2007) sees in the book not just heterogeneity of the pieces but “the presence of motion that is capable to form these pieces in one form," and the main role of arabesques by N. Gogol, in M. Yampolskiy’s interpretation, is “the combination of earthly and heavenly, material and ideal” (p. 352, 353). Musical pieces in arabesque genre stand out for its elegance and rich musical structure; it is a genre of an instrument theatrical piece composed predominantly for piano (i.e., Robert Schumann, Claude Debussy), generally with a complex structure, richly ornamented design and “lacy”melodic curves (Kupriyanov, 2008).

The free artists at the beginning of the 20th century (Henri Matisse, Maurice de Vlaminck, Andre Derain and others) painted in a so-called “fauvism”style to recreate a landscape image as the arabesque of observation. This metaphorical term stood for a process of induced landscape structuring along intentionally distorted lines. The landscapes painted in the fauvism style are imbued with striving to project the intensity of life in nature. Their decorative effect was based on an aggressive tone of big splashes of pure contrast colors pushed to the limit (Benjamin, 1993. P. 307). Nature and landscapes served them not much as an object of illustration, but rather as a cause for creating tense and expressive colorful symphonies, however keeping the connection with the seen reality (**Fig. 3**). The fauvists took the main color inspiration and motif from nature but enhanced and gave an edge to it, often using a color outline to divide color splashes (Duthuit, 1977; www.zavadskaya.wordpress.com).

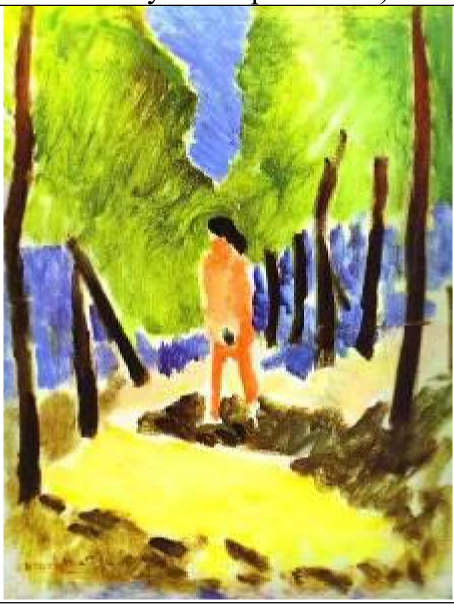


Fig. 3a. Nude in Sunlit Landscape. Henri Matisse (1869-1954) (album.foto.ru/photos/22631)

Fig. 3b. Landscape with red trees. Maurice de Vlaminck (1876 –1958) (http://www.arteyes.ru”painting.morris-de-vlamink.vlamink.html)

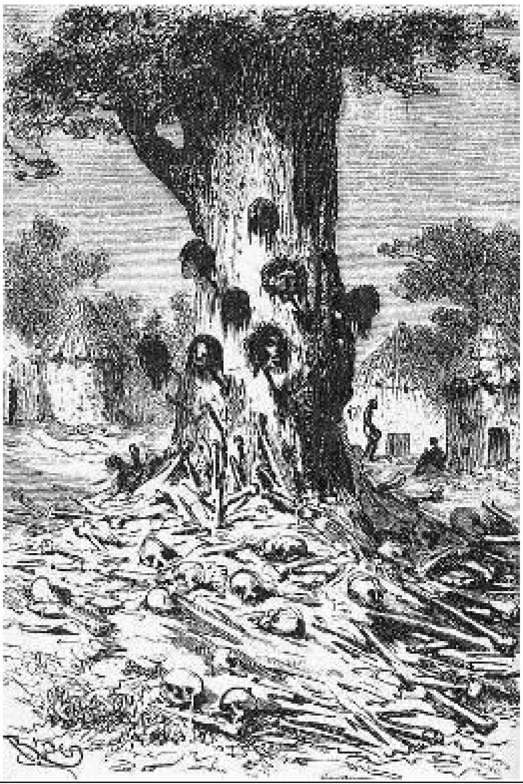
Later foliage patterns consisted of stylized foliage, flowers, and stalks came to be called arabesques **(see Fig. 4)**. In these latter days any *glimpse sketches, “Ligature”of facts* are called arabesque, while an English-Russian dictionary defines “arabesque”as *“crank”* (Addition to the Big English-Russian Dictionary, 1980). A. Kupriyanov describes events and life line tangles of the great representatives of botanical science in his two books “Arabesques of botany” (2003, 2008).

Here we will study some uncommon biological and ecological features of the tree species naturally growing in forests of Russia. Unlike murderous vampire trees occurring in foreign forests **(Fig. 5a, b)** all our trees have infallibly peaceful features.

Fig. 4. Arabesgue motif on silk (http://attoptem.ucoz.ru/news/struktura_arabeski_pechat_shelkovoj_tkani_khrizan/2013-05-20-12).

“American Weekly”, January 4, 1925 (Menninger, 1967).

Fig. 5a. Man-eater trees devouring birds, monkeys and people were discovered by explores in the 19th century in the jungle on different continents. (http://akmaya.ru/post129362912/); (http://animalspace.net/asanimals/asmythical/271-suschestva-okazavshiesya-mifom.html). “Vampires of the green world demonstrate complex types of movements, often more aggressive than most animals. They have at least hunting and digestive reflexes, lie in waiting skills, and dispose of bio-waste. Now and then it seems they have a consciousness of this, although it’s a destructive one. “Vampire”plants are one of the miraculous wonders of the nature. O. Borisov (2013) states that if human vampirism refers to the realm of legends then plant vampirism is a proven scientific fact.



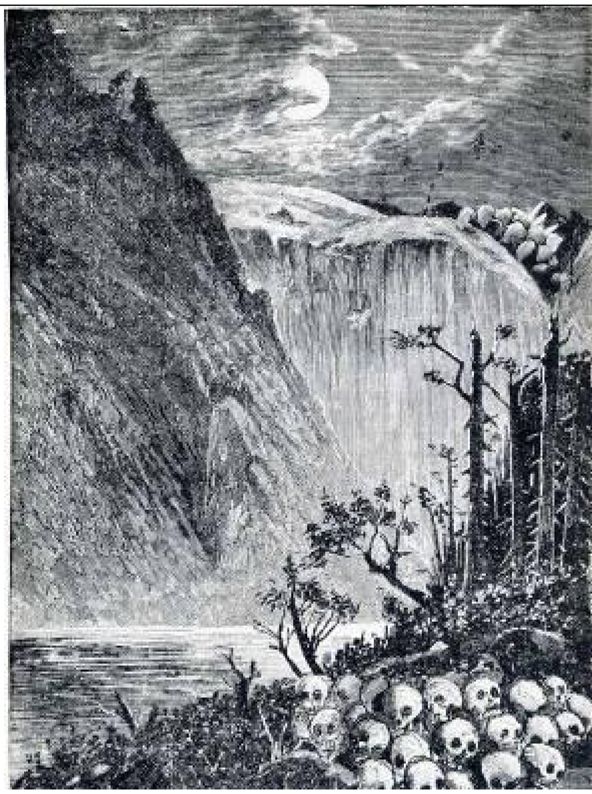


Fig. 5b. Trees-vampires. Painters: Édouard Riou (1833-1900) (Jules Verne “Five Weeks In A Balloon”, 1863) and Max Ernst (1891-1976) (“A week of kindness”, 1934).

Since Ancient Rus' forest has always played the role of a man's friend and defender from different hardships, such as so called "foreign monsters,"African and Australian dragon tree and different kinds of bottle trees (**Fig. 6a,b**) don't play into the ideology and the structure of the book.

Therefore our forests stood at the origins of Russian people's distinctive culture. Back in the 19th century Russian thinker-russophile, philosopher, and sociologist, Nikolay Danilevskiy (1822-1885), noted that unlike steppe nomadism, that 'indulges in laziness,' the forest promoted a settled lifestyle of the Slavs, a development of primary culture and hence had a "strong cultural and tribal power". The forest also had another influence, "forest with its mystic grounds and shade brings a poetic spirit to the people living in it". I don't think that this distinctive culture could originate *without any outside influence* otherwise than in the forest country" (Danilevskiy, 2011. P. 276-277).

Fig. 6a. Dragoon Tree. (lat. Dracaena draco). Medieval scientists considered it as a half animal and half human and the red juice as real blood. (http://www.liveinternet.ru/users/ugolieok/post255567355/).

Fig. 6b. Baobab (lat. Adansonia digitate). Tree spicy occurring in African savannah. (http://photoflowery.ru/photo/c6/c6f20844573aebbab24a53760fd308b8.jpg).

Perhaps the forester Boris Sergunenkov (1981) experienced that particular sensation of unity with forest, a sense of it, that distinct call of the wild while living in the forester's office for a long time. "When I walk in the forest and look absently around and then suddenly stand there like as if I was made of stone, or listen to the noise of a pine and I can stand like that for an hour or two not moving a muscle, enjoying the sun or feeling the breeze; and I forget about the forest, people, about myself and my existence and I think to myself if I'm becoming a pine? I feel the sun and the wind is like my brother and I stand turning to stone, and any bird could nest on my top and I would not bother it. I can sense unfamiliar smells then, notice unseen tones of grass and flowers, and I am still a human being and sort of not, but a pine or an animal. The forest, trees, ground, grass are all close to me, like I was born here; I feel the connection, a nearby tree seems to be my brother, the river is indeed my sister…" (P. 346-347).

B. Sergunenkov's book named "My forest" is a unique inspired poem to the forest. "Woods were still. They are quiet. They make noise but soundless. Why is it so? Because forest can never be quiet. It can only aim to be quiet and still. If you let it be still it will immediately disappear, die and fade away, even when it is still it always goes forward, moves every hour, every minute with its every grass blade, waves its every leaf. The forest is meditative, it is menacing, angry and gloomy and it rejoices. It always speaks loud or under breath, or loud and quiet at the same time" (P. 341-342). One more thing, "It is hard to believe but the woods feel shy of good deeds. There is nothing more disgusting for it than to seem good. That would be clear if it was naturally shy. But it is not. As opportunity offers it can demand something and stand up for itself. This shyness of course has nothing to do with qualms of conscience after an evil deed; it has a different root. After all it doesn't lead to disharmony or mental disorder but to a pure feeling of stability. But also this shyness puts it in so much trouble that it is ready to abandon good deeds gladly, and if it doesn't do it it's not because the forest doesn't want to, but because it cannot. Here it gave water to the one who was thirsty, gave some berries to those who were hungry, showed the beauty and kept out of danger and did what it was supposed to do. "What should I be proud of?", – the forest thinks. What did I do that I can be proud of?" I gave water to one thirsty man but how many are still thirsty? I fed a hungry one with berries but how many are still looking for food? Showed the beauty but how many are there who don't see it, don't feel it and don't understand it?" (P. 34-35).

1. Larch – what a mysterious genus *Larix* Mill…

Larch (the genus *Larix* Mill.) **(Fig. 7)** is the only deciduous coniferous wood species of the Northern Eurasia and the only wood species that is so often described by researchers as "mysterious". F. Arnold (1898) in his book "Russian Forest" mentions one of the mysteries of larch. He illustrates the phenomenon of gradual complete "crust formation" on cut surfaces of "living"stumps as a consequence of their residual growth over the years after cutting down trees. Neither naturalists nor even foresters could find an explanation of this phenomenon for a long time. Nowadays this property is common to more than 150 species of wood and it is caused by the concretion of root assemblage of nearby trees and the development of a combial layer that provides mutual transfer of grafted trees. These days researches from Japan developed a computational method to put the number of grafted root assemblages in a forest stand. According to M. Kalinin and his coauthors (1998) the age of living stumps of the coniferous species can reach up to 90 years.

Fig 7. Siberian larch (Larix sibirica Ledeb.*): 1 –general view (autumn coloration); 2 –basal, or extending shoot; 3 –branch with a brachyblast with needle and macro- and microstrobile; 4 –macrostrobile: a) cover and seed scales with a seed bud, b) cover scale; 5 –branch with a spur shoot, needles and microstrobiles; 6 –microstrobiles; 7 - formed strobile; 8 –mature strobili; 9 –seed (Forest encyclopedia, 1986).*

Following aspects and evidences of larch mystery have bioecological as well as historico-geographical origins. The Swiss scientist H. Müller in his article "About the mystery of larch", tries to explain why common larch successfully grows in one condition and doesn't in another. Why it grows well in the Alpine high mountains (1700-2400 m A.S.L.) and why it gets infected with a larch cancer throughout and dies in warm and moist climate of Germany and Scotland. Foresters have been interested in why in permanent frozen ground and in high mountain conditions, larch is barely harmed by injurious forest insects and diseases but grows in a form of sparse forest and very slowly. Looking sad but in more favorable conditions of the European flat lands larch homogeneous stands meet sample area level in productivity (sometimes it comes up to 2 thousand cubic meters on hectare!) which is 2-3 times higher than the productivity of native species but along with that it can't be reproduced in a natural way.

Il'inskiy (1937) finds outlier occurrence of larch in the Carpathian Mountains and the Tatras mysterious and suggests that larch survived the Ice Age in different refugiums or "life refuges". Although *Larix* species is old, perhaps for that very reason it hasn't been conclusively determined at what point of the development of the plant world this species first occurred. Single Pliocene findings of larch took place in Northern Mongolia but the largest spread of larch here falls onto the Pleistocene; and there is a hypothesis that the Khaingai range is one of the centers of origin of "semi-taiga" larch forest (Dugarzhav, 1996). Pachoskiy (1910) considered one type of larch to be similar to a fossil Galician type that is still represented in Western Europe as a common larch (*L. decidua* Mill.), and that it must have grown on the territory from the Atlantic Ocean up to Kamchatka or even further to North America.

Sukachev (1938) believed that in the beginning of the Tertiary era of at the end of the Cretaceous period two branches of the modern *Larix* genus were defined; the western branch includes larch, common larch and Siberian larch; Japanese larch, eastern larch, Korean Dahurian larch all belong to the eastern branch that traces its roots to "somewhere in Asia". The latter is confirmed by E. Wulf (1944) writing "The genus most similar to the evolutionary range of larches in which common larch, Siberian and Dahurian larch represent the end segment which is preserved in the modern mountain flora of China" (P. 410).

Mostly larch, pine and birch were planted in Europe in the post glacial period but later as a result of unfavorable factors, larch areas shortened. Possibly having in mind just the post-glacial period, the Swiss Alps (by the professor A. Bühler, 1886) and Altai (by F. Keppen, 1885) were considered as larch habitat, and Il'inskiy (1937) believed that *Larix* genus undoubtedly originated from Angara river region forming a continuous range there.

The expansive boreal and subalpine forests in the Northern Hemisphere are typically characterized by evergreen trees. Dominancy of evergreen trees in harsh forest environments has been attributed to the greater annual net carbon gain (Mooney, Dunn, 1970; Waring, Franklin, 1979) and more efficient use of the nutrients and other environmental resources by evergreen trees compared to species with a deciduous leaf habit (Chapin, 1980; Mooney, Gulmon, 1982). Needle longevity of evergreen trees, for instance bristlecone pine (*Pinus aristata* Engelm.), may exceed up to 40 years (Ewers, Schmid, 1981). The greater leaf longevity of evergreens has been suggested to reduce the annual carbon and nutrient requirement to produce new foliage (Chabot, Hicks, 1982). The conservative use of nutrients by trees in boreal and subalpine forests should be particularly important, because nutrient availability is low due to adverse effects of low soil temperatures on decomposition, mineralization, and nutrient and water uptake. A genus with a shorter growth period and at the same time synthesizing enough amounts of metabolites necessary for life support during a long rest period turns out to be more vigorous.

However larches, the deciduous conifer wood plants, are a common forest-forming species in the most part of subalpine and boreal forests in the Northern Hemisphere. Deciduous form of larch means annual full needle foliage replacement whereas evergreen species only replace a small part of it. Additional carbon consumption related to the full needle fall puts deciduous species in unfavorable conditions, especially in the permafrost areas with a short vegetation period. According to the oral evidence of Efremov, frozen soil in Kamchatka shortens the life-sustaining period of larch fine roots to two weeks per year.

Gower and Richards refers to that in the article "Larches: Deciduous Conifers in an Evergreen World" saying, "The wide-spread occurrence of larches in subalpine and boreal forests is an intriguing puzzle given the concept that the evergreen habit is more advantageous in harsh environments. Larches therefore must possess physiological and morphological characteristics that enable them to survive, grow and reproduce as deciduous conifers in environments where evergreens normally dominate" (P. 818). Among the characteristics mentioned above, the most important is carbon balance which is defined by foliage, photosynthesis efficiency and tree "architecture".

Gower and Richards see a larch "intriguing puzzle" in the fact that a complex of its morphological and physiological characteristics supposedly doesn't explain how this species sustain atmospheric carbon fixation similar to evergreen trees. However, Ivanov (1936) proved among all species, larch has a high efficiency to degrade carboxylic acid. Under the daylight conditions the amount of degraded CO_2 for 1 kilo of needle of spruce, fir and pine tree is 39%, 59% and 75% respectively in reference to the larch figure. However larch is a light-demanding type; a minimum light intensity in the crown dieback area for beech, spruce, pine and larch makes 1,7%, 3,2%, 10,5% and 16,7% of illumination intensity of an open area respectively. Due to the fact that larch is a photophilic plant "tree thick layers and long branches always turn south on both level ground and mountain flanks; this fact is so well known and so true that Ural mining workers used it as a compass" (Keppen, 1885. P. 211).

Physiological research of the Siberian larch run by the Russian scientists shows that the species is characterized by a number of specific adaptive features such as the high photosynthetic rate under sufficient lighting and short growth season. Also by more efficient thermal control of photosynthetic system, strong transpiration on cold soils, the ability to form great assimilation system of needle under low nutrient power, intensive development of lateral root system and root initials on frost zone, enhanced cambial activity of root system and intensive growth of absorbing (tender) roots over two summer weeks. Dominating development and long term functioning (up to 100 years) of brachyblast (spur shoot) with "bundle" needle under harsh climatic conditions define needle saturation of the crown that among other factors compensate the respiration power use (Bannikova and others, 1999; Pautova, 2002).

Bannikova and her coauthors (1999) considered the biological point of larch endurance on subcellular, cellular, tissular, organismic and population levels and explain that in the extreme conditions when "metabolism price" gets higher the species absorbing a high amount of energy and using it for the most part for growth and reproduction turn to be most resistant. In this extremely harsh condition, larch becomes a very long-living species, for instance, in the northern foot hill of the Eastern Sayans (the left bank of the Uda River) some trees are 1350 years old and up to 56 meters tall (Popov, 1961).

Since a butt-log portion is protected by think bark (up to 25 cm), larch is considered as a fire-adapted species and recovers well afterwards. There are known cases of Dahurian larch needle rehabilitation from rest buds of 15 years old natural stand after a fall crowing fire on Kolyma (Starikov, 1959). Sochava (1956) links a wide spread of larch in boreal forests particularly to wildfires that destroy all the other species.

*Fig. 8. The "Reindeer Brooks" nature park plan. Centuries-old larches marked with a red square (see **Fig. 9**).*

Fig. 9. Larch veterans alley. Photos by V. Usoltsev.

Due to this characteristic larch can survive for centuries. In the vicinity of Nizhnie Sergi (Sverdlovsk Region), on the territory of nature park named "Reindeer Brooks" (**Fig. 8**) there is a unique alley of forest veterans centuries-old larches. It is known that old metallurgical plants produced charcoal. Larchwood was not a good material in coal production; compared to coal from other wood species, larch coal wasn't firm enough and consumed lots of ash. Larchwood was more valuable as a material for hydraulic structures but the plan of building a dam on the Serga River was never implemented. That saved forest veterans from being cut down. Time has left indelible marks on them, including the result of wildfires, but they are still alive… (**Fig. 9**).

Perm' area studies specialist and writer Yan Kuntur writes the following about this kind of centenarians: "Trees in general are weird and unrecognizable creatures. Not only are they older than most of the buildings created by people, but even older than whole cities and even countries. They are the patriarchs and lords knowing what will never fit in people's limited memory…Trees seem to grow through the time stringing beads of time on the axis of their body and the beads start immediately spinning around following the sun. They are unseen and sensed…" (Kuntur, 2010. P. 64.).

If larch doesn't make a high quality coal and almost isn't used in charring of wood, then since the dawn of time it's been used as a construction material due to the high decay-resistance characteristics. There is a unique article by an unknown author,"About the influence of soil, felling time and moon phases on the strength of carpentry wood and constructional timber"published in one of the issues of the "Forest Journal" (Lesnoi Zhurnal) back in 1874 that states the following "The taller the tree, the weaker it is. The descent of sap period is the best for felling. Well wooden pipes made of larch that grew on upland last for 60 years and the same types of pipes made of larch growing on low land become useless in 30 years. Felling should take place during the decline of the moon when sap goes down" (p. 184).

Yet history knows examples of a longer life time periods of larch in wooden constructions. Venice is still based on 500 year old piles made of Siberian larch. Furthermore a 6 meter long float constructed of fossilized larch trees was found in the mountains of Yakutia; each tree was so big that you couldn't put your arms around it. Larch there is of the same age as "Northern Noah" (Borisov, 2015).

Beyond the main (boreal) area larch predominantly grows on mountain terrain: there is common larch (*L. decidua*) in Central Europe (the Alps, the Carpathians and the Tatra Mountains); Japanese larch (*L. leptolepis*) is in Japan; there is Prince Rupprecht's larch (*L. principis-ruprechtil* Mayr) and Chinese larch (*L. potaninii* Batal.) and Masters larch (*L. mastersiana* Rehd. *et* Wils) in the south of China and there is Himalayan larch (L. *griffithii* Hook. *f. et* Thoms.) in the Himalayas. In Northern America, Eastern larch is a well spread boreal species however, unlike Eurasian boreal larch, it almost doesn't get outside of the northern limits of evergreen trees dispersal.

Six larch types are presented in Sikhote Alin including the south Primorye; three of these types are rare (1.5% of forest area) but yet a competitive species and herein historically young, *Larix komarovii*, extend its area at the expense of such epiobiotic species such as Korean Dahurian and Lubarsky larch (Gukov, 1969, 1981).

At the present time 15-19 species of *Larix* genus are document for the Northern Hemisphere which includes 13-14 main species along Northern Eurasia and three hybrid species. Apparently only *Larix* genus among other forest-forming species is represented by such a variety of species ordered by climate gradient. These species successively rotate according to the climate continentally gradient **(Fig. 10)**: common larch → Sukachev's larch → Siberian larch → *Larix Czekanowskii* → Dahurian larch → hybrid species of Dahurian and Cajander larch → Cajander larch with continentality indexes according to A. Borisov (1967) respectively 30 →50 →60 →75 →80 →90 →100% **(Fig. 11)**.

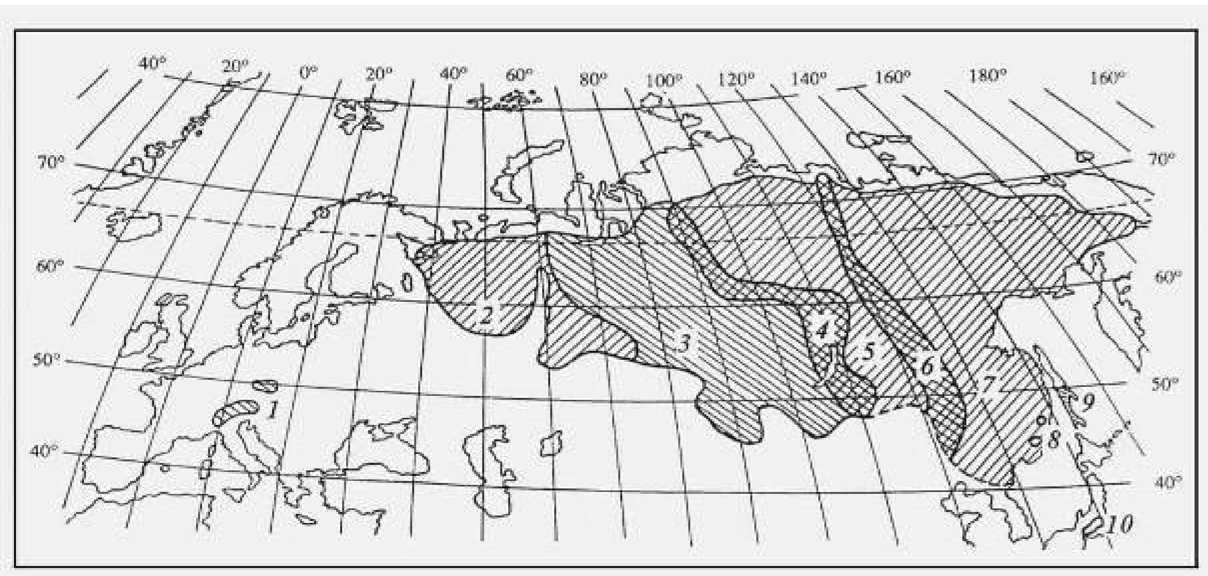


Fig. 10. Larch species areas in the Northern Eurasia: L. decidua Mill. ***(1);*** *L. sukaczewii* N. Dyl. ***(2)****; L. sibirica* Ledeb. ***(3)****; hybrid form of the area joint of L. sibirica u L. gmelinii (L. × czekanovskii* Turcz.*)* ***(4)****; L. gmelinii* (Rupr.) Rupr. ***(5)****; hybrid forms in the area joints of L. gmelinii u L. cajanderi* ***(6)****; L. cajanderi* Mayr. ***(7)****; L. maritima* Suk. ***(8)****; L. kurilensis* Mayr. ***(9)****; L. leptolepis* Gord. ***(10)*** *(Abaimov and others, 1980).*

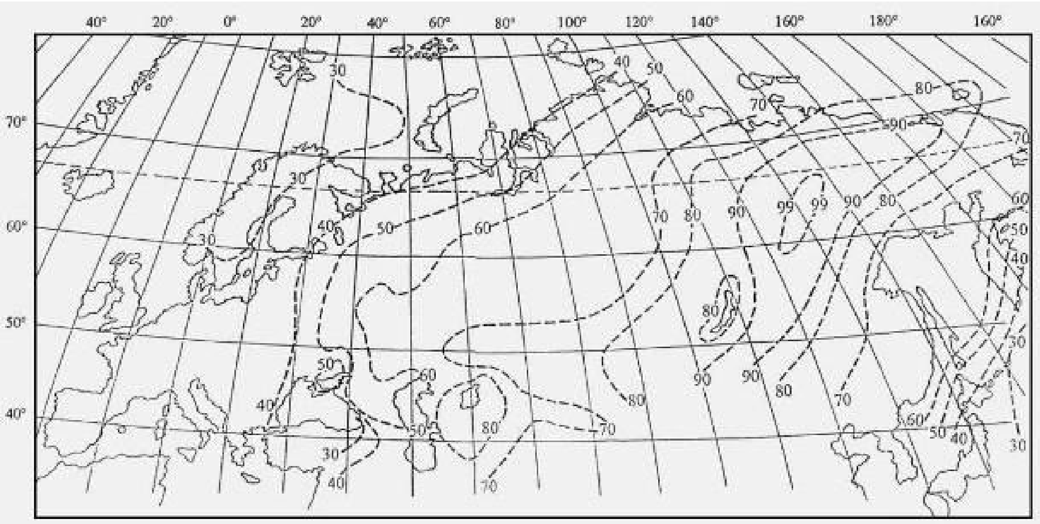


Fig. 11. Climate continentally isolines in the Northern Eurasia rated by A. Borisov (1967) using a simplified Zenker's formula. Isoconts expressed in percentage terms.

On the east of *Larix* genus area species rotate according to the zonal gradient (from the south to the north) in the following order: Japanese larches → Lubarsky larch, Korean Dahurian larch, Komarov larch → *Larix amurensis* Kolesn., *Larix maritima* → *Larix ochotensis* Kolesn., *Larix kurilensis* Mayr. → Cajander larch in subzones respectively: subtropical softwood → mixed coniferous-broad leaved forest → south boreal forest → middle boreal forest → northern boreal forest (tundra forest); however the second listed order perhaps is not so much determined by the present natural zoning as geological history of larch.

Tyulina (1929) characterizes larch as the hardiest tree out of all the coniferous species in regard to climate extremes; larch spreads further north and forms a forest polar limit (**Fig. 12, 13 and 14**); and on the south it reaches deep into Mongolia leaving behind the rest of the coniferous species forming a south forest line on the desert border. There larch forest are characterized firstly by a high hypsometric level (1500-1600 m) and secondly asymmetry of their south and northern aspects. In the mountains of Khangai, Mongolian Altay and the Darkhat Basin forests cover only northern flanks. The south spread range of larch in Mongolia is Baytag-Ula Mountain ($45^{0}01$ N, 91^{0} E) but there are also more southern occurrences of larch in China (**Fig. 15**).

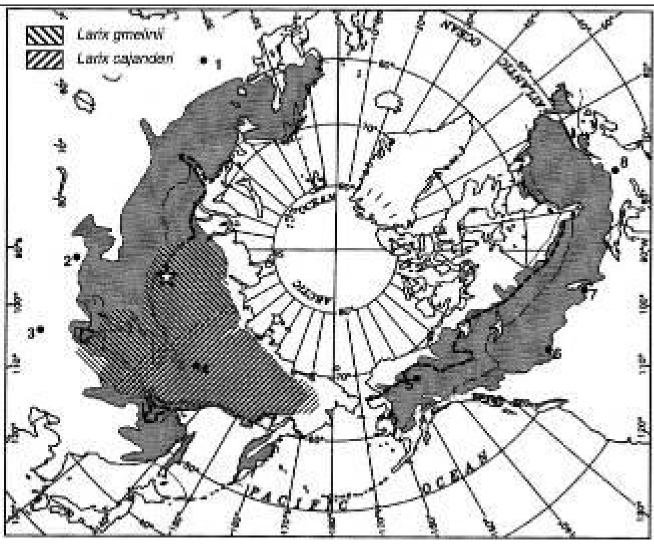


Fig. 12. Boreal forest in the Northern Hemisphere (marked as dark spots). Space occupied by Dahurian and Cajander larch (Osawa, Zyryanova, 2010).

Fig. 13a. Siberian larch in the basin of Sobi river (Polar Urals) in the forest line. 250 years old, 12 m tall, stem diameter is 45 cm. Photo by S. Shiyatov

Fig. 13b. Larch on Staritsky Peninsula surrounded by dwarf Siberian pine. Magadan Region (Mazurenko, Andreyev, 2007).

Fig. 14a. Larch on the timber line. The Shemur mountain range, Northern Urals (750 m A. S. L., $60^0$40'N, $59^0$40'E). Photo by M. Bogachev

Fig. 14b. Larch in the area of Cape "Tolstoy" on Magadan. Photo by V. Ryabkov.

Fig. 14c. Larch open forest with brown willow undergrowth on Kolyma Far North-East (Mazyrenko, Moskalyuk, 2009).

Fig. 14d. Larch on 72^{nd} parallel on Taimyr "forest that escaped to tundra"(http://www.moya-planeta.ru/travel/view/arymas_les_ubezhavshij_v_tundru_3221/)

Fig. 15. Prince Rupprecht's larch (Larix principis-rupprechtii Mayr*) in Central China (https://commons.wikimedia.org/wiki/File:Larix_principis-rupprechtii_Taihang_Shan.jpg).*

Putting multiple proofs of larch spread beyond steppe limits in different regions of Siberia and the Urals together, Tyulina (1929) suggests that larch resistance to both physical soil dryness on the border with steppe and physiological dryness on cryosolic subsoils helps larch to manage these extremes being pushed off there due to its photophily by other species. "And if so…"– Tyulina continues –"then larch can be considered as a typical taiga resident only with known limitations and might be…Siberian larch taiga is what rested of more continental conditions dominating there before"(P. 15).

The world largest larch solid wood primarily with a very low productivity level (IV-Va site indexes) is located in the Eastern Siberian north of latitude 48°N (see **Fig. 13, 14**). Due to harsh winters cryogenic soils with melting depth of less than 1 m spread far south on the most part of Siberia, where due to warm summers larch forests reach far north forming extensive open forests while root competition takes the leadership (Sofronov, Volokitina, 1998; Sannikov and others, 2012). Extreme continental climate in this case helps to eliminate larch competitors and helps it to spread to the tundra and in the mountains. Larch shapes the northern border of forest cover along all of Siberia and the Far East going beyond the Polar Circle. In Khangay (Mongolia), Eastern Sayans, Altay and partially the Urals, larch grows as a single species forest reaching 350 years of age; it defines the forest line here that gets to 2500, 2220, 1900 and 1160 meters A.S.L. respectively.

The Siberian origin of larch in the European part of Russia was noted by Keppen back in 1885 saying, "Coming from Siberia and crossing over the Ural mountain range and spreading throughout its entire length, larch deeply expands to the flat land of north-east Russia, on the west reaches almost Lake Onega and on the south gets almost to the Volga River near Nizhny Novgorod" (p. 223). Keppen (1885) supposes the mentioned western range dependence on the transition from the Ural mountain range limestone, to Scandinavian granite ground and draws an example of larch native habitat on the Solovetskie Islands that was confirmed during a recent forest inventory (Polyakov and others, 1986).

In regard to hiatus between the Ural Range and Kama River (see **Fig. 10**) Keppen (1885) states that larch "comes over to the western flanks widely unwillingly" (p. 231) and sees the explanation in the buried soil of Permian formation with a rare limestone occurrence.

In the Urals larch starts losing its position in tree layer body. N. Nesterov (1887) gives the following characteristics of its south taiga habitat on the western flank of the south Urals, "larch single species forests are rare and small in area, 30-40 dessiatina, but usually mixed with spruce, pine tree and birch; it likes to spread over mountains, stony and sandy loam soil and completely avoids moors…, often it's the dominate species on mountains tops but it barely sustains climate difficulties there: it grows open, it nearly always has a dry crown and few short branches, and now and then only a bare stem sticks out" (p. 707).

There are almost no wild single species forests of larch on the territory of European Russia. As Keppen notes (1885), in the Perm and Vologda provinces it grows next to pine, spruce, fir tree, cedar, birch and alder, and in the Kostroma province it occurs mostly as an"improper mix with pine" (p. 217). It meant that there is a widespread story of pine under an open mature larch canopy with a complete absence of larch reproduction. Arnold (1989) thought that was a consequence of high photophily of the latter, and one of the reasons of its rare occurrence on the European part of Russia.

Sambuk (1932) studying Pechora River Basin states that "spruce and pine displace larch throughout, leaving the latter only the extreme range of silva" (p. 83). And further it says, that competition "result in the situation where larch started slowly retreating and keeps recoiling, and if not for human activities it would have entirely disappeared" (p. 87). Sambuk meant an anthropogenous origin of wild fires.

In the Northern European part of Russia (Arkhangelsk region, Komi, north of Vologda region) larch grows as a mix of pine and spruce on well drained sandy loam soil with a close position of limestone and it accounts for 0,75% of forest area (Polyakov and others, 1986). In the territory of Udmurtia larch account for 0.3 % of forest area and mostly has human origin (Baranova, 2004).

West of Siberia, distribution pattern of larch changes in general. As Il'inskiy (1937) notes, "Siberian larch that covers great areas of Siberia has regressive and discontinuous area in the European part of the Union and at the same time successfully grows in homogeneous forests both west and south of country" (p. 350). Strip or discontinuous spread is characterized to the whole area of Sukachev's larch from the Arkhangelsk region to Kazakhstan's steppe where it occurs only as a single relict spot **(Fig. 16)**.

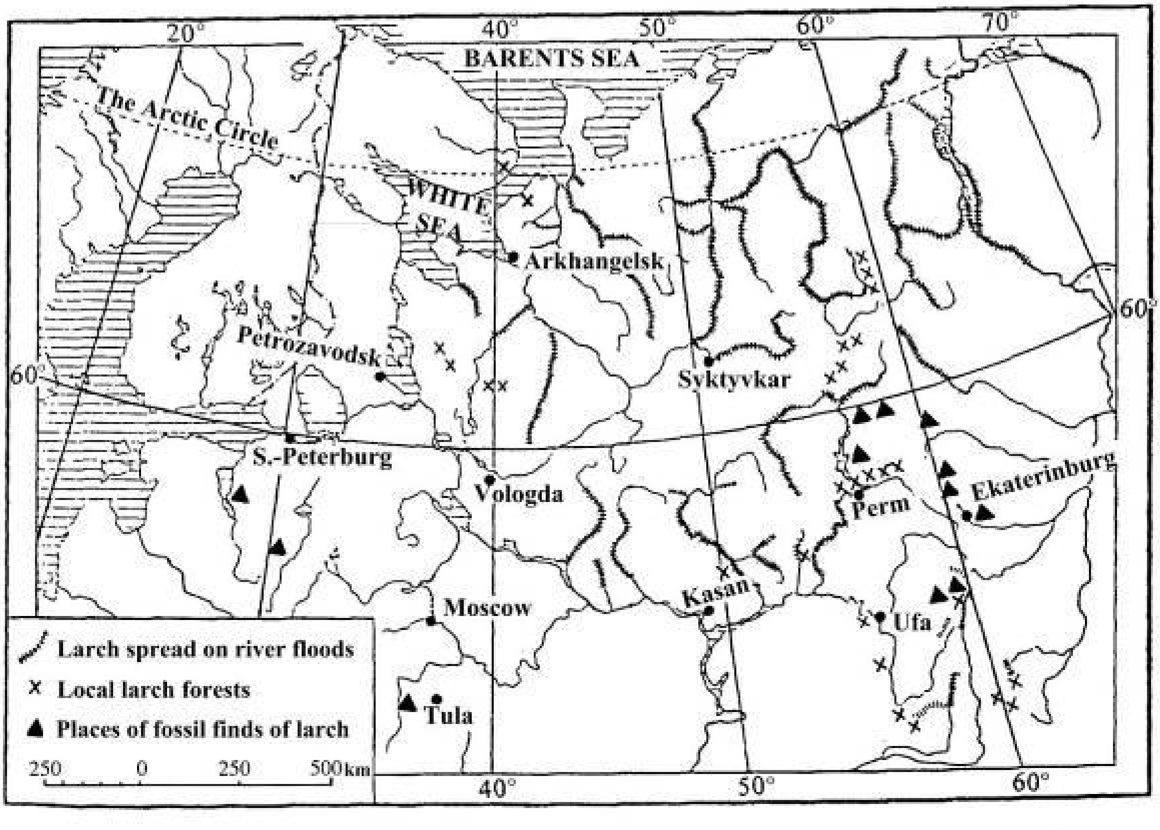


Fig. 16. Larch spread on the European part of Russia (Alekhin et al., 1961).

Since the beginning of the Subboreal period corresponding to the post-glacial warmth peak (approx. 1000 years B.C.) and up to the middle of more the humid and chilly the Subatlantic period (around 700 A.D.) south of the Urals steppes crowded our larch forests. Since the middle of the Subatlantic period under the more humid climate conditions larch forest intensively spread over steppes. L. Tyulina commonly found the rest of those forests as "living giants 400 years of age" and the stem diameter of 1.5 m on chest level on steppe meadow margins and on south-east flanks of Ilmenskiy range primarily on carbonaceous rocks. Their trunks were crooked and had exceedingly fine texture, i.e. they bore "the marks of more than 300 years long battle with the last spots of steppe" (p. 10).

One of a few nature sanctuaries still exists in the endless Orenburg steppes **(Fig. 17)**. Despite the great age larch abundantly bears fruit and along with that seeds have good germinating capacity. In 2012 several transplants were planted next to the parent tree; they established well and in 2013 reached up to 1 m in height. This unique phenomenon conflicts with a well-known fact that going north to south in a latitudinal profile and from the upper tree line to the foot hills in an altitudinal profile, parthenocarpy and conophagus activity gets higher. As a result seed efficiency equals to zero in the south Urals and on the foot hills of Khangay Mountain (Novozhenov, 1973; Yanovskiy, 1980).

In 2013 vandals submitted the tree to "survival capability" test. They laid tires around the tree and set them on fire. But the tree did get harmed: how would they know that the bark thickness of this particular tree-veteran can get to a quarter meter and the crown can rehabilitate from the resting beds even after completely burning-out during crown fires (Starikov, 1959).

Fig. 17. Relict 500 year old larch in absinthial sheep fescue and feather-grass steppe. Orenburg region, Adamovsk sub-district, 18 km north of Bratslavka station. 12 m high, 80 cm stem diameter. Photo by A. Bornikov.

Absolutely healthy larches of over 400 years of age and with a 27 cm thick bark were found at the end of the 19th century in Obshchiy Syrt (53°N, 57°E) that borders the south Urals on the west. The tree diameters were 18 cm wide at the crown base that was raised 32 m high. This kind of larch timber is highly firm, "neither a saw nor a froe can handle a tree basis; a special stage is supposed to set up to cut it above human scale" (Simon. 1910. P. 1137). There are enormous larch stumps and the remains of pine stumps here among stands on Devonian age sandstone. Under Peter the Great, this part of wood referred to is ship-building timber. Under Catherine the Great, academician Lepekhin travelled there and he wrote that he had seen dominating larch wood everywhere there. Nowadays larch woods are unnoted" (p. 1134). D. Gerasimov (1926) dates the Maximus larch spread in this region to the Boreal warm period and the first half of the Atlantic humid period.

Krasheninnikov (1937) supposes that these South Ural larch-pine-birch forests represent well-preserved "Pleistocene forest-steppe". Approximately 70 km away from the above mentioned nature sanctuary (see **Fig. 17**) on the territory of North Kazakhstan (Kamystinsk forestry farm of Kostanay region) these larch veterans occur in birch forest "islands" surrounded with young off-springs **(Fig. 18)**.

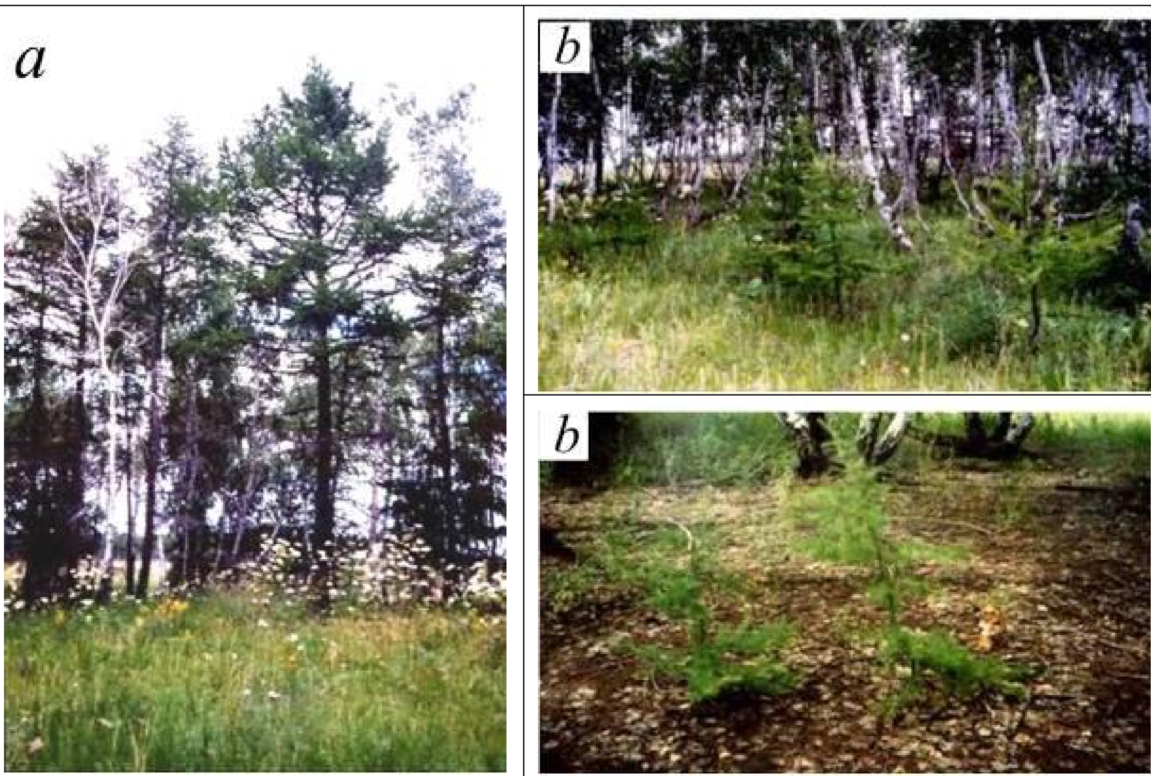


*Fig. 18. Relict larches in birch forest outlier of Kamystinsk forestry farm of Kostanay region (**a**) and larch regrowth (**b**). Photo by M. Semyshev.*

Fig. 19. Larch forest shelter belt of Borovsk forestry farm of Kostanay region and larch regrowth of the different age under its canopy. Photo by M. Semyshev.

In the 1970's, the Kazakh Scientific Research Institute of Forestry and Agroforestry ran a high-profile project on creating experimental forest shelter belts (Bozrikov, Danchev, 1984). In the former Kustanay region they mainly used birch and larch. Birch was later sufficiently harmed during the herbigation, but larch survived. Furthermore, today larch forest shelter belts successfully regenerate naturally **(Fig. 19)**.

It's a rather unexpected development due to the intensive growth on the western and south area limits. Pure larch forests form a thick annual fall needle litter and larch canopy transparency stimulates turf formation. All of that as a whole restrains natural seeding and as a result causes the absence of regrowth. Having examined larch conditions on the Ufa plateau S. Konashova (2000 a, b) states that the absence of larch regrowth leaves the future of those stands with no perspective to rehabilitation.

Nature does nothing in vain: if in the natural larch forests in the north of the Krasnoyarsk region, forest ungulates split the litter and turfy layer (Falaleyev, 1958), then in the anthropogenic forests this function is fulfilled by cattle. As it was discovered in the Ekaterinburg and Kirov regions, grazing of livestock causes a turf layer and litter disintegration and an increase of not only a total amount of larch regrowth under the canopy, but also its part in relation to pine tree regrowth (Konovalov, 1959a, Grozdov, 1960). Grazing of livestock might encourage natural regeneration of larch in forest shelter belts on autumn fields in the Kostanay region. However heave litter concentration around single larch trees is unlikely and conductive environment for larch regrowth here is developed out of broken canopy of birch forest "islands" on sod formation resistant plots (**Fig. 18**, bottom right). Yet in proper soil conditions, larch can grow further south on the territory area-wise than the south most Naurzum pine forest of the Kostanay region (51°30 N, 64°15 E; average annual rainfall is 233 mm; average annual temperature is 2.4°C). Larch tree plantations outstanding now with great growth capacity and overall good conditions due to underwater draining **(Fig. 20)** were formed in a herb-feather grass steppe on a dark-chestnut sandy loam soil of the Dokuchaevsk plateau (oral report by M. Semyshev and T. Bragina).

Fig. 20. Larch plantations planted in Naurzum pine forest in 1965. Total area of 2 ha in 2013. Photo by T. Bragina.

Exceptional integrity of wood remaining on the north limit of forest vegetation allowed the scientists of the Institute of Ecology of Animals and Plants of URAS (Ural Branch of Russian Academy of Sciences) to reconstruct the polar border of larch spread by tree-rings and documented that it sprouted in the Yamal peninsula at the beginning of the Holocene age, i.e. 9,000-11,000 years ago. In the Holocene age, larch spread line consistently shifted to the south and three chronological periods were defined: Eoholocene (10,500-7,400 years ago), Mid-Holocene (7,400–3,700 years ago) and Neoholocene (the last 3,700 years); during every mentioned period the spread line was relatively stable. The last drastic shift of the larch north limit to the south fell on the second half of Neoholocene (starting 500-700 A.D.) (Hantemirov, Shiyatov, 1999). It is related to the development of a cool humid Subatlantic period and on the south line of the area that coincided in time with the last larch expansion to steppe.

At the same time, around 745 A.D., larch intensively expands to the Polar Ural mountains. The expansion lasted up to 13th century and reached 340 m A.S.L. at maximum tree size and stand density in the comparison to the other periods and then the process reversed. Generally in the last 1250 years the larch timberline went down to 430-800m along the flank (**Fig. 21, 22**) (Shiyatov, 1995; Mazepa, 2011).

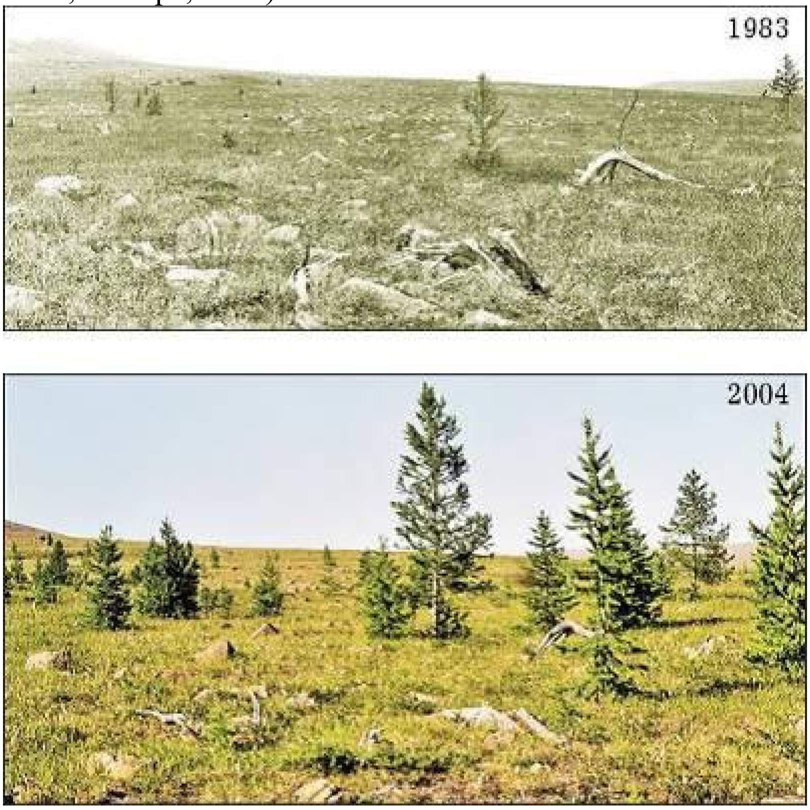


Fig. 21.Photographs taken in the same middle part of Transect 2 in 1983 and 2004, showing abundant old woody remnants and contemporary uphill-dispersing larch (Shiyatov, Mazepa, 2011).

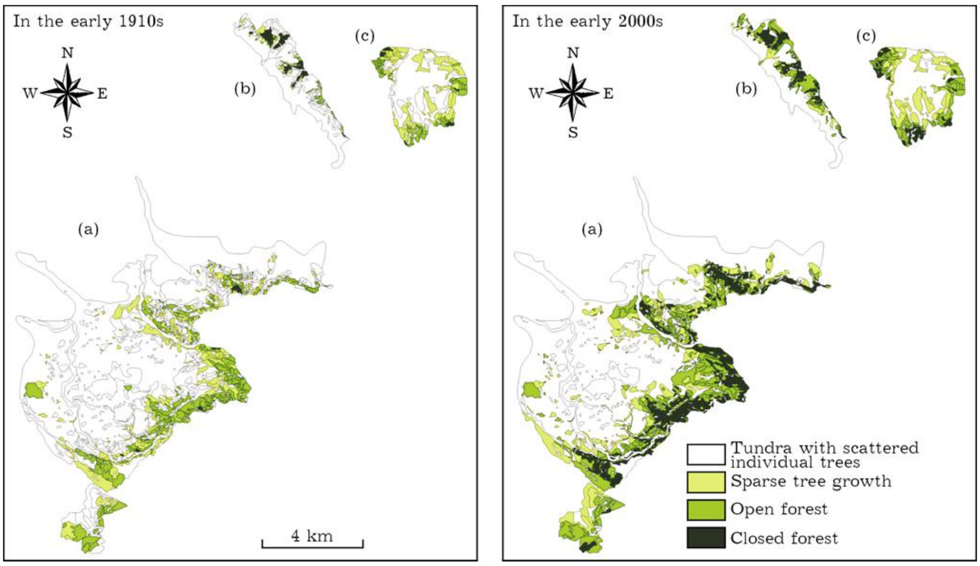


Fig. 22. Distribution of various larch forest-tundra communities in the upper treeline ecotone in the early 1910s and 2000s; (a) –the area of the Rai-Iz massif; b –the Slantsevaya Mountain area; c –the area of Chernaya and Malaya Chernaya mountains (Shiyatov, Mazepa, 2011).

In homogeneous stands, there larch sets the productivity standards despite the growing contradiction of Sukachev's larch environment requirements to relatively mild climate conditions on its western area line and thereby explaining it's rarer occurrence in natural stands west from the Urals.

In the northern taiga subzone on the Solovetskie Islands of the White Sea (65°N, 36°E), 47 year old pure species plantations of Sukachev's larch have 400 m^3 per ha of standing volume and I site index whereas in high pine and the spruce forests site index doesn't go over V class (Polyakov et al., 1986). In the same subzone in the vicinity of Plesetsk, the 189 year old larch forest reached 654 m^3 per ha of standing volume. In general larch forests in the northern taiga subzone provide 1.5-2 times higher standing volume than pine forests (Kalinin, 1965).

In the middle taiga subzone on the Karelian Isthmus, Sukachev's larch seeded by Fockel had a standing volume of more than 1800 m^3 per ha by the age of 183 years which is 3 times higher than the standing volume of native needle-leaved species (**Fig. 23**). In mixed coniferous-broad-leaved forest subzone in Lithuania, 103 year old European larch in plantation had a 1084 m^3/ha standing volume (Yankauskas, 1954); in Belarus by the age of 90 years –1132 m^3/ha; in the Moscow region at 60 years old –800-820 m^3/ha; in Vladimir region at 76 years old –812 m^3/ha (Polyakov et al., 1986). Polish larch plantations at the age of 61 years in broad-leaved forest subzone in the Ukrainian Polesye had a 771 m^3/ha of standing volume whereas in the Carpathians 134 year old larch plantation reached a standing volume of 1160 m^3/ha (Nikitin, 1966).

Fig. 23. Lindulovskaya Grove is a unique monument of domestic forestry. Leningrad region, Vyborg district, Roshchino (http://dendrology.ru/books/item/f00/s00/z0000009/st007.shtml). Photo by O. Yevlakhov.

Larch pure plantations in forest-steppe subzone on chernozems (Orel region) are characterized by high productivity, reaching a standing volume of 528 and 803 m^3/ha at the age of 50 and 80 years respectively. In the same subzone in the Ukraine in Sumy, Zhytomyr and Kiev regions, Sukachev's larch planted in chernozem sandy loam soil had a standing volume of 427, 643 and 979 m^3/ha at the age of 32, 58 and 90 years respectively, which is three times higher in regard to pine plantations under the same planting conditions and wood quality (Yablokov, 1934).

The mentioned numbers indicate negligible productivity differences of larch plantations by a zonal gradient of the Eastern part of Europe (from North to South) and a balanced mixture of productivity factors for larch. However moving East to the more continental climate conditions on the same latitudes, Siberian larch productivity on plantations decreases: in Povolzhye at 95 years old its standing volume in plantations reaches 600 m^3/ha (Karaseva, 2001), and in Krasnoyarsk steppe at the age of 113 years it only goes up to 300 m^3/ha (Panov, Shishiikin, 1998).

On the continentality pole (Yakutsk), natural larch forests (*L. cajanderi*) at the age of 130-380 years have an average standing volume of only 100-150 m^3/ha, and closer to the Pacific coast (the Khabarovsk territory, the upper Amgun River) the 200 year old larch standing volume gets to 660 m^3/ha. If in Yakutia larches are 27-28 m high at maximum, then in upper Amgun, they reach to 43 m and 45 m in Sakhalin (Kabanov, 1940; Povarnitsyn, 1949; Orlov, 1955; Pozdnyakov, 1975).

Within the main area in Eastern Siberia, the average larch forest height goes down from 36 m in the Valley of Gilyuy River (55°N) to 25 m if moving north to the valley of Indigirka River and 24-26 m on the steppe border in Mongolia if moving south (Dugapzhav, 1996). The crown shape changes correspondingly – it goes from ovoid-pyramid shape under the better conditions to the spherical and creeping shapes as a result of brose freezing in the north and to the flag shapes as a result of one-sided dehydration caused by the cold breeze in sub-goltsy belt (Povarnitsyn, 1949).

In the low land conditions of the Siberian Far North, larch is able to survive stagnant humidity or hydration, however on the rest of Eurasian territory, perhumid water-logged soil disagrees with it both in the natural Siberian conditions (Povarnitsyn, 1941) and in the plantation in Europe (Baranova, 2004). Larch plantations die on sandy soil from the moisture deficit in Belarus, the Bryansk region, the Ukraine and the Buzuluk pine forest.

There are particularly many competing opinions related to larch cultivation where every positive view on its cultivation issue plays off a complete opposite one (Bühler, 1886; Timofeyev, 1947). According to Müller (Müller, 1918), when it comes to common larch the cultivation of a typical Alpine species on low land is considered as a natural occurrence. In relation to common larch climate, requirement issue generally most of the western European specialists point at the benefit and need of continental climate for a successful larch growth due to the *Larix* genus historical origin (Timofeyev, 1947).

The nature of mixture with other tree crops is important for plantation survival; however in this context, the examinations are also competing and sometimes are exactly opposite. There is for instance a report (Kucheryavykh, 1948) that larch grows more successfully together with broadleaved species. A. Verzunov (1975) differentiates their influence on larch and determines a positive impact of the Tatarian maple and the small leaved linden and a negative impact of the white birch and the ash-leaf maple on larch.

Due to the biochemical interactions through phytoncids, in a forest mixed with larch, 4 year old birch reduces larch growth by 15-25% against the development excluded by the birch presence; and at the same time birch increases its growth by 10-14% in comparison to a pure birch forest. Unlike birch trees, in a larch-linden mixed forests the growth of larch increases by 20-24% and linden growth by 7-16% in comparison to pure larch and birch plantations (Kolesnichenko, 1976). Larch grows less sufficiently in the combination with birch than in pure stands and also in older ages (Salmina, 1973).

During the first two decades after the planting the relationship between pine tree and larch were in favor of the latter in the Middle Urals, on the flat lands of the South Urals and south of the chernozem' soil of Northern Kazakhstan (Kharitonov, Vidyakova, 1965; Shebalov, 1968, 1976; Verzunov, 1975); hereby in below-ground sphere it was found that the larch root system was developing towards the pine roots and by contrast the declination of pine roots from larch root patches. The last phenomenon is also characterized for an above-ground surface: pine crown throw (radius) is always longer towards the same species rows than to the side of confronting larches. Yet at the age of 25 years, within the Northern Kazakhstan conditions the roles of these two species change to the opposite and larch begins to fall short of growth in a degree proportional to the pine share in the composition (Verzunov, 1975). According to V. Timofeev (1981), this kind of role switch in the European part of Russia relates to the earlier age - 8-15 years.

The similar pattern was laid down under the circumstances of a common upgrowth of pine and larch in the Moscow and Vologda regions (Polyakov et al., 1986). Pine and larch plantations of 51 years of age grow successfully together on sod-podzolic soil of the eastern foot hills of the Middle Urals (Talitsa), however the latter has started coming short of growth –by 10 % in height and by 33 % in diameter (Kharitonov, Vidyakov, 1965). There is no more reliable information on the combined larch-pine plantation development in the Ural-Kazakhstan region.

Interesting results came out on two lots of the 90 year old combined larch-pine plantation planted on the Omsk forest-steppe chernozem' soil. According to N. Gribanov, the share of larch stand volume goes from 20 to 50% on the first lot and stays at 20% on the second one. On both lots pines are distributed evenly. Since on the first lot larch was presented in isolated tree groups and on the second lot, larch location had a random nature and it was suggested that the competitive pressure on larch from pine was higher than it was from larch on pine (Kuzmichev, Sekretenko, 2001). It appears that all the attempts of combined larch growing with pine delivered negative results in the central Russian and Western European areas in the long run (Klamroth, 1929; Yablokov, 1934).

The mixture of larch and spruce is considered as the most advantageous one for the Moscow region forests. In that case, stands are forming under the turf formation absence (Yablokov, 1934; Tkachenko and others, 1939). Therewith larch spruce plantation gets higher grates based on the aesthetic forest value scale (Kovtunov, 1962). However positive results of planting common larch and spruce together in Western Europe came out only under the optimal larch growth conditions (Klamroth, 1929), and there are some evidences that among the conifers spruce is the worse component for larch (Kucheryavykh, 1948).

If all the attempts of larch plantation in the steppe zone of Ukraine didn't bring positive results (Nikitin, 1966), then there are numerous examples of a successful cultivation of this species under extreme continental climate in the droughty steppe of Kazakhstan on the south forest line. Larch in Aman-Karagay insular pine forest (Semiozerniy and Basamansk forestry farms of Kustanai region) (52°20 N, 64°E) larch is characterized by a higher drought resistance, more extensive root system and does not suffer from winter dehydration (Verzunov, 1986).

Siberian larch plantations put in leached clay-loam chernozem' soil (310 mm of annual rainfall) by Y. Sedlak in 1912 in the Kazakh Uplands showed great growth. Unique Siberian larch plantations of 1904-1914 combined with pine, birch and brush on dark-chestnut soil in the steppe zone beyond the south forest line (surroundings of present Astana, 270 mm of annual rainfall and 5-8 m groundwater depth) are still in satisfactory conditions. Positive experience of larch plantations in arid steppe of Kazakhstan in extreme continental climate does not mean that all the territory of Eurasia beyond larch natural area can be used for its cultivation. There is no claim based on the remaining larch stands that it grew successfully in the old days. Sometime afterwards, as a century ago (Müller, 1918), forester may ask again why larch cultivation was possible in 1900 and is not possible in 2015, for instance? Good conditions of the old larch stands could be mandated by the favorable combination of climate and soil conditions only in single locations. Ever increasing aridization of the south forest area line cut down the number the habitat of that kind.

Tendency of larch area change can be determined by its rehabilitation ability in one region or another. In this regard Siberian larch positions on the south area line in the South Altay Mountains are rather inconsistent. Rehabilitation takes place in all forest types however it almost failed on black forest earth throughout: under the dry conditions due to turf formation and soil drying out, under the medium moistening conditions due to the developed grass canopy suppression. Most successfully the process of natural rehabilitation occurs under a broken larch canopy in the subalpine belt of the southern Altay (Povapnitsin, 1941; Lagov, 1961). The same process on the Mongolian Khangai Mountains can be characterized as satisfactory but only on overripe understocked areas (Dugarzhav, 1996).

Within the natural area in the Middle Urals, Sukachev's larch has great rehabilitation capacity under the canopy (Konovalov, 1959a), however further west there is no undergrowth due to the developed ground vegetation and low germination capacity as a result and from the 1920s to 1980s the larch share in composition decreased threefold (Polyakov et al., 1986).

Larch plantation low rehabilitation capacity is also noted to the west and south of its natural habitat mostly due to the same reasons: strong turf formation under transparent canopy specific for larch and thick 10-15 cm litter (Yablokov, 1934; Verzunov, 1987). K. Klamroth (1929) also referred to turf formation in single species plantations of common larch in the foot hill of Harz supposing that the natural habitat of single species plantations of larch were located in the sub-goltsy belt. It appears that turf forming is a circumstance of canopy transparence and forming of a thick litter under the canopy is the result of extensive needle growth and fall hamper the natural larch distribution both within and beyond its natural habitat.

The spread of larch within and beyond its area is also suppressed by the entomological factor that doesn't play a crucial role under the extreme climate conditions in the main larch habitat. It is stated that 80-100% of latch seed in the Urals are effected by *Lasiommalaricicola*, larch tortrix, dark pine knot horn, gall midges; and 90-99% of preserved seeds are empty (parthenocarpy). Seed efficiency in the Polar Urals and zinc in the sub-goltsy belt of the Northern and Middle Urals is almost four times higher than on the main territory of the Middle Urals and on the South Urals it almost equals zero (Novozhenov, 1973). A similar occurrence is typical for the Khangai Mountain belt where the activities of the mentioned above cone insects are more evident in mixed herb foothill of larch forests. Cone infection rate there goes up to 90%. Under the extreme conditions of sub-goltsy the belt cone insect activity slows down drastically and cone infection rate drops to 30% (Yanovskiy, 1980). With the increase of the climate continentality and general hardening of the environmental conditions, the harmful effect of the needle-eating and root insects (Siberian silk moth and May beetle in particular) declines (Rozhkov et al., 1966).

It is known that green plantation stability to the damaging factors of the urban environment is becoming a more pressing issue in proportion to the urbanization of the natural landscape, as then the functional deviations on all the structural levels – cells, tissues, organs and organism – are observed foremost among the conifers. Special research in Arkhangelsk, Tomsk, Krasnoyarsk, Irkutsk and other cities showed that larch resisting abilities to damaging factors reveal also under these conditions. It was found that the radial growth of larch practically depended on an urban environment technogenic pollution level; larch crown 2-3 times less liable to defoliating and needle decoloration as compared to spruce, pine, cedar and other conifers (Zhidkova, 2002; Kurovskaya, 2002).

Consequently natural spread of larch in Eurasia and the plantation survival beyond its area are determined by the environmental conditions in which other species either cannot sprout or have low leaf area potential. Developed adaptive reaction of larch including a deciduous status let it resist extremely low temperatures, summer and winter dehydration and also damaging factors of an urban environment. In addition to that, larch forms a well-lit, photosynthetic yield and nitrogen uses an efficient crown that provides a level of atmospheric carbon fixation matched to evergreens.

As a typical continental climate species, larch has a continuous area on an immense territory of Siberia at relatively low productivity and low density that goes beyond the area of other conifers. However under milder and better forest growth conditions of the European and Far East parts of the area, larch yields its leading positions to other species: its area becomes more "pierce"and it occurs only combined with other species. West and south-east of Siberia, and with the reduction of climate continentality, larch productivity level goes up and sometimes several times and outgoes in this regard other species, but at the same time a set of growth conditions appropriate for successful growth and reproduction of larch shortens.

Under this condition, intensive needle growth and metabolism with a transparent canopy specific for larch encourage thick litter or turf formation that exclude natural reproduction. A thick litter and turf formation and also massive damage of seeds by insect pests and diseases in the milder climate and under better soil conditions become the factors limiting territory expansion of larch even in more favorable growth conditions for it where larch is forced out by other tree species.

On the south limit of the Eurasian forest zone in the sharp continental climate of the Kazakh steppe, larch plantations are more resistant to the adverse environment in comparison to pine plantations although the latter grows successfully here as a natural stand form with almost no larch in it. In the Ukrainian steppe in the less continental climate, a general mortality of larch stands take place, however pine cultivation there usually delivers great results.

The foregoing let us make a conclusion that larch can be successfully used in the urban greening both within and beyond its natural area and in relatively mild and dry climate zones. The above statement can be proved by the fact of a successful growth of larch on the streets of Yekaterinburg and other cities.

2. Scots pine (the genus *Pinus* L.) is “Cinderella”and the “Queen” of the Russian forests.

The genus of pine (*Pinus* L.) includes about 100 species spread in boreal and mid-latitude zones and also in the mountain regions of the subtropical zone of the northern Hemisphere. There are about 10 species in our country. The genus *Pinus* is divided into two subgenuses: five-needle subgenus, or wingless seed cedars (*Haploxylon*) and two-needle pines with winged seeds (*Diploxylon* or Pinus).

Scots pine – *Pinus sylvestris* L. belongs to the *Sylvestres* species of two-needle *Pinus* subgenus (Bobrov, 1978) and in terms of area is the most common species of the genus *Pinus* in Russia and among conifers only larches occupy a bigger area than pines. This a large evergreen whorl-branching light-demanding tree with a transparent crown. Its needle foliage is adapted to conservative water consumption, tolerates temperatures of -50°C to +50°C and lives for 5-6 years (Mamaev, 1983). The bark is thick, scaly dark grey-brown on the lower trunk, and thin, flaky and orange on the upper trunk and branches (**Fig. 24**).

Fig. 24. Scots pine (Pinus sylvestris L.): 1 - General tree image; 2 - Two-needle spur shoot; 3 - A branch with male and female strobiles; 4 - A female blooming cone consisted of macrostrobiles; 5 - Macrostrobile (a – seed scale with two seedbuds; b – cover and seed scales); 6 - A branch with a hibernating cone (a) and a matured cone (b); 7 – An open mature cone after a jactitation; 8 - staminate cone built of micro strobiles; 9, 10 – microsporophyll; 11 – pollen; 12 – A sclerotic seed and cover scales with a corymb; 13 – sclerotic seed scale with two winged seeds: 14 – winged seed (Forest Encyclopedia, 1986).

A Scots pine usually grows to 40 m in height and has a 1,5 m trunk diameter. There are however some exceptions: in 1990 in the Carpathian region, the author happened to see a unique 100 year old natural stand of scots pine with a1m thickrhizosphere layer and limestone litter. Giving that the stand was 60 m tall, the crown was concentrated on the 4-5 meter upper trunk. For some reason this pine is lacking of a seed reproductive ability and the local forester tried to spring it using the grafts brought by rock climbers.

Sometimes there are dark-bark mutants of Scots pine and one of its unique species occurs nowadays in the Borovoy experimental forest district in the Buzuluk Coniferous Forest in the Orenburg region (52°40’ N, 52°10’ E) in section 97 (**Fig. 25**).

According to the data (Tkachenko and others, 1939; Mamaev, 1999) the lifespan of pine is up to 500-600 years. However these kinds of “Methuselahs” are no longer found in the Russian pine forests because if they don’t burn down then they occasionally get to cut down. A rare exception is the 500 year old single pines in Udmurtia (F**ig. 26a**).

There is a 350 year old pine in Buzuluk Coniferous Forest in the Orenburg region and it’s an age mate to Peter the Great (Borovoy experimental forest district, section 218, division 17). Apparently the tree was registered during the first forest establishment in 1844 (the third forest inventory in the Russian history after Lisino and Elk Island) and survived despite the occasional total crown fires due to growing on a sandy low hill in the middle of the once surrounding bogs (Usoltsev, 2008).

Fig. 25. A unique Scots pine with black bark surrounded by common pines. Buzuluk Coniferous Forest, Borovoy experimental forest district, section 97 (Usoltsev, 2008).

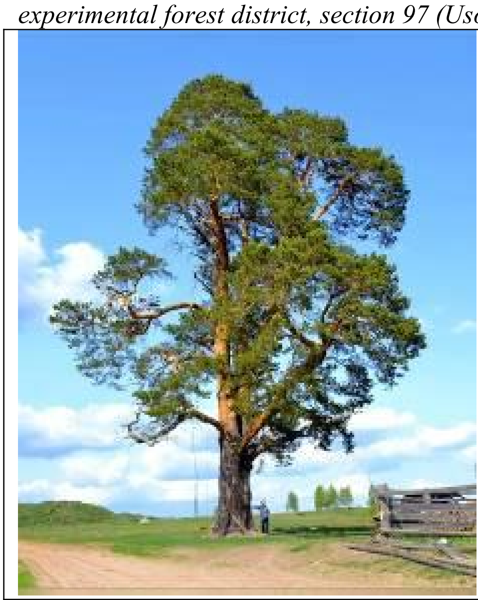


Fig. 26a. A rare example of a 500 year old Scots pine in Udmurtia, Yegorovtsy village. 5.3 m stem diameter (http://www.geocaching.su/?pn=101&cid=10106).

Fig. 26b. Aged (Elderly) pines and their young generations (offspings) in the morning fog. The Middle Urals, Nizhnie Sergi. Photo by V. Usoltsev

5,000 year old *Pinus longaeva* D. K. Bailey that grow in Utah, Nevada and California (U.S.A) and 2,000 year old *Pinus aristata* Engelm., or Bristlecone pine, which occur in Colorado, New Mexico and Arizona (U.S.A.) are the oldest pines on the planet (Elias, 2014). In California there is the Methuselah tree that got its name after one of the ancestors of the mankind that lived for 969 years. The estimate germination date is 2831 B.C., i.e. it came to life when a human being just started tilling the land (**Fig. 27**). As of 2015, the approximate life span is 4850 years. In its lifetime it witnessed Columbus' discoveries and was contemporary with Egyptian Pharaohs. The tree grows among several old pines, the tallest one is 10 m in height and the rest of them are about 3 m tall. The tree is growing high in the mountains at heights of 3,000 meters (http://www.rumbur.ru/nature/59-dolgojiteli).

Fig. 27. The world's oldest pine - 4846 year old Methuselah tree, California (U.S.A.) http://lifefacts.ru/sosna-mafusail-samyiy-staryiy-zhivoy-organizm-na-planete-4/).

Artistic people don't pass by those forest veterans. The Ural painter captured a dramatic moment in a forest: for the whole long life a pine doesn't have a young generation; it is getting surrounded by birch springs (**Fig. 28**).

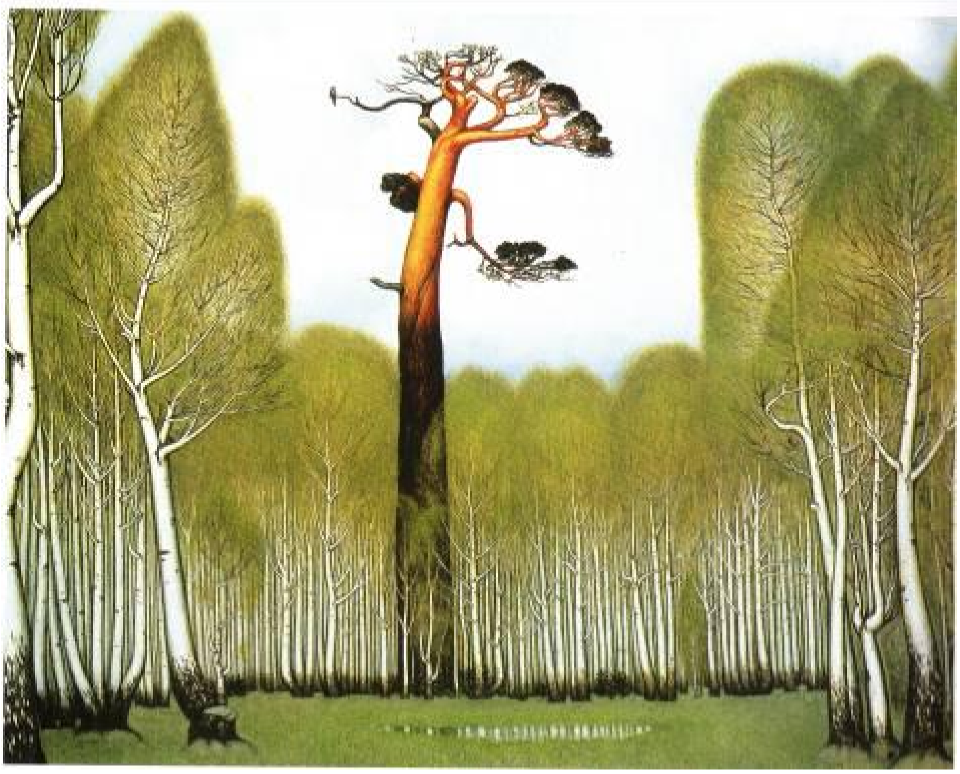


Fig. 28. An old giant pine in the spring round dance of birch coppice - by the Ural painter Gennadiy Mosin.

Scots pine is a pioneer tree with a short territory attack period. Winged seeds and good floatation ensure high migration potential of pine. Seed migratory range downstream can reach up to a few hundred kilometers per year (Sannikov, 1976; Petrova, 2003).

Scots pine is adapted to both black soil and sandy soils. It forms frowy wood withwide-ringed pine. As a result, sometimes a trunk falls to pieces during tree cutting and hitting the ground. Such conditions are typical for instance for Scots pine planted in the steppe of Velikoanadolskiy Forest park (Donetsk province of Ukraine) that was established by V. Graff in 1843. The foliage of this type of pine only lasts for a 1 – 1.5 years. On the contrary pine forest growing in sandy soils form a firm narrow-ringed wood ("close grain" pine) and roots can get 6 meters deep trying to reach ground waters; under these conditions pine sometimes presents a "survival" standard (**Fig. 29**).

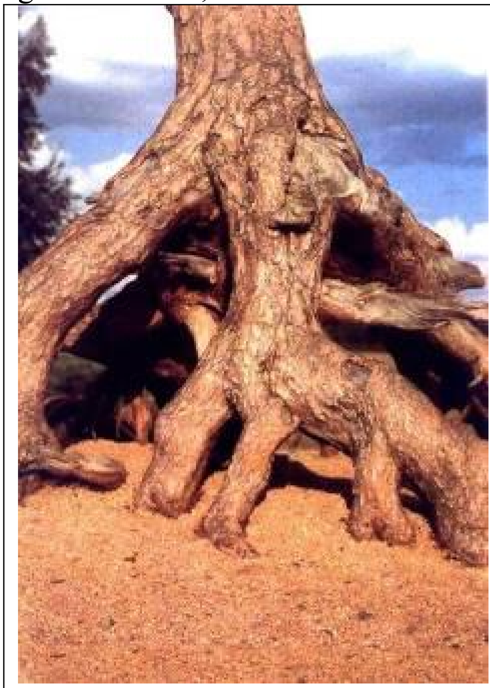


Fig. 29a. Scots pine getting out of a sand dune. Photo by Yu. Kuydin.

Fig. 29b. Loneliness. Photo by O. Belyalov.

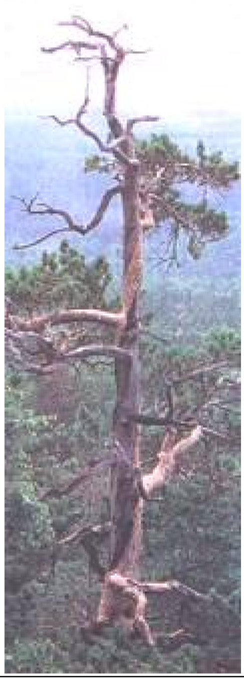


Fig. 29c. Agony. Photo by N. Nasryeva.

Scots pine has the largest ecological amplitude and is widely distributed in the contrasting regions in terms of climate and site conditions. It doesn't depend on warm conditions in the north and drought resistancein the south. Pine environment is specific under dryland conditions is that stands often "rebirth" by the regeneration of tree tops from lateral branches (**Fig. 30**). V. Nesterov came to the conclusion (1949) that the "drying of pine tops and formation of a new crown from lateral branches is typical for Buzuluk Coniferous Forest" (p. 67), herewith the process of tree top drying and rehabilitation alternate in time. Under this extreme growth conditions up, 95% of root systems unite/fuse togetherdelivering animprovement ofadaptivepotentialin general (**Fig. 31**). As a result of the root grafting during decades you can see an increment accretion stumps.

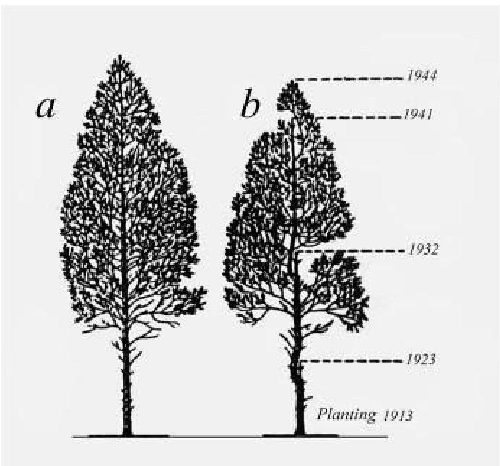


Fig. 30. Pine architectonics under normal growth conditions (a) and three times regenerated pine after drought seasons under humidification deficit conditions (b) in Buzuluk Coniferous Forest, section 137 (Nesterov, 1949). Calendar years are marked with numbers.

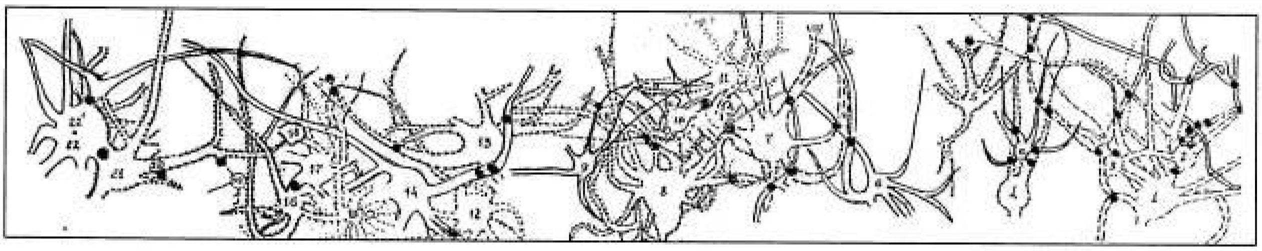


Fig. 31. Root system structure in a 120 year old pine forest on a sampling area in Kazakh Uplands; trees are marked with numbers; root-grafting spots are circled (Koltunova, 2013)

A similar "renewal" phenomenon of pine in the "written-off" plantations, i.e. already excluded from the forest fund, was registered in Aman-Karagay pine forest in Turgay Depression (Northern Kazakhstan) when after the drought season in the end of 1970s, supposedly 10-15 year old written-off Scots pines turned to be in good conditions at the end of the 1990s and were defined by a steady growth with newly formed tops. However after decapitation on seed plantations detached tree tops usually do not rehabilitate (**Fig. 32**).

Fig. 32. Topped scots pine with no height growth on a seed plantation in Buryatia; 45 years old, topping height is 4,5 m (Tarakanov and others, 2001).

In the Pleistocene age pine expanded from the Western Siberian to the south, to the Kazakh Uplands, Turgay Depression and to the Southern Urals. Since The Atlantic Age due to the warming pine as a light demander and thus uncompetitive species was supplanted on the west by broad leaved species and gave its place to steppe on the south. Within the area pine always was supplanted to poor sandy soils, to limestone and chalk outcrops (**Fig. 33**) and on the north to sphagnum bogs (**Fig. 34**), in other words to the habitats where there was no competition (Bobrov, 1978). Scots pine mostly expands in the taiga zone where it is often affiliated to sandy relief elevations and a river valley terrace and also builds up unique sphagnous pine forest communities on bogs. Further East pines avoid regions of continues permafrost areas and occupy large areas in the Middle Siberia.

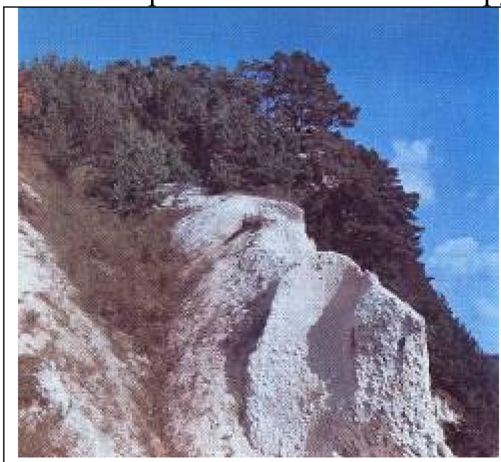


Fig. 33. P. sylvestris f. cretacea Kalenicz. *ex* Kom. *on the chalk outcrops from Bryansk to Slavyansk (Forest Encyclopedia, 1986). Specially protected type of Scots pine.*	*Fig. 34. Scots pine (P. sylverstris* L. *f. sphagnicola) on a peat bog (http://www.roadplanet.ru/home/reports/1215/)*

Today in better conditions pines are not capable to compete with spruces, firs, Siberian pines and are displaced by them to the worse habitat areas; pines usually dominate on dry sandy soils and boggy grounds. Although due to a deep root system and a thick bark, pines suffer less from forest fires then spruces, firs and Siberian pine and that's why the most part of pine forests was formed after fires on dark coniferous forest areas (Sukachev, 1938).

In the Pleistocene age, Western Europe was covered with tundra and forest-tundra and coniferous forest were pushed to the south beyond the Alps. In the Holocene Scots pines restore its area in Western Europe. In the middle of the 19^{th} century, buried Scots pine stumps related to the first half of the 16^{th} century were discovered in The Forest of Compiègnenear Paris, but later pines were supplanted by deciduous species. In the historical time *P. sylvestris* forests covered the most part of the Great Britain and some of them remained up till today in Scotland (**Fig. 35**) and on some islands of the North Sea (Jenik, 1987).

Fig. 35. Remaining parts of Pinus sylvertris forest in Scotland (Jenik, 1987).

In relation to the relict pines of Scotland let's make a retrospective journey into their ancient history (see **Fig. 35**). Sprouts of pine "forefathers" so called "Norfolk Island" pines can be tracked back to the depth of the centuries (**Fig. 36a**). There is a unique paper by unknown author about the discovery of the most ancient forest of fossilized Norfolk Island pines in the "Forest Journal" (Lesnoi Zhurnal), no. 23, 1847. Here are some snippets:

"On the Isle of Portland near England coast there is one of the most wonderful memorials that witnessed revolutions taking place on the planet. This is the forest; the trees have stayed in their place with all the roots on the primitive soil that was fossilized under the water actions that once gained on this country. This fossilized forest withstood the ravages of time in order to become an object of botanical research. Humus is 12 to 18 inches deep, tops a calcareous layer, it is black and dark brown in places and consists of decomposed vegetation, clay and silicon. The tree, which roots often go deep to the second calcareous layer, grows close to each other and mostly broken… The trunks are up to 30 feet in height and according to the researchers, belong to the Norfolk Island pine species (*Araucaria excelsa*) and are not found in this form anymore. There are stumps in the shapes of a pineapple and an artichoke by their feet (**Fig. 36b**). … The Isle of Portland forest does not include any plant substance: it has tuned into a transparent stone allowing seeing the inside of a former plant so that its elements are subject to study" (p. 183).

Then this unknown author tries to explain the phenomenon of this tree in a historical context. "Once it also grew in Europe and by its structure resembled a palm tree also having some conifer and fern features. In this transition from one family to another you can trace a common link that connects plans with each other and brings them to some primitive species. The image of this fossil space gives an idea of an inconsistency of the climate and geographical location of countries. The calcareous layer of soil is full of sea shells; hence it's fair to suggest that before plants first appeared the sea was covering all the space of this part of England. Little by little the solid mass was rising above waves, grew over and produced a plant fragment and, finally, there was a whole forest and then being high above the sea level only during a certain amount of time the isle was covered with water with all the plants on it again. … From there the country went a few hundred feet down to the depth of the sea and then rose up again right before us as we see it today. A part of the layer covering the forest was washed away with water streams; it came out of the gulf, was washed to a steep shore and now is exposing all the secrets of the great revolutions of the primitive world. Besides that, this country suffered a lot of local changes; for example, some parts of the forest area declined already after the vegetation development and some of the trunks stood crooked…" (p. 184).

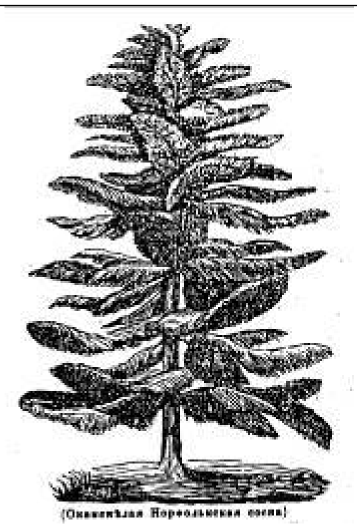


Fig. 36a. A sketch of the Petrified Forest on the Island of Portland on England coast by an unknown author (The Petrified forest…, 1874).

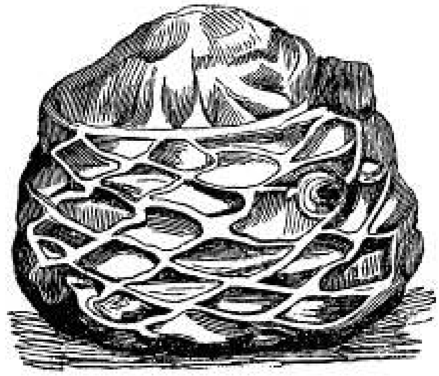


Fig. 36b. A petrified stump of the Norfolk Island pine (The Petrified forest…, 1874).

Fig. 36c. Norfolk Island pines (Acaucaria heterophylla) in the modern Australia (http://www.shutterstock.com/s/"araucaria+heterophylla"/search.html).

Fig. 36d. Norfolk Island pine lace radial fronds (Rychagova, Natapov, 2004).

Fig. 36e. Norfolk Island pine in Gondwana – the tree of dinosaur age (Rychagova, Natapov, 2004).

Apparently the mentioned above author insisting the Norfolk Island pines (araucarias) do not occur anywhere else was wrong. Araucarias (total approx. 40 species) have a reputation of "botanical hermit" and they grow in separate groups mostly in the Southern Hemisphere on the continent of the former Gondwana: in Australia, Southern America, New Guinea, New Caledonia, New Zealand. And only the Norfolk Island pine (*Araucaria excelsa*, or *Araucaria heterophylla*) reaching 40 meters in height and having a 1 meter trunk in diameter ended up "in a lucky island isolation" (Rychagova, Natapov, 2004).

The Norfolk Island pine is indebted to the British navigator of the 18th century captain James Cook for its discovery and name. On October 10th 1774 the captain and the naturalist, J. R. Forster, accompanying him, came ashore of a small deserted island in the Pathetic Ocean. The mountain island was overgrown with gigantic deep-green trees looking like pines. The explorers were amazed not only with the gigantic tree size but also with an image of branches never seen before. The samples of this tree were transferred to the London Royal Botanic Gardens. Later it was proved there that the samples belonged to the *Araucariaceae* family. Cook named the discovered island Norfolk in honor of a proud name of his compatriots, and the trees were dubbed Norfolk Island pine and included *Araucaria heterophylla* species (Rychagova, Natapov, 2004).

Norfolk Island pines come under the notion of pagoda trees – their shoots grow as horizontal layers and due to their location, a tree outline causes association with a pagoda (Menninger, 1967) (**Fig. 36b**). Norfolk Island pine has wide lace radial branches looking like fronds and slowly taper with the distance from the trunk (**Fig. 36d**). Casting symmetrical branches leave unique clear hoops (Rychagova, Natapov, 2004).

Based on numerous fossilized molds, in subsurface rocks of the Triassic and Jurassic periods Norfolk Island pines first appeared more than 200 million years agoon the Northern and Southern Hemispheres including the territory of former Gondwana. During that time dinosaurs prevailed in the animal world (**Fig. 36e**). Perhaps it is not a coincidence that the idea of the writer of Jurassic Park, Michael Crichton's, and genetic material of dinosaurs was abstracted from the Mesozoic bloodsucking insects sealed in ancient amber. Traditionally it was considered that amber originated from the fossil pine (*Pinus succinifera*), however using the modern infrared spectrometry it was discovered that amber originated from araucaria gum (Rychagova, Natapov, 2004).

Hence the origin of our "Cinderella" and "The Queen" of the Russian forests possibly dates back to the age of dinosaurs and the tree that has out lived them by many millions of years inspires a special respect.

P. sylvestris area is the largest in comparison to the other tree species areas and is characterized with a wide range of climate conditions. This species grows in the most natural zones of Northern Eurasia. On the north–west it reaches the North Sea Islands, on the Kola Peninsula as a prostrate tree it forms the norther forest line at heights of up to 500 m, on the far east side of Siberian, it spreads up to the Sea of the Okhotsk coastline, on the west – up to Switzerland and on the south pine forests get to the border of the steppe (**Fig. 37**).

Pine avoids regions of a complete permafrost occurrence. That becomes the main obstacle of pine spread to the north, and pine there has adjusted to the harsher conditions than in any other taiga regions. Under the same overground phytomass amount of pine on non-permafrost and of larch on permafrost root mass in the first case which will be twice smaller than in the second one that is determined with the deficit of nutrients and a corresponding compensation effect (Kajimoto et al., 2006) (**Fig. 38**).

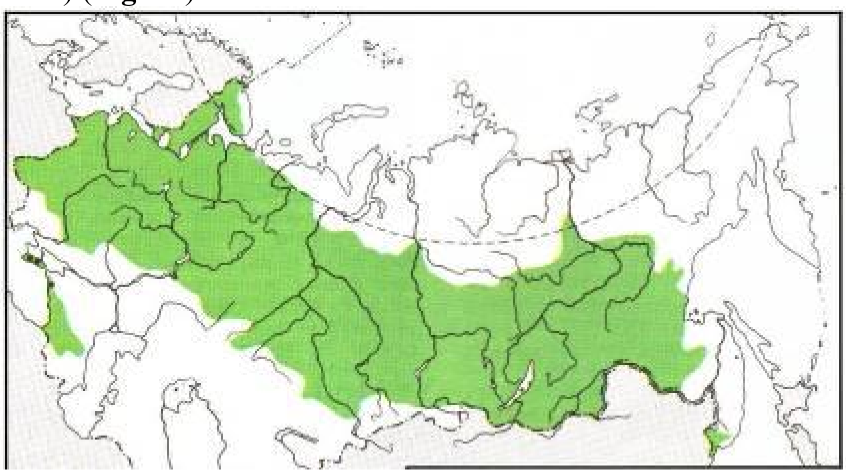


Fig. 37. Scots pine (P. sylvestris L.*) area on the territory of the former USSR (Forest encyclopedia, 1986).*

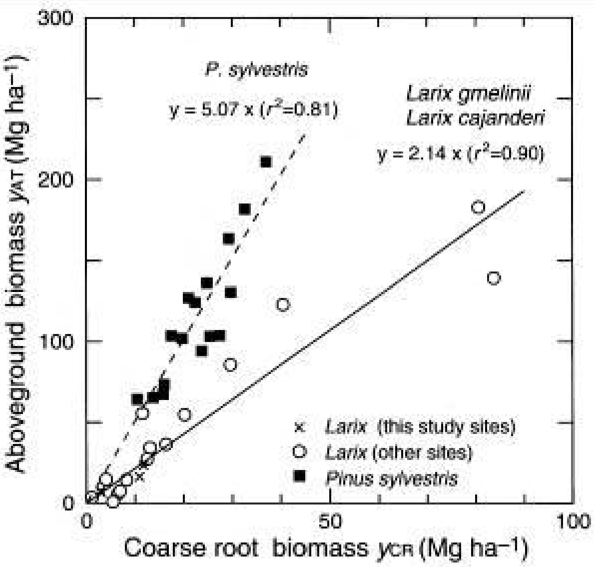


Fig. 38. The relation between aboveground biomass and coarse root one in pine and larch forests in Siberia (Kajimoto et al., 2006).

Due to the permafrost ubiquitousness and well developed moss layer on the growth limits during the evolution, pine has developed a capacity to successfully sprout on burned spots after forest fires where there are optimum conditions for reproduction and congelation goes up to 2 meters deep. Pine maintains its positions until the ground vegetation development and soil hydrothermal regime deprivation becomes the obstacle to the natural regeneration that also causes a supplantation of pine with the other species (Boichenko, 1970).

From the North to the South of Western Siberia, in the direction from forest-tundra towards the north, middle and south taiga and then to forest-steppe and steppe average volume of mature growing stocks are 70, 116, 138, 128, 193 and 134 m^3/ha respectively (Taran, 1973). Hence the ecological optimum (most favorable combination of warmth and moisture) of Scots pine on the horizontal gradient is located in forest-steppe subzone (Gabeyev, 1990).

P. sylverstris area is regressing and fragmentary on the Far East. There pine is a relict species that survived the past period of its more abundant distribution. East from Amgun-Bureya interfluve pine does not grow anywhere under the oceanic climate conditions and all the occurrence spots affilialed to the continental climate conditions. Negative attitude permafrost, sandy soil preference and poor development on clay soil leaves pine a limited number of possible habitats where it's capable to lead and compete with other species (Kolesnikov, 1945).

The south area line of Scots pine isn't determined due to implicit distinction between the continuous and outlier distribution regions. Keppen (1885) provides a list of the main pine outliers on the European part of Russia that "in the old days were directly connected to the continuous distribution region" (p. 81): Polesye and also along the Dnepr River on sandy soil up to 49°N, along the Psel, Vorskla, Severski Donets, Oskol, Don, Bityug and Oka rivers (in former Kyev, Poltava, Kharkov, Kursk, Voronezh and Tambov provinces).

In the Asian part of Russia the south distribution line of Scots pine is represented with the pine forests: Buzuluk, Dzhabyk-Karagay pine forests, pine forests of Turgay Depression (Ara-Karagay, Aman-Karagay, Kazanbasy and Naurzum), the Kazakh Uplands pine forests, the ribbon pine forest of Priirtyshie, Bayano-Karkaralinsk upland sparse forests, pine forests of Kalbinsk range and the ribbon pine forest of the Minusinsk lowland on the south of Krasnoyarsk region.

Keppen (1885) writes that "in ancient time the present Orenburg steppes abounded with great forests that afterwards were destroyed by semi-wild Asian nations being nomadic here up to the begging of the 18th century" (p.109). However at the end of 19th century, according to the articles 119 and 120 of "The Steppe Provision" lands of Akmolinsk (present Astana) region as a part of Steppe Governorate General and spreading to the border of Tobolsk province, occupied by nomads are declared to be state property but at the same time remain "in permanent public utilization of nomads… Hence having the right to be nomadic in forest lands the Kirghiz are allowed to forestage and only in the recesses the common law to collect fallen deadwood and branches for free is applied" (Yatsenko-Khmelevskiy, 1908. P. 60).

Developed in the Pleistocene, a continuous pine forest belt to the south of the west Siberian Plain nowadays is split into 5 isolated pine forest massifs that represents an intrazonal phenomenon in the semi-dry and dry steppe zone (**Fig. 39**).

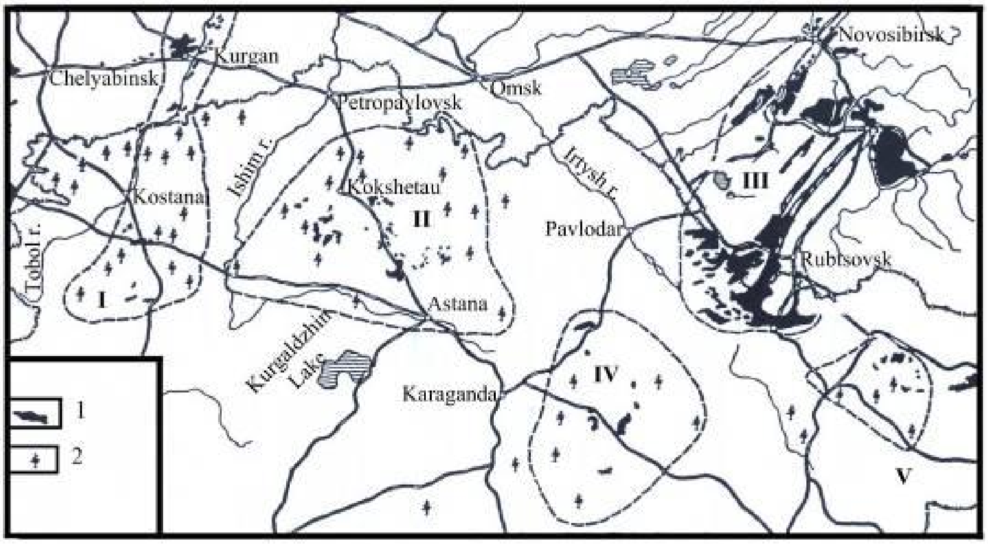


Fig. 39. Steppe pine forests of Kazakhstan and the Altai Territory. I – Outlier pine forest of Turgay Depression; II – Pine forests of the Kazakh Uplands; III – The ribbon Pine Forest of the Ob–Irtysh Interfluve; IV – Bayano-Karkaralinsk upland sparse forests; V – Pine forests of Kalbinsk range; 1 *– present pine forests;* 2 *– disappeared pine forests (Gribanov, 1960).*

A land area of the most south pine forest of the Turgay Depression Naurzum pine forest (51° 30'N, 64°15'E) was about 5.5 thousand ha in 1884, decreased by 82% (Tekhneryadnov, 1959) and was about 1 thousand ha by 1940; according to Keppen, the Naurzum pine forest is "an ideal oasis in a desert" (**Fig. 40**). By 1970s the land area decreased by 90% more as the result of forest fires (Smetana, Malanin, 1974). With annual precipitation in Naurzum, that in the last 20 years was about 217 mm the groundwater level didn't go above 4 m (Tekhneryadnov, 1959), however all the attempts of an artificial regeneration of pine on wind-blown sand remained after the fires didn't succeed. The only method that delivered a positive result in the 1980s was a planting in the broken with a digger ground that would protected seedlings from sand abrasion and at the same time draw the groundwater level nearer to the roots, but for obvious reasons was not suited for use on long distance burned areas. Nevertheless, planted in broken ground pines of the 1980s are well preserved and continually grow today.

Fig. 40. Pine forest on Naurzum nature reserve on sandy soil. Photo by O. Belyalov (Bragin, Bragina, 2006).

The Kazakh Uplands (see **Fig. 39**) is an ancient folded rock land formed with sandstones, conglomerate, prostrate trees and limestone. This rock mass is torn with a granite intrusion of a different age. Long continental regime led to the wide spread of weathering crust on the bed rock. An average annual precipitation is 444 mm. Pine grows on granite on the slopes and on mountain tops at up to 600-1000 m high forming a rocky pine forest (**Fig. 41**). 15 meter trunks are usually covered with lichen. Longevity of the needles is up to 9-10 years.

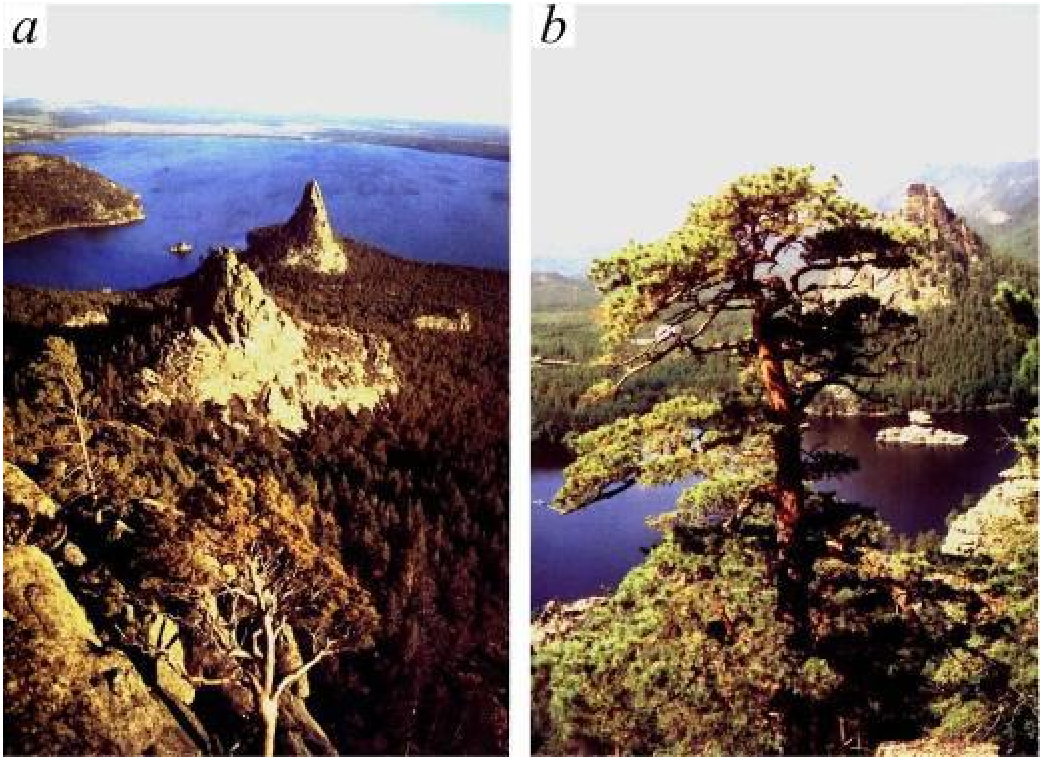


Fig. 41. Rocky pine forest of the Kazakh Uplands in the northern Kazakhstan: (a) the view to the Borovoe Lake from the Sinyukha Mountain (947 m a. s. l.) and (b) the view on the Blue Bay of the Borovoe Lake: there is Okzhetpes Rock ("An arrow can't reach") in the background on the right and there is Zhumbaktas Rock ("Rock of mystery", or Sphinx) on the bottom. Photo by Kuydin.

The ribbon pine forests of Ob–Irtysh interfluve (see **Fig. 39**) originated on the ancient sand banks formed due to melt waters of Altai ice flow that brought lots of sedimentary rock from the mountains. The ancient flowing dells like five parallel ribbons cut the steppe from north-east to south-west being starkly different from the surrounding environment by terrain, topsoil and vegetation. Among all the dry pine forests of the south pine area limit, the ribbon pine forest of Ob – Irtysh шnterfluve are under the worse climate conditions in comparison to the Buzuluk pine forest, Turgay insular pine forests and Minusinsk pine forest.

Bayano-Karkaralinsk upland sparse forests (see **Fig. 39**) have features of highly rugged rocky low mountains or flattened hills with soft landscape (**Fig. 42, 43**). Rocky low-hill terrains are built with granite intrusions and appear in the shape of small (100-400 km^2) isolated stocked woods. As a result of forest fires the land area of pine sparse forests there decreased: between 1816 and 1949 in Bayanaul by 6 times and between 1901 and 1955 in Bakhtinsk pines forest by 10 times. Despite the southward extended location, arid climate features in Bayano-Karkaralinsk low mountains are significantly less prominent than in the ribbon pine forests of Priirtyshie (Tokarev, 1969).

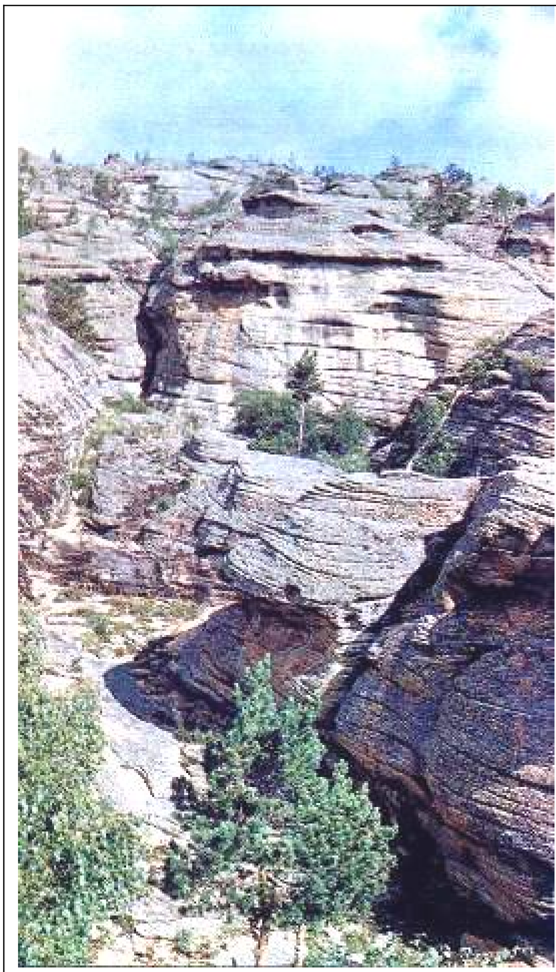


Fig. 42. Scots pine on "layer-pie" of granite slabs in the Karkaraly National Park. Karkaralinsk upland sparse forests with the highest elevation point of 1403 m A.S.L., western part of Karaganda' region, Central Kazakhstan. Photo by Bondin and Yakushkin.

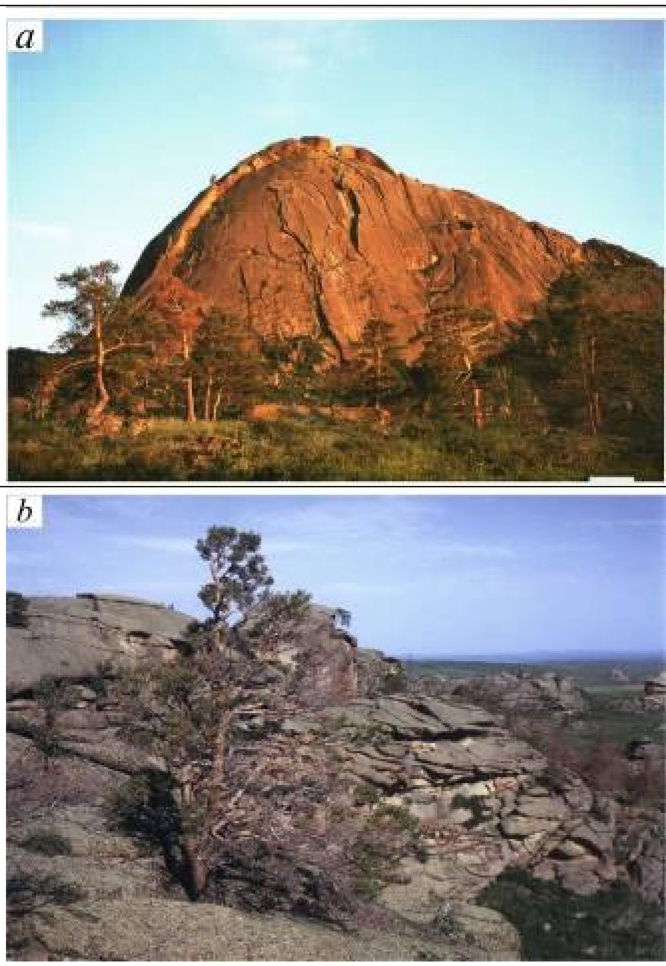


*Fig. 43. Scots pine against **a** (on top) and on **b** (on the bottom) gigantic granite exposure in the Bayanaul National park. Bayanaul sparse forests with the highest elevation point of 1027 m A.S.L. (Akbet mountain top), southern part of Pavlodar' region, Central Kazakhstan. Photo by Belyalov (Ogar', Ivashchenko, 2006).*

One of the pine characteristics in these sparse forests is large seed production and high progeny quality of seeds (96-99% of germinative capacity). The amount of cones is almost 30 times higher than in the main forest belt of Russia. Here pine finds the optimum conditions for sprout and survival in the poorest and driest rock habitat revealing the most competitive abilities against grassland and scrub vegetation. Ground forest fires destroying steppe vegetation encourage pine regeneration in sparse forests: on fire-sites the regrowth amount is 5-6 times higher that on land of pieces that were not touched by fire. However due to the high fire frequency their positive role comes to nothing since the regrowth suffers the most from the fire (Tokarev, 1969).

Three ribbons of Minusinsk pine forest located on the south-east edge of the Minusinsk lowland are the eastern analogue of the Ob-Irtysh interfluve ribbon pine forests (**Fig. 44**). They were shaped on lake and river deposits of once powerful and now shrinking rivers which valleys spread in the direction from the north-east to south-west, from the Tuba River to the Yenisei and are accompanied with upland fringes and dune hills down the river stream. Overall the Minusinsk pine forest has better habitat water availability characteristics than Kazakh pine forests. Longevity of needles in Minusinsk pine forest is up to 6 years.

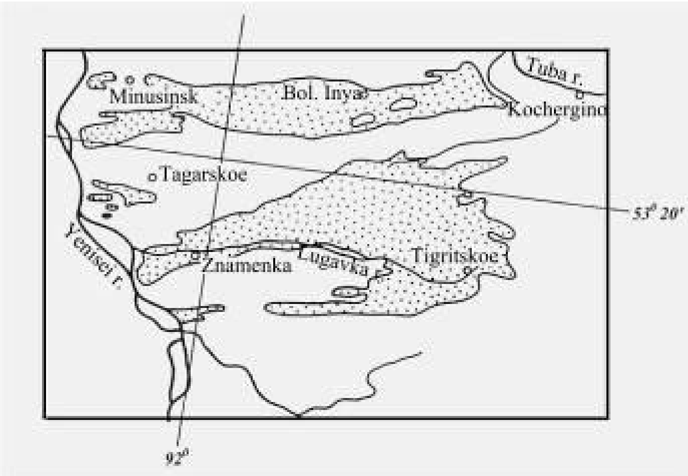


Fig. 44. Layout of the Minusinsk ribbon pine forest on the south-east of the Minusinsk lowland (Orlovskiy and others, 1974).

Pine forests are characterized as the most fire-prone forests. Fires cut down the land area of the Dzhabyk-Karagay pine forests on the south of Chelyabinsk region to 60,000 ha and once together with the other isolated pine forests in the south of the region, it used to be one united large area of tall-trunk pine (Mamaev, 1999). Pine forests that survived on the south edge might be completely destroyed by the forest fires that are devastating to nature (**Fig. 45**) and year by year are becoming more frequent due to the aridization of the southern forest area part (Shvidenko, Shchepashchenko, 2013).

The Buzuluk pine forest is under the most danger since there are about 160 oil-wells there (**Fig. 46**). In 1974 after the large oil leak and heavy forest fires the oil wells were suspended. In 2002 the National Nature park establishment campaign was started on the territory that previously was under the jurisdiction of “the Buzuluk pine forest” forest administration. The director of the Steppe Institute of URAS Alexander Chibilev led the planning project.

Fig. 45. Crown fire is a tragedy for all forest flora and fauna (Forest encyclopedia, 1986).

Fig. 46. Ticking bombs in the Buzuluk pine forest – the wells are still effusing water and oil mixture. Photo by Chibilev (http://www.nkj.ru/archive/articles/21437/).

Chibilev’s achievements as a scientist and steppe specialist do not raise any doubt and his work deserves respect. However after the new “Forestry Law” backed all the foresters into a corner, he took advantage as the “main ecologist” of the region. Upon that he excluded all the research foresters of the Forestry Department of the Orenburg State Agrarian University from the project, moreover with the support of oil business owners he started a bullying campaign against foresters in mass media, on all the TV channels, in the newspapers and on the radio under the slogan “Foresters are the forests’ main enemy”.

Chibilev got to work being armed with “landscape and ecological knowledge” without acknowledging forestry basics known by every forestry department student. The research results by the research foresters of several generations in the Buzuluk pine forest (G. Morozov, A. Tolskiy, S.

Korzhinskiy, V. Sukachev and many other) were ignored. In the “Ecological-economical grounds for the foundation of a national park” (2008) Chibilev set himself up over the Russian classical foresters: “Foresters and wood cutters think that they and only they know the life and issues of a forest” (p.135). The soil scientist A. Klimentyev (2010) also associates himself with his chief and institute colleague: “So called “technical” management forced by men destabilizes the structure of pine forest ecological community which life is based on the principals and “recipes” that know no equals among physical systems offered by people” (p. 371).

By Chibilev’s project (2008), more than 70 “utility zones” around the suspended wells are excluded from the national park land use (**Fig. 47**). He assures that according to the project, there will be no oil production in the Buzuluk pine forest. However if the project does not provide for the oil production in the “utility zones” around the wells what benefits did “Buzulukneft” of “TNK-BP Holding” pursue funding the print publishing of the mentioned “Ecological-economical grounds”? Yet “Buzulukneft” is already producing oil at both on the pine forest land (Komsomolskiy village) and peripherally (Troitskoe and Pasmurovo villages and other). Oil production numbers (URL: http://www.orenburgneft.ru/press/news/?year=2009&month=08) and unavoidable oil spills (URL: http://www.ecoindustry.ru/news/view/9175.html) increase year by year.

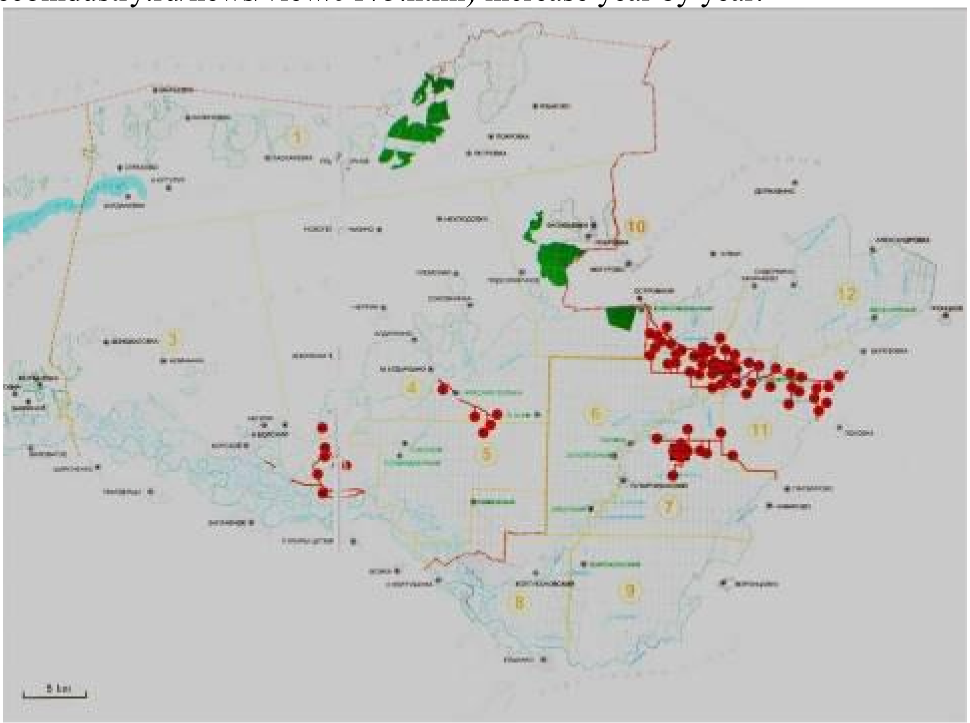


Fig. 47. Map of the national park “Buzuluk Pine forest”. “Utility zones” around the wells are parked with red circles; present mining allotments are marked with green, forestry sections are marked with circled yellow numbers (Chibilev, 2008).

Chibilev holding himself out as a “fundamental science representative” forbade any kind of interference in forest ecosystems including sanitary felling and deadwood cleaning. He turned the Buzuluk pine forest into a “profound rest zone” by setting it up for a transfer to absolute deadwood abundance” and an ecological disaster zone taking into account oil splits.

Over the course of its history, the Buzuluk pine forest burned multiple times. According to Keppen’s witness (1885) 5,000 ha of the Buzuluk pine forest burned down only in 1843. As a result, about 60,000 ha remained and again in 1868 another 3,600 ha burned down. However the foresters regenerated it occasionally and now it appears as a specific artificial ecosystem to the wide extend. As known, artificial forests are less resistant to damaging factors than natural ones. Now the pine forest can only exist in a so-called “managed forest” status. It’s a common biological law: no wild animal raised by a human survives going back to their natural environment. That’s why quoting Antoine de Saint-Exupéry, “You're responsible for what you have tamed”.

It's impossible to bring the Buzuluk pine forest back to the unspoiled condition using the methods that are forced into application by the ecologist and steppe experts of the mentioned institute particularly considering growing human pressure and aridization of climate. The main curse of the pine forest is not the foresters as Chibilev thinks, but a pine fingus (*Fomitopsis annosa*) – a basidiomycete and a dangerous agent of brown pocket rot in the middle part of roots that causes extensive windfalls. Foresters used to manage this trouble one way or another but today it turns this "rest zone" into a burial ground of the forest. Another curse is a pine sawyer (*Monochamus galloprovincialis*). Since even a sanitary felling and deadwood cleaning are prohibited in the "rest zone," old pine forests that used to be cut down forehand now turn into windfall timber and thus sawyer reproduction spots that also has started spreading on old by still growing woods. According to the scientific forecasts climate aridization especially on the south forest zone ultimately leads to more frequent insects epidemics and extensive mortality (Shvidenko, Shchepashchenko, 2013) and thus further debris-strewn forests.

As the result "landscape ecologist" activity passed a final death sentence on the pine forest and if this "fire pit" dished up with some oil inflames as it already happened on the European part of Russia in 2010, then a desert or in a better case-scenario a steppe beloved by Orenburg "landscape ecologists" will replace the pine forest. They are convinced steppe is more productive and is a better carbon depositor than the forests, which by the way disagree with generally known facts.

An extensive area of Scots pine determines its strong geographical changes and in consequence of which it is represented with lots of different species and subspecies, forms and mixes (Pobedinskiy, 1979). A top mountain zone in the Carpathians and the Caucasus region is often covered not with snow but with mugo pines, or mountain pines in a prostrate tree form (*P. mugo* Turra) occurring also in the mountains of middle Europe, Northern Italy and the Balkan Peninsula and was included to *Montanae* species by E. Bobrov (1978) (**Fig. 48**).

*Fig. 48. Mugo Pine (Pinus mugo Turra) in the Teberda National Park in the Caucasus (**a**) and in the Rila Planina Mountain at 1800 m A.S.L. in Bulgaria where its branches rich 20-25 cm thick and 4-5 m in heights (**b**). Photos by V. Simonenkova and S. Goroshkevich (http://росхвойные.рф/index.php?page=user&login=gorosh).*

In the Caucasus, *P. sylvestries* forms a pine subspecies (*P. sylvestris* L. ssp. *hamata* (Stev.) Fom.) that has been lately marked out as an independent species *P. hamata* D. Sosn. (Bobrov, 1978). *P. hamata* D. Sosn. is widely distributed in Crimea and in the Caucasus and reaches to the boarder of Turkey; often occurs as a single species plantation in the Kura Gorge, in the Borjomi surroundings sometimes occupying several thousand hectares (**Fig. 49**). Pine here is under 280 years old and up to 30 m in height. Together with birch trees, pine often forms a forest line as high as 2500 m A.S.L. keeping trunks straight and slim and not higher that 6-7 m (Keppen, 1885).

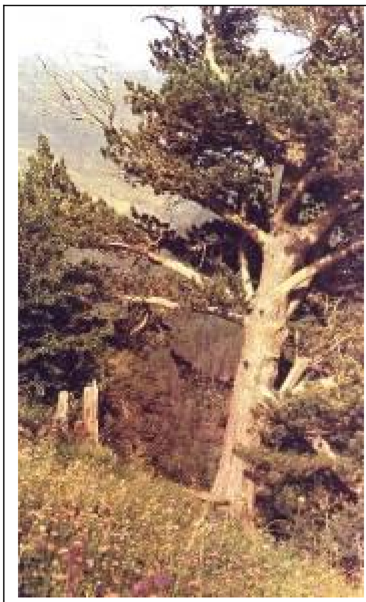


Fig. 49. Pinus hamata moutains (P. hamata D. Sosn.*) in the Caucasian biosphere reserve (Forest encyclopedia, 1985).*

Fig. 50. Umbrella pine or stone pine (P. pinea L.*) is typical element of the Mediterranean landscape and is cultivated in the Crimea and in the south Caucasus as an ornamental plant. Stone pine has an open umbrella-type crown, seeds are eatable nuts that are bigger and taste better than Siberian pine nuts (Komaskella, 2002).*

Fig. 51. One of a kind the Pitsunda pine grove (P. pithyusa Stev.*) on the the Black Sea shore in Abkhasia. Crimean Caucasian flora relict (Forest encyclopedia, 1986).*

Fig. 52. Eldar pine (P. eldarica Medv.*).*

Fig. 53. Weeping pine (P. patula Schlecht. *et.* Cham.*) on the Caucasian Black Sea shore (Forest encyclopedia, 1986).*

Fig. 54. Jack pine during the blossom season in the Komsomol Park in Vladikavkaz, North Ossetia (Gabeyev, Olisayev, 2004).

Two other species of pine - Pitsunda pine (*P. pithyusa* Stev.) and Eldar pine (*P. eldarica* Medv.) are characterized with a local distribution in the Caucasus; the first one occurs in the lower alpine of the Greater Caucasus Mountain Range along the Black Sea coast line, the second one distribute in the lower alpine of the Eastern Transcaucasia on Eliar-Oug Mountain. Both species refers to the specially protected plant group. E. Bobrov (1978) included Pitsunda pine that is also known as Corsican pine (*P. brutia* Ten.) to *Halepenses* subdivision. The spreading crown of the Pitsunda pine bares similarity to the crow shape of the umbrella pines (**Fig. 50**). There is only the large Pitsunda pine grove on the Pitsunda cape where it grows well on the sandy seashore (**Fig. 51**).

The Eldar pine (*P. eldarica* Medv.) is a distinct xerophyte and grows as an open stand on stiff slopes on stony soil with clayey sand. It's a beautiful relatively tall tree reaching 15-20 meters tall with a wide slightly spreading crown and a trunk diameter up to 60 cm, covered with a thick (up to 20 cm) grey-orange bark **(Fig. 52**). An extensive root system penetrates up to 4 meters deep into sandy soil cracks (Tkachenko, 1939).

Another morphology wise very elegant species is Patula pine or Weeping pine (*P. patula* Schlecht. *et* Cham.), native to Northern America, grows on the Black Sea coast close to Sochi and Sukhumi. The tree is 15-20 meters tall with wide light crown with light green hanging needle-foliage (F**ig. 53**).

Jack pine (*P. banksiana* Lamb.) naturally growing in Canada and forming pine forest on poor sandy soils is often used for the urban greening in the south of Russia. A tree is up to 25 meters tall and the trunk often branching by the base. It is also cultivated in the south of Russia, Ukraine and Belarus. Its cultivation is more practical in the forest zone of the European part of Russia on the poorer sandy soils inadaptable even for Scots pine (Kachalov, 1970). It has high decorative characteristics and has been used during park and green constructions (**Fig. 54**).

Crimean pine (*P. pallasiana* D. Don) grows in Crimea, on the Balkans and in Asia Minor (**Fig. 55**). The species has about 20 synonyms (Kovaleva, 1999) and was included into the *Nigrae* species classification by Bobrov (1978). In Crimea, this species prefers the southern slopes and ranges from the lower limits of the beech belt to 900-1000 meters, in the Caucasian Mineralnye Vody region (Kislovodsk, Pyatigorsk) forests distribute up to 1500 meters. F. Arnold (1898) characterized it as a huge tree 35 meter tall and diameter of 1.5 meter wide reaching up to 600 years of age, and according to Keppen (1885) "this tree grows not so much in height as getting thicker forming a spreading and with age a perfectly doming top" (p.187). In the Caucasus Crimean pine needle-foliage last up to 5 years on 1200 meters A.S.L. and up to 4 year on 1500 meters.

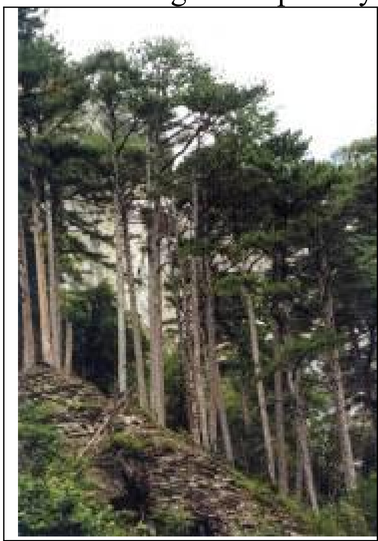


Fig. 55. Crimean pine (P. pallasiana D. Don) on the Crimea yayla at 700 meters A.S.L. (Sannikov and others, 2004).

Fig. 56. Aleppo pine (P. halepensis Mill.) in the Mediterranean region (https://ru.wikipedia.org/wiki/Сосна_алепская#/media/File:Pino_secolare_-_Castelleone_di_Suasa.JPG).

Fig. 57. Maritime pine (P. pinaster Sol.) in Montenegro (http://www.plantarium.ru/page/image/id/216163.html).

The needle biomass of the Crimean pine forests is twice size of the same index of the hamata pine ones (Kovaleva, 1999). Occasionally the Crimean pine together with the Hamata pine forms an upper forest line and small groves in the northern regions of the Black Sea coast where also the Pitsunda pine is present. The Aleppo pine (*P. halepensis* Mill.) falls into the same group in the Mediterranean region that reaches up to 14 meters in height and 0.5 meter diameter (Keppen, 1885) (**Fig. 56**).

Maritime pine (*P. pinaster* Sol.) is distributed on the Mediterranean Sea coast in Portugal, Spain and in the south-west of France that relates to fast-growing species: by 10 years of age it can reach up to 4 meters in height (**Fig. 57**). It prefers loose deep soils; it grows well on light greensand, establishes itself deep and likes an open position. The needle length and cone size are the largest among other European pines (Ovsyannikov, 1934).

In Japan, the Japanese red pine (*P. densiflora* Sieb. *et* Zucc.) is most common and it was included in the *Sinenenses* sequence by Bobrov (1978). The tree resembling Scots pine has a red-brown scaly bark and bare grey-brown shoots, reaches 36 meters in height; prefers clayey soils however, grows on any ground except boggy soils from the south of Hokkaido to the southernmost tip of Kyushu (**Fig. 58**). It is a light depended species, prefers dry high lands, the optimum altitudinal belt for it is 2000 meter A.S.L. The Japanese black pine (*P. thunbergii* Parl.) grows on the Shikoku, Kyushu and Honshu islands which relates to the European black pine; this tree is up to 40 meters tall and prefers sandy coasts (Ovsyannikov, 1934) (**Fig. 59**).

Fig. 58. Japanese red pine (P. densiflora Sieb. *et* Zucc.*) (http://pitomniki.su/index.php?option=com_pitomnik&task=photo&id=56&file=Pinus_densiflora.jpg&Itemid=69).*

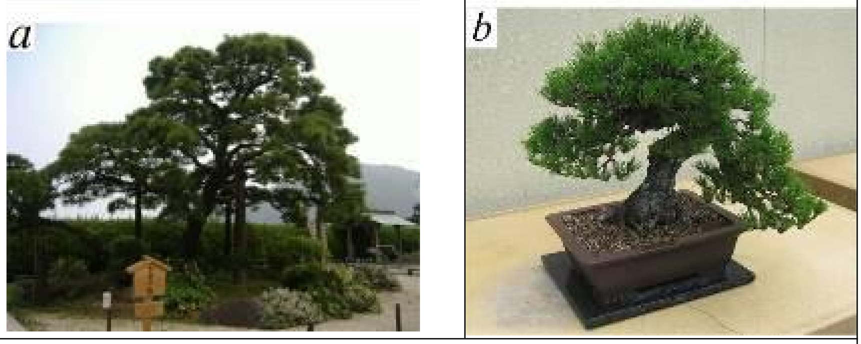


Fig. 59. Japanese black pine (P. thunbergii Parl.*) **(a)** (http://upload.wikimedia.org/wikipedia/commons/8/86/Omiya_no_Matsu.JPG?uselang=ru) and Japanese black pine bonsai **(b)** (http://pitomniki.su/index.php?option=com_pitomnik&task=viewtree&id=57).*

Pinus funebris Kom. or tomb, cemetery or funeral pine grows in the south of Primorye and the Far East (**Fig. 60**). It got the name due to its cultivation in cemeteries in North Korea. It is one of the hybrid forms of Japanese red pine (*P. densiflora)* and Scots pine. The most common *Pinus* species in China is Chinese pine (*P. tabulaeformis* Carr.) (**Fig. 61**) and its characteristic feature is a propensity to hybridization with other species (Bobrov, 1978).

Fig. 60. Pinus funebris Kom. *in Primorye (Forest encyclopedia, 1986).*

Fig. 61. Chinese pine (P. tabulaeformis Carr.*) (http://www.plantphoto.cn/tu/166716).*

Coming back to Scots pine we can summarize that its “Cinderella” status as being everywhere supplanted by other species from the best Eurasia habitat resulted in a situation that it can successfully grow under the conditions where other wood species and sometimes even some grass and shrub species cannot (**Fig. 62 and 63**). As a result it is widely spread on large territories and is only second after larch by this index. Due to the drastic cut of the agricultural land usage in the last decades, pine intensively spreads to the old arable lands throughout Russia (**Fig. 64**).

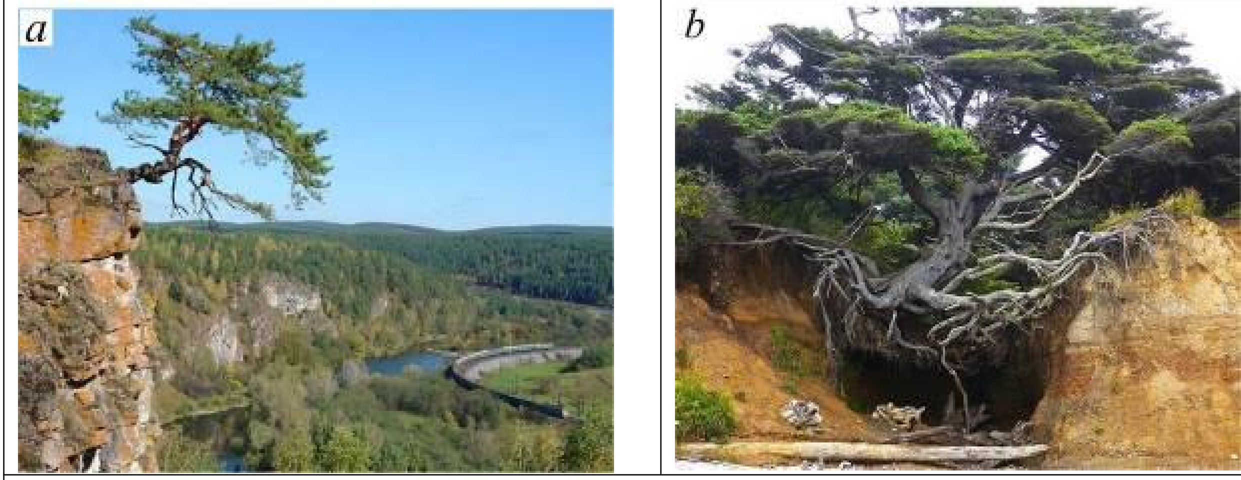


*Fig. 62. Love for life: "On a rugged cliff, the very edge, above the endless chasm…" (Vladimir Vysotskiy); (**a**): Photo by A. Selyunin; **b**: "the tree of life" in the Olympic National Park (Washington State, USA).*

Fig. 63. Nature mistake? Baikal Biosphere Nature Park. Photo by L. Agafonov.

Fig. 64. Scots pine spreads to unused old arable lands. Chelyabinsk region, Dzhabyk-Karagay pine forest, Annensk forestry farm, section 110, polygon 14. Photo by L. Atkina, 2002.

During the phylogenetic process, pine has adapted to the extreme growth conditions both on the northern and southern area line. A low warmth requirement in the sub tundra zone explains adapting compensation of warmth deficit to enhanced light absorption and also high root absorption activities. On the south line pine makes up the deficiency in water and nutrients by an extreme intensive development of root-ends that weight wise are equal to 65-82% of the root system (Usoltsev, 1988). Moreover Scots pine is one the most commercial valuable species. The combination of pine unpretentiousness to the site conditions, relatively fast growth, large trunk timber stock and high stem volume per ha is the reason why 40% of the total annual forest planting works on the land of 800,000 hectare accounts for Scots pine (Forests of Russia…, 2006).

However pine plantations often get damaged by elks (**Fig. 65**). Intensive conifer storage on the large lands is followed with the regeneration of cutover stands with young larch stands that serve as an appealing elk feed and stimulates an elk population growth. If a pine is planted in this kind of land then young plantings of 0.5–2.0 meter tall are completely or partially damaged by elks. There is a conflict of interests between foresters and hunters. A mature elk eats about 20 kg of woody forage young bark per day. Within the elk population, pine has different appealing levels among species: it makes up 83 % in a male elk diet and 26-40% in a female elk diet (Galako and other, 1994).

Fig. 65. Elk (Alces alces) in young pine plantations of Naurzum pine forest. A summer walk to the winter "memorable" places. Photo by Bragin (Bragin, Bragina, 2006).

Elks do not eat pine in summer; foliage is enough for them. Although pine is not the best feed for elks, during snowy winters when animal activity decreases and grass and bushes are out of reach, young pine plantations become almost the only source of feed. There is a high number of rich fresh shoots in young plantations and they usually are range on open fields that allows animals to get a better overlook and see the danger in time. That's why in thin plantings trees get damaged by elks twice more than in thick plantings. Spruce is not good for feeding and elks don't touch 50/50 mixed plantations of pine and spruce at all (Galako and other, 1994).

Elks are concentrated on those parts of forests where they are bothered less. In winter trying to hide from hunters, elks seek safety in nature parks and reserves and the number of "migrants" skyrockets. Certainly there is not enough feed and if there are young pine plantations then they are completely devastated. If there is no feed left then elks under the stress of fear stay in place until they exhaust the option of choosing to die of hunger rather than getting killed outside of the protected area (Adamovich, Vatolin, 1973).

Coming down to the young pine plantation site elks choose, each line of trees move alongside of it till the end carefully gnawing the upper part of each tree. Usually the tree line rehabilitates from lateral branches and under certain external influence/environment they build up strange looking "dancing" groves with age (**Fig. 66**).

Fig. 66. “Dancing” pine forest planted in 1960 in the National Park “Curonian Spit” outside Kaliningrad city ***(a, b)*** *(http://oxablogg.blogspot.co.il/) and in Gryfino, west Poland* ***(c)*** *(http://www.fcw.su/blogs/vsjakaja-vsjachina/-krivoi-les-v-polshe.html).*

Despite the relatively low air and industrial pollution resistance of pine it’s widely used in urban greening and different kinds of protective belts. Mamaev emphasizes the importance of conifer use for greening, including pine in order to create a modern city landscape. Mamaev’s study (1983) focuses on outlook evaluation of Scots pine and other conifers in urban greening and reveals all pros and cons of our pine cultivation in cities and urban forests.

Probably many of you noticed unusual constructions on tree crowns that look like huge balls or nests. They are popularly call witches’ brooms (**Fig. 67**). In the old days people either enchanted them or were scared of them or used them as a protective amulet. It was thought it was witches or evil spirits’ tricks: they fly around forests and bewitch trees and their future “transport” starts growing on them.

Fig. 67. “Witch’s broom” on a Scots pine (http://commons.wikimedia.org/wiki/ File: Zmiany_niepasozytnicze_pinus_sylvestris_ beentree.jpg?uselang=ru).

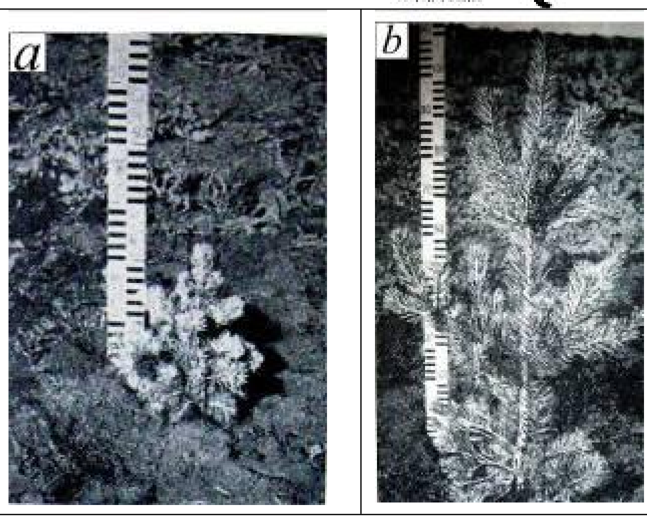


Fig. 68. “Witch’s offspings” at the age of 8 sprouted of “witche’s broom” seeds of a parent tree; ***a*** *– “broom” gene type, 24 cm tall;* ***b*** *– normal type, 152 cm tall (Shulga, 1979).*

Drastic changes of branching structure within a crown in the form of tight short shoots accumulation occurs in many conifers. The question of their origin still stays unknown. There are at least two most common explanations. The first one refers to different kinds of rust fungi infections and the second one relates to a mutative nature (Vanin, 1955; Noskov, Negrutskiy, 1956; Khirov, 1973; Shulga, 1979; Yamburov, Goroshkevich, 2007).

Following the second version the off springs sprouted from "witch's broom" seeds were studied. The offspring splits into "broom gene" (scrubby and heavy branched) and normal species (**Fig. 68**) which confirms the mutative nature of the phenomenon. However the share of the first ones ranges: 30, 39, 45 and 100% (according to Khirov, 1979; Noskov, Negrutskiy, 1956; Samofal, 1940 respectively) that's why genetic interpretation is not defined (Yamburov, Goroshkevich, 2007). According to the professor B. Chadov, "phenotype "witch's broom" has a genetic nature and occasionally occurs as a somatic mutation" that can be inherited but doesn't have whole penetrance and can relate to the mutation category of regulatory gene, i.e. development controlling genes.

Fig. 69. "Witch's" offspring at the age of 40 (3 meters tall) in the park of the Kazakh Forestry Research Institute (Shchuchinsk, Kazakhstan): "witch's broom" of a parent tree, grafted to a normal type pine transplant; the grafting spot is visible (Photo by V. Usoltsev).

Fig. 70. "Witch's" offspring at the age of 40 (about 4 meters tall) sprouted from a witch's broom seed of a parent tree in The Botanical Garden of URAS (Photo by V. Usoltsev).

Both "witches' broom" pieces graft to normal pine stocks (**Fig. 69**) and a tree sprouted from which "broom's seeds" (**Fig. 70**) keep a specific shape of a crown by damped growth and reproduction abilities (**Fig. 71**). The dwarf form of Scots pine with a close oval low falling, short needles and tiny cones crown occurs on the south of the Scots pine area under harsh arid conditions of the central and southern Kazakh Upland, ribbon and insular pine forests of Northern Kazakhstan, on the rocky outcroppings of the Shirinsky steppe in Khakassia; it's half as short as the other species of the same age and ground phytomass and needle volume is 16-17 times smaller (Shulga, 1979; Tikhonova, 2013). By seed propagation, 43% of plants keep this feature. By vegetation propagation using grafting, the results are similar to the ones of "witches' broom" piece grafting, i.e. the crown of a specific shape and damped growth.

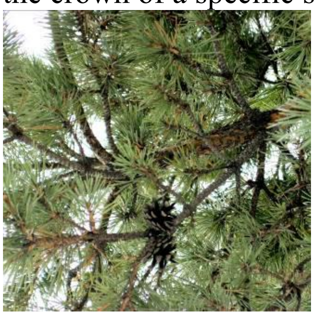


Fig. 71. Generative organs in the "witch's offspring" crown in the Botanical Garden of URAS (Photo by V. Usoltsev).

A unique and original shape of these pines makes them look decorative and that can be used for selective programs, landscape design and urban greening purposes (**fig. 72**).

		*Fig. 72. DendroArt: Graftings of scots pine witch's broom (**a**) and mountain pine (**b**) (http://www.wildlife.by/node/162).*

3. Spruce (the genus *Picea* Dietr.) – its geography and biology puzzles

As it follows from the feature description of larch in Chapter 1, all of the puzzles of one or another plant relate to insufficient information about it and as a result the contradictory of both observed facts and their interpretation. Such kind of ideas and a learning process as a whole has a historical nature. For example, we first learned about a unique desert tree saxaul (a present name of *Haloxylon* Bunge genus) from the first corresponding member of the Saint Petersburg Academy of Science P. Rychkov from Orenburg in 1762 (Drobov, 1921). Later in 1786 Falk mentioned it (Litvinov, 1913) using an absurd name *Pinus orientalis*: he took sick "shortened" branches of the saxaul that shape-wise resembled cones of conifers as real cones. 38 years later Eversmann defined this genus as *Tamarix* and later in three more years, K. Mayer first gave an accurate description under *Anabasis Ammodendron*. Later Bunge referred it first to the *Arthrophytum*genus and only later to *Haloxylon* genus. Finally in 1913 Litvinov singled out three independent species in *Haloxylon* the genus, and there are five of them today.

The genus *Picea* Dietr. includes about 45 species however, a relatively intensive hybridization complicates even their simple description. Usually Meyer's classification scheme is applied, which splits the genus into three sections – *Morinda, Casicta* and *Omorica* (Bobrov, 1978). There are several theories related to the place of origin of the genus. The mountain theory supposes the origin of *Picea* genus in the mountain conditions during the Tertiary (Tolmachev, 1954; Orlov, 1955).

According to Nat (1915), the conifers appeared in the Middle Urals region when "orogenic processes caused a split-off of the Ural Island among the Jurassic see" (p. 542). In the late Jurassic period spruce forests took a dominant position/ascendant among conifers, well after pine comes into existence and even later the Siberian pine. They occupied slowly the Ural slopes and the entire Transural region that were gradually reviling from the sea.

European spruce forests survived the Ice Age in the Alps and the Carpathians and have distributed from there after the glacial retreat. The isolation of the *Picea* genus in several refugiums determined/conditioned its gradual differentiation. At the end of the Pliocene, the east margin of the Eurasian continent crept by 2000-3000 m and it led to the East Asian spruce differentiation (Bobrov, 1978).

During the Ice Age in Siberia, the Siberian spruce (P. *obovata* Ldb.) survived in the Altay-Sayans "refuge" and after the retreat of a glacier it spread to the west towards the common spruce migration (*P. abies* (L.) Karst.) and later their hybrid mixture started (Alekhin et al., 1961; Bobrov, 1978). The most common hybrid today is *P. × fennica* Rgl., that is distributed in Finland, Sweden and Norway and also to the east of the 30th longitude in the European part of Russia. According to Bobrov's observations, (1978) the hybrid process takes place on the Far East between *P. obovata* and *P. jezoensis* and towards the south between P. *jezoensis* and *P. koraiensis* Nakai.

Common spruce (*P. abies* (L.) Karst.), Siberian spruce (*P. obovata* Ldb.), oriental spruce (*P. orientalis* (L.) Link), Schrenk's spruce (*P. schrenkiana* F. *et* M.) and Ajan spruce (*P. jezoensis* (Siebold & Zucc.) Carrière) are the most distributed in Eurasia (**Fig. 73**). The common spruce area is fragmented and set before with three local areas – Alpine, Carpathian and Baltic ones that independently developed in the postglacial time (Il'inskiy, 1937). Distribution of common spruce to the south of the Western Europe and almost to the Arctic Ocean shows that its climate dependence has a wide range. It is frost-resistant but sensitive to high temperatures and air aridity. A lateral root system conditions signify a soil moisture dependence. Spruce is characterized with high shade tolerance; needle longevity reaches from 5-7 years in the mid taiga subzone and up to 12-18 years in the Khibiny forest tundra.

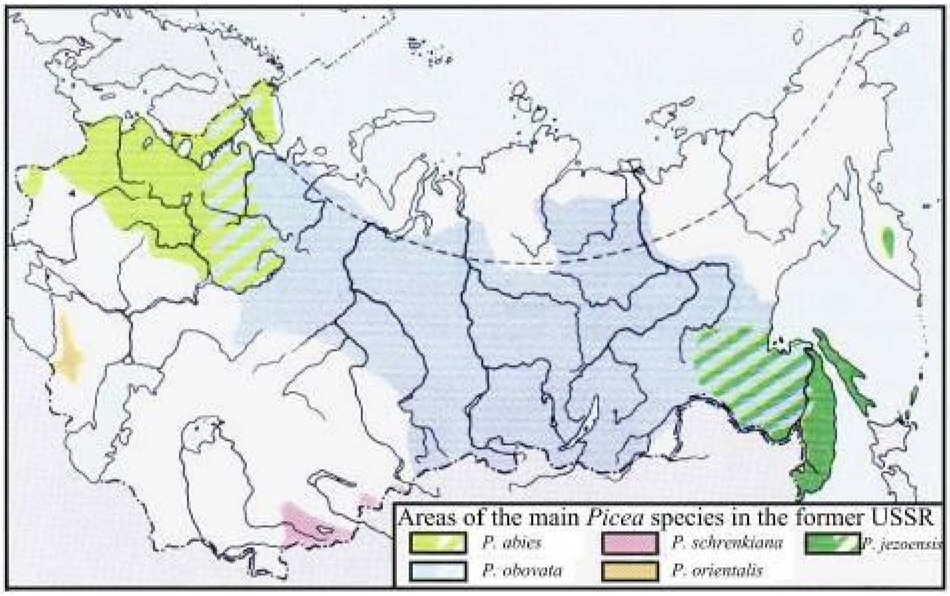


Fig. 73. Areas of the main spruce species in the former USSR (Forest Encyclopedia, 1985).

In the undisturbed forests, common spruce was a very sustaining tree – in the Bohemian Forest spruces were often up to 500 years old and in 1832 a 1200 year old spruce was discovered in Piedmont. In 1879 a fairly healthy 1029 year old spruce was found in Finland however generally spruce trees in the south of Finland are no older than 130-150 years (Keppen, 1885).

If in Western Europe common spruce reaches up to 50 meters in height and 2 meters in diameter, then eastward its height expectedly gets shorter and already in the European part of Russia it is only 30 meters tall (Sukachev, 1938). By biological characteristics is resembles the Siberian spruce (**Fig. 74, 75**).

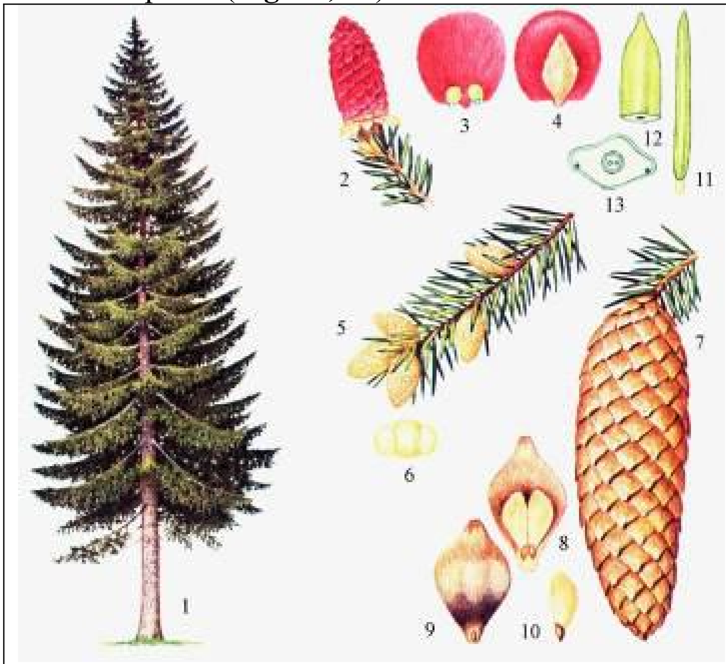


Fig. 74. Common spruce (Picea abies (L.) Karst.*): 1 – general view; 2 – macrostrobile; 3 – a cover scale and two seed buds; 4 – seed and cover scale; 5 – microstrobile; 6 – pollen; 7 – a mature cone; 8 – seed scale and two mature seeds; 9 – seed and cover scale of a mature cone, external view; 10 – a mature seed; 11 –a needle; 12 – needle top; 13 – a needle crosswise cut (Forest Encyclopedia, 1985).*

Fig. 75. Abudant seed production of common spruce. Photo by A. Tarko.

On the north-east territories of the European part of Russia in the 19th century, closed spruce forest were primarily of pristine status and had absolutely poor species composition and ground vegetation represented with a thick layer of moss (Keppen, 1885; Nesterov, 1887; Arnold, 1898; Sochava, 1930). Tyulina (1922) gives the following characteristic to the pristine sustainable spruce forest of the mid-taiga subzone near the Pinyug village of the Kirovsk region (what Dyrenkov (1984) later called spontaneous taiga): “Dark forest canopy is extremely monotone on long ranges, … a solid thick moss blanket. Ground surface is often piled with rotting detritus heavily clothed in spruce regrowth; steady regrowth grows crossing in all the directions gave a unique image to this back forests” (p. 162).

Nat (1915) called the pristine spruce forests of the northern taiga Cis-Ural region on the western slope of the Urals foot hill located east of the Pechora river “Great Parma”. He characterizes it as “a stable type and permanently associated with the occupied soils perhaps during the whole geological age periods” (p. 556). The moss carpet here is unbelievably thick (up to 80 cm), a “natural represser,” but at the same time it is a “huge moisture condenser”. It is impossible to for a spruce seedling to break through its thickness and “the regeneration takes place only on the old felt with the wind tree trunks or on the reached over the moss carpet stumps” (p. 557). A distinctive feature of “parma” life is a total oppression. That’s why it is always a single species forest with any addition of light dependent species. The stand volume is no more than 130-180 cubic meters per hectare.

Keppen (1885) writes the spruce forest “harsh nature” growing “in the true spruce motherland” of the Ural Mountain Range and describes them as a “proper spruce forest, the most wild and lonely” (p. 299) that occupy the deepest humid mountain regions. N. Nesterov (1887) gives the following characteristic to the old-growth forest of the western Ural mountain slope along the Nizhnie Sergi – Mikhaylovsk – Nizhniy Ufaley line: “Spruce is a typical species in these regions; it occupies a large space, covers the mountains, fills valleys and gills. Thick spruce forests occur also on bogs and mountain tops. Spruce is primarily a mountain tree however, here it is often accompanied with larch and the higher you go the more you find the latter in the forest composition; and on the very mountain tops, larch is already dominating over spruce species” (p. 707).

Spruce as a “natural tyrant” in the limits of a spontaneous dark coniferous Ural taiga shows an intensive expansion to the idle lands including urban territories. A unique alley, called Rest Street, that connects the residential areas of Nizhnie Sergy town (Ekaterinburg region) and Nizhnie Sergi Sanatorium, was opened through the pristine spruce and fir forest. Today, the metal tower structures that were put up alongside of the street represent a special “opposition arena” of the wild nature to urbanization pressure where the forest tries to win temporally lost dominant positions back (**Fig. 76**). The opposition goes with varied success (**Fig. 77**). However, as soon as people drop back nature takes its course… (**Fig. 78 and 79**).

The phenomenon of a spruce terminal shoot growth inhibition with electric waves of a power transmission line stands out in the mentioned “opposition alley” (**fig. 72**). It’s well known that we live and function in the broad and complex energy ocean: as a consequence of the biochemical processes, growing tissues radiate ultraviolet light (Gurvich, 1944). This radiation becomes “visible” in the induced high frequency field and that allows it to get its photo image (V. Kirlian, S. Kirlian, 1964).

Marchenko’s (1976) experiments confirmed that biofields of different tree species do not recognize each other. It turns out that the foliage biofield of our tender white birch, a poetic symbol of Russia, impresses the prickly needles by 4 N (**Fig. 73 and 74**). Foresters account for the known needle “blow-off” effect under surrounding decidious species impact for its mechanic “whipping”. It is hard to imagine and yet how tender birch foliage can whip a bristle spruce or pine if anything.

Fig. 76. Opposition alley. Photo by V. Usoltsev.

Fig. 77. Cut spruces that settled down among the towers and endangering the high tension lines. They gave place to young optimists. Photo by V. Usoltsev.

Fig. 78. Pripyat city 25 years after the Chernobyl tragedy (http://pripyat.at.ua/photo/pripyat_city_volk/1-0-121)

Fig. 79. Chernobyl radioactive wolfs. The world largest population of wolfs has formed in Chernobyl zone. (http://chornobyl.in.ua/radioaktivnye-volki-chernobylia.html) (http://nwn.su/pripyat/)

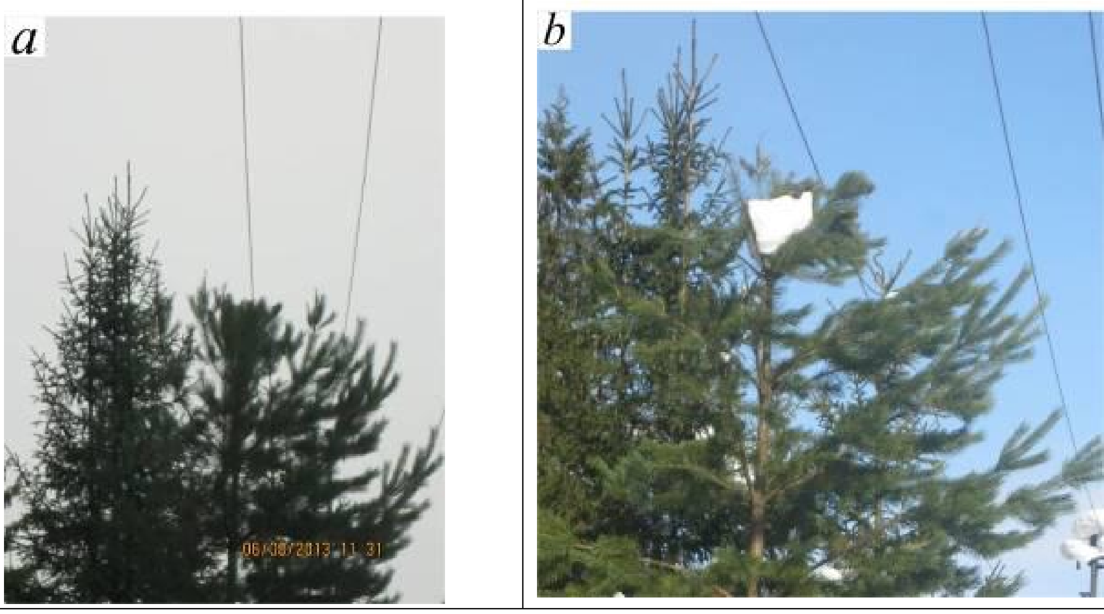


*Fig. 80. Growth inhibition of a spruce leading shoot (middle) with the electromagnetic field of the power line as the result of its repulsive impact on spruce biofield: in summer (**a**); in winter (**b**). As the result of leading shoot growth inhibition the tree top assumed a spherical shape; snow piles on it in winter. Photo by V. Usoltsev.*

Fig. 81. Changed structure and shape of spruce bioelectrical field that was registered on Marchenko's photo plate (1976) with the use of balanced output generator by V. Kirlian and S. Kirlian's procedure (1964).

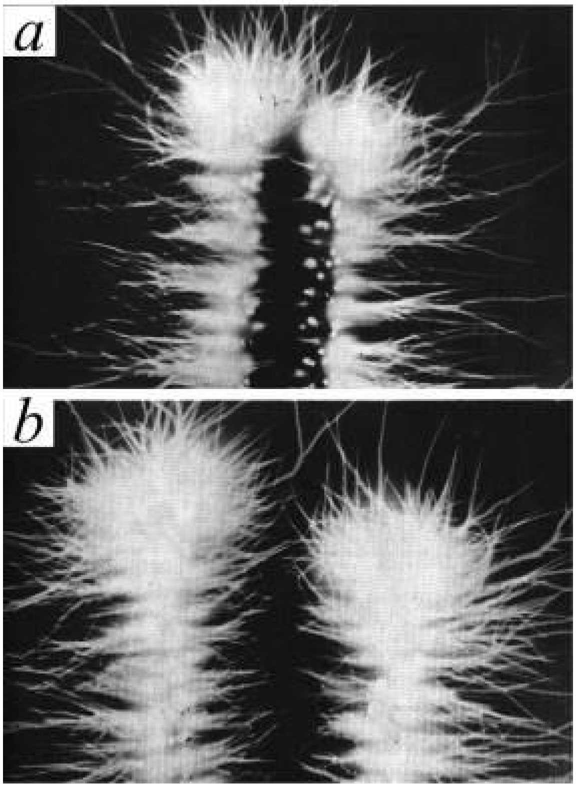


*Fig. 82. Birch biofield shapes: closely-spaced shoots (**a**) and after drawing them apart (**b**) (Marchenko, 1976). A single tree bio field fades with the distance from a trunk and biofield of closely growing trees bounce off, forcing tree trunks to separate to a certain distance so a "peaceful equilibrium" is reached between them.*

There is a similar situation on the central sanatorium alley: the birch "blew off" needle-foliage of the closely growing spruce so that the top part of spruce crown is almost bare. However the spruce is clinging to life, there is still hope to survive because terminal shootbuds remain (**Fig. 83**).

Common spruce doesn't distribute in the mid-taiga of the European part of Russia, but instead only on sandy soils and sometimes on bogs. North to the northern taiga subzone and then to forest tundra, spruce role in the cover canopy composition changes. The space where it is absent is getting bigger and its dominance in the stands over other tree species becomes less full. The tree size decreases and its growth slows down. In the forest tundra itself, spruce takes clearly a more selective habitat position choosing windproof and well warmed spots. By the north area line, spruces occupy a miniscule space in the local favorable conditions and, also integrated in the surrounding tundra, affiliate to the sunny slopes (Tolmachev, 1962).

*Fig. 83. "Blow-off" of spruce needle under nearby birch biofield influence (**a** – in summer; **b** – in winter). In the winter time without experiencing any pressure from the bare birch tree the spruce leading shoot is straightened. Photo by V. Usoltsev.*

In the European part of Russia, towards the north, the spruce seed productivity isdecreasing but along with that the share of buds damaged by plant pests also decreasing: in the middle taiga – 39-88%; in the north – 19-28% and in the forest tundra – 5%. The abundance and species composition of the parasitic fungi and the spruce forest related to them stand defectiveness drops with the same progression (Chertovskoy, 1978).

Proceeding to the southern distribution line, the spruce role in the vegetation composition gets smaller. Then the cutback of viability appears (decrease of age limit and seed productivity). Spruce transfers to the colder habitat (northern slopes) showing also here a strictly selective attitude towards to the particular conditions, but quite the opposite of the one that can be noted on the northern area margin (Tolmachev, 1962). The description of the only spruce occurrence in Obshchiy Syrt by F. Simon (1910), is a distinctive confirmation of what was mentioned above. Here, far beyond the area, among chalky sheer cliffs and gorges, a good quality spruce stands with a continuous moss carpet occupies a smooth northern slope. There are "only sad looking pine and birch trees out all the tree species in the hard limestone gorges" on the rest of the territory (Simon, 1910. P. 1124).

In the north of Belarus, a common spruce is a dominant species however, the Belarus Polesye is located outside of a spruce continuous distribution and spruce stands have a forest outlier nature here. During the glacial retirement, Polesye was represented as a gigantic plavni that became the reason of the late distribution of spruce here. According to Polyanskaya (1931), these spruce outliers lasted until at least the beginning of the 20th century, not the remains of spruce shrinking area but the outpost of its spread. However since 1960s due to the climate aridization, spruce area shifts to the north and the Belavezha spruce forests come out of their ecological niche which caused their degradation, massive dying-off and secondary pest spread (Rodin, 2005).

Productivity degradation in the northern direction is also applied to the Siberian spruce: along the Ural longitude its site index declines from I-II in the South Urals to V and lower on the

Near-Polar Urals (Mamaev, 1973). Along the Ural Mountain Range, spruce in the dark coniferous taiga composition rises up the upper line from 400-500 meters in the Northern Urals to 900-1000 meters in the Middle Urals (Denezhkin Stone and Konzhakovsky Stone) and further up to 1300 meters in the South Urals (the Yamantau and Iremel Mountain tops) (Sochava, 1956). However, spruce single species forests on the upper line primarily occur only in the South Urals and in the southern part of the North Urals. Wells developed and regenerated spruce forest block at the age of 100 years, 30 meter tall and with the average trunk diameter of 45 cm occurred in the southern Trans-Urals (around 55°30' N, 61°E) on slightly bleached fresh light clayey loams layered with lake marl. Tyulina (1929) thinks these spruce forests are growing far beyond of their continuous area as the relicts of cold and humid ice age.

A geographical grade of assimilative and generative organ size of the Siberian spruce is determined in the Urals: needle length in forest steppe is 12-14 mm, in the south taiga (Tavda, Yekaterinburg Region, 58°30'N) it grows to 14.6 mm and then to the north it gradually goes down to 13 mm in the mid-taiga, to 12-13 mm in the north taiga and to 11-12 mm in pre-forest tundra forests (Tyumen region, 67 ° 30' N). Respectively the cone size changes: from 55-60 mm on Magnitogorsk latitude to 75-77 mm in the south taiga and there is a following decrease to 55 mm in the Usa River basin (Mamaev, 1973). East from the Urals Siberian spruce spreads from the north along the Siberian river sides (**Fig. 84**).

Fig. 84. Siberian spruce on the Lena riversides. Photo by Ryabkov.

Eastern spruce (*P. orientalis* (L) Link) as a representative of *Picea* genus in the Caucasus is an endemic (**Fig. 85**). Eastern spruce belongs to the early species that has existed in Western Europe during the Cretaceous period (Keppen, 1885). Dark conifers reached a wide spread in the Caucasus under the climate cooling conditions although they were distributed there earlier, in the Tertiary period. Biologically, the Eastern spruce in the Caucasus resembles a common spruce. Having found its way into the eastern Caucasus during the climate-favorable period of the last glacierezation, the Eastern spruce was found to be on the very east of the area, in the unnatural area for it conditions due to the post-glacial climate change. In dry years it doesn’t only suffer from drought but also gets attached by bark beetle (*Ips sexdentatus* Boern.) that brings no harm to the common spruce in the north (Dolukhanov, 1940).

Fig. 85. Eastern spruce (P. orientalis (L) Link*).*

The Eastern spruce is purely a mountain tree and lives for up to 500-560 years. Growing stick in spruce forests is up to 2600 m^3/ha however, average value gets to 800-1000 m^3/ha (Keppen, 1885; Orlov, 1951). This species is typical for the western part of the Caucasus Isthmus and on the south-west it reached to Turkey.

Eastern spruce occupies the most favorable area, for it is in the middle of the altitudinal belt in the north-west Caucasus (1100-1600 m). High summer temperatures and poor rainfall prevent its spread to the low-hill terrains and a short vegetation season and thick (up to several meters) snow coat doesn't allow the spruce to extend upslope. Single spruce forest rarely occur here, usually spruce grows here as a mix with Caucasian fir that dominates in terms pf area. The maximum age of 560 years of the eastern spruce was registered on the Pakhvova River terrace (the Malaya Laba river basin). That tree was 65 meters tall and 1.9 meter in diameter (http://alanles.ru/dolgovechnost-derevev.html). High height and productivity of the dark conifers in Caucasus are related not as much to high intensity as to enhance growth time by I*a*-I*b* site indices. Unlike lowland spruce forests of European Russia where growth in height stops by 160-180 years, and in Caucasus spruces of that age keep actively growing (Orlov, 1951).

Another representative of *Picea* genus Schrenk's spruce or Asian spruce (*P. schrenkiana* F. *et* M.) (**Fig. 86**) in the Tian Shan Mountains is an endemic. Schrenk's spruce is a massive well-shaped tree with thick narrow cylindrical or conical shape crown that under the better conditions reaches up to 50 meters in height and 2 meter trunk diameter; the distinctive features are a significant crown density, poor self-pruning even in closed stands and high needle longevity of 20-25 years. Although the areas are adjoined, the Schrenk's spruce differs from the common spruce with longer needles (20-40 mm) with wax coating, heavier seed weight and in other bio-ecological ways (Gan, 1970). Here is Yuriy Linnik's characteristic of Schrenk's spruce (2015): "Tian Shan endemic going high into the mountains as if it gets away from the gravity power and that reflects in its proportions: it seems that angles becomes sharper and the outlines are more gothic. That's the way it should to be according to Newton's formula!" (p. 210).

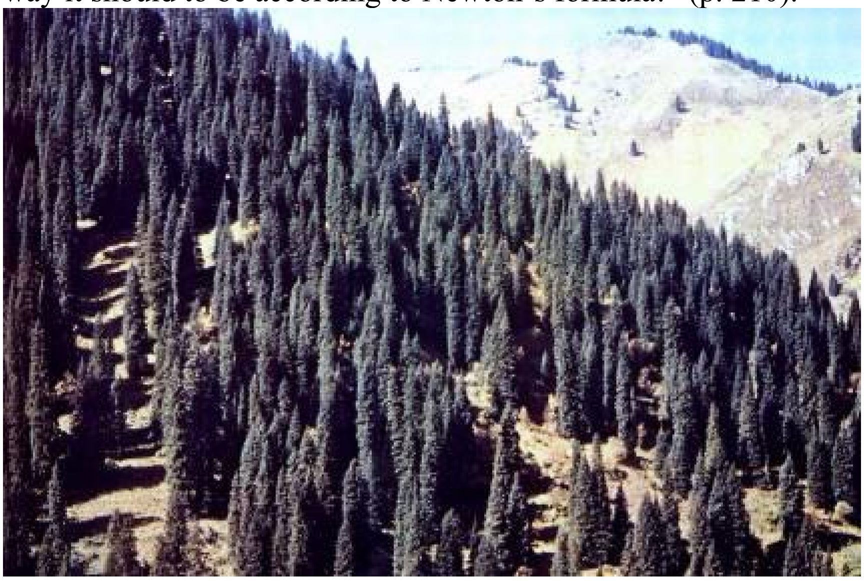


Fig. 86. Columnar crowns of mountain species of Schrenk's spruce (P. schrenkiana F. et M.), Tian Shan (Jenik, 1987).

Shrenk's spruce growing conditions are starkly different from the growing condition of all the other species of Northern Eurasia. Annual rainfall is from 230 to 730 mm and 75% of it accrues for winter and spring time. Due to the rare rainfall in the summer, growing conditions are close to semi desert. The rainfall amount correlates with the altitudinal zonality and rises with the elevation increase. An average annual precipitation on the Terskey Alatau range at a 1770, 2040 and 2550 height are 497, 676 and 717 mm respectively and humidity factors are 0.46; 0.75 and 1.13 (Chernykh, 1985). Due to the dry climate, the snowline goes on 3400-3500m high, which is 1000 m higher than on Altay Mountains (Gudochkin, Chaban, 1958; Alekhin and other, 1961; Bayzakov et al., 1996).

The Tian Shan spruce forests occupy almost specifically the northern slopes, and are limited to flowing cloughs, broken and have a park-like nature. As the result, the grass community is well developed there and this forest grows according to the I-II site index. Spruce forests with moss carpet at 1600-2600 meter elevation that belong to the III-IV site index are also typical for the

Kungey Alatau Range although they are distributed less there. In the Dzhungarsk Alatau Range, dry rocky spruce stands at the V-Va site index and have been forming on slopes with a 35 ° -40 ° inclination at a 1700-2400 meter elevation. Schrenk's spruce "krummholz" are usually typical for the timberline in the Tian Shan Mountains. A quite rare prostate form of Schrenk's spruce occurs in the subalpine belt of the Zailiyskiy Alatau, Terskey Alatau and Kungey Alatau Ranges.

Ajan spruce (*Picea jezoensis*) is one of the main forest forming species of the Far East (**Fig. 87**). As some other *Picea* species, it has a lateral root system and that's why it is very sensitive to the moisture stress in dry seasons, which is one of the reasons why premature spruce stand are dying-off. It is a slender beautiful 40-50 metes tall tree. The crown has a right conical peaked shape. The trunk is straight, covered with dark gray bark, almost smooth early in life and with flaky roundish chips at the old age. Shoots are light dun or a yellow-green color. It is easily distinguished from the other species by its flat 2 cm long needles. It is distributed on mountain slopes with other species at 400-1200 m A.S.L. elevations. Mostly it forms mixed stands. Genealogically, Ajan spruce is a very old species. In North America and the Balkans, spruce species belonging to the *Omorica* species like the Ajan spruce are found and are very similar to it. Ajan spruce can be named as on the oldest species of the Primorye flora.

Fig. 87. Ajan spruce (http://boomerangclub.ru/up/images/informaciya/priroda-sakhalina-i-kuril/multemediinie-diski/Drevesnue/el%20ayn.htm).

One of the features of the Ajan spruce stands is high stand density (unlike Shrenk's spruce) which provides a relatively high volume stock (Orlov, 1955). In spite of the wide ecological range of the Ajan spruce, the majority of the stands refer to medium and low capacity stands (III – IV site indices) and some parts die at a standing stage under different kinds of factor impacts and do not reach a physical maturity (Zolotarev, 1950).

Several *Picea* species can be named that are distributed outside of Russia however; they are successfully cultivated throughout the country. The Glehn's spruce (*P. glehni* Mast.) is growing in the south of Sakhalin and on Hokkaido Island in Japan. 40-50 m tall tree with a cone-shaped thick crown and reddish-brown bark (**Fig. 88**).

Brewer's spruce (*P. breweriana* S. Watson) grows on the border between the North American states California and Oregon (**Fig. 89**). It is considered as one the oldest spruce species. The tree is up to 40 meters in height with a 150 cm diameter trunk; with a cone shaped crown and distinctive weeping level branches. The shoots that are a red-brown tomentous, later change color to a silver-grey. The bark is purple-grey in color. Buds are 5-7 mm long and rounded on the bottom. Needles are 16-35 mm long, flattened in cross-section, dark green in color at the top and mat grey below. The cones are cylindrical, 6.5–12 cm long, dark purple when immature and maturing red-brown with wide scales. They can reach up to 900 years of age. The typical weeping branches develop only by 10-20 years of age.

The white spruce, or Canadian spruce *P. glauca* (Moench) Voss (**Fig. 90**) is a coniferous evergreen tree which grows to 15-20 m tall but rarely can reach 40 m tall. Trunk diameter is up to 1 m. The bark is thin and scaly. The crown is narrow – conic in young trees, becoming cylindrical in older trees. The needles are 12-20 mm long, rhombic in cross-section, blue-green at the top and blue-white below. The cones are slender cylindrical, 3-7 cm long and up to 2.5 cm wide. They are green or reddish, maturing to brown. The seeds are black, 2 - 3 mm long with a light brown 5-8 mm long wing.

Fig. 88. The Glehn's spruce - P. glehni Mast. *(http://www.planetarium.ru/page/image/id/96457.html)*.

Fig. 89. Brewer's spruce - Picea breweriana *(http://flower.onego.ru/conifer/en_5053.jpg)*

Fig. 90. The white spruce or Canadian spruce - Picea glauca *(http://www.uzhniy.ru/sale/52/1858/).*

The Serbian spruce – *P. omorica* (Pančić) Purk. (**Fig. 91**) grows in the south of Europe and the Balkans (the former Yugoslavia) on steep banks of the middle course and upstream of the Drina River, on the rocky limestone slopes at an altitude of 950-1500 m. The tree is up to 40 m tall with a narrow pyramidal, almost conical crown keeping the shape throughout the years; the shoots are relatively short spaced from each other and elevated. The needles are glossy, dark-green, with two white-blue strips below; very beautiful. It lives up to 300 years in the wild, unpretentious in soil and climate conditions, propagated by seeds. In terms of ornamentality, it only yields to the Blue spruce; it is shade-tolerant, prefers moist air and is wind and gas resistant.

*Fig. 91**.** The Serbian spruce - Picea omorica (http://www.tsvetnik.info/pinophyta/picea_omorica.htm); (http://flower.onego.ru/conifer/picea.html).*

Fig. 92. The Engelmann spruce - Picea engelmannii *(http://resinosa.ru/trees/coniferous/spruce/spruceengelmannii/).*

Fig. 93. The blue spruce – P. pungens (hhtp://www.forestalinews.it/conifere-abete-rosso-del-colorado/).

Fig. 94. Blue Siberian spruce - P. obovata var. coerulea (http://www.lestrade.ru/photos_comp/albums/284/1851/)

Engelmann spruce – *P. engelmannii* Parry *ex* Engelm. (**Fig. 92**) grows in the western part of North America as single and mixed stands at altitudes of 1500-3500 m, up to the alpine tree line, most often on the northern mountain slopes and valleys. Species area includes a forest belt of the Rocky Mountains. The tree is 30-50 m tall with a 90 cm diameter trunk. The crown is thick, conic and sometimes asymmetrical with slightly dropping shoots. The bark is fissured, scaly, thin and brown-red in color. The young shoots are yellow-brown and rusty pubescent. The needles are 15-25 mm long, 1.5-2 mm wide and rhombic in cross-section.

The natural range of the blue spruce – *P. pungens* Engelm. (**Fig. 93**) is located in the west of North America from the south-east of Idaho to the south through Utah and Colorado and up to Arizona and New Mexico. It grows at altitudes of 1750-3000 m. The tree is 25-30 m tall, rarely up to 46 m tall; the trunk diameter is up to 1.5 m. The bark is thin and scaly. The young trees have a narrow conical shape that later matures to a cylindrical one. The needles are 15-30 mm long and rhombic in cross-section. The color ranges from grey-green to bright blue. The cones are slightly cylindrical and 6-11 cm long and 2 cm wide. The cone color ranges from red to purple; mature cones are light brown. The seeds are black, 3-4 mm long with light brown 10-13 mm long wing. The blue spruce is widely used for unban greening in Russia.

The majority of the foresters think that the native Canadian blue spruce, mentioned above, (*P. pungens* Engelm.) widely used for urban greening in Russia, is the only blue spruce species. However blue species of the Siberian spruce (*P. obovata* var. *coerulea* Malyschev) grow in Baikal Siberia that was included in the regional Red book (Pleshanov, Shamanova, 2007). The tree is up to 30 meters tall with the pyramidal crown, grey and with fissured bark. The needles are hard, angular in cross-section and spiny with tints of blue. The wax bloom gives the needles a tint of blue. It grows in the eastern Sayan Mountains in the Shumak river valley, on the south coast of Lake Baikal, in the Utulik, Babkha, Khara-Murun and the Small Mangyly river valleys. It also grows in the mountain river terraces in small groups or as a single tree. It propagates by seeds. In the north-west region of Khamar-Daban, a relict blue form of spruce grows together in the fir forests however it also forms its own stand on the small land pieces. There are five isolated blue spruce populations – Khamar-Daban, Sayan, Charsk, Sokhondinsk and Upper-Amur' (Shamanova, Semenova, 2004).

The blue spruce is drawn towards the foothills, rivers and lake valleys. Due to its high oriental qualities, it is successfully used for urban greening in the Siberian cities. Though the needle "blueness" remains, only on the shoots of the current year and the central part of the crown is the typical Siberian spruce dark green color (**Fig. 94**). The Siberian spruce with blue needles was also found in Altai and the Kuznetsk Alatau and was described as an Altai sub-species *P. obovata* var. *altaica* Tepl. (www.moydom-dv.com).

In the **Figures 95 and 96** you can see the shoots of four spruce species that are not presented in the Ural forests, but are cultivated in the Botanical Garden of URAS. The pictures were taken at the initial stage of tillering at the beginning of June. As seen, the Ajan spruce shoot start growing earlier when the rest of the three species only break their buds.

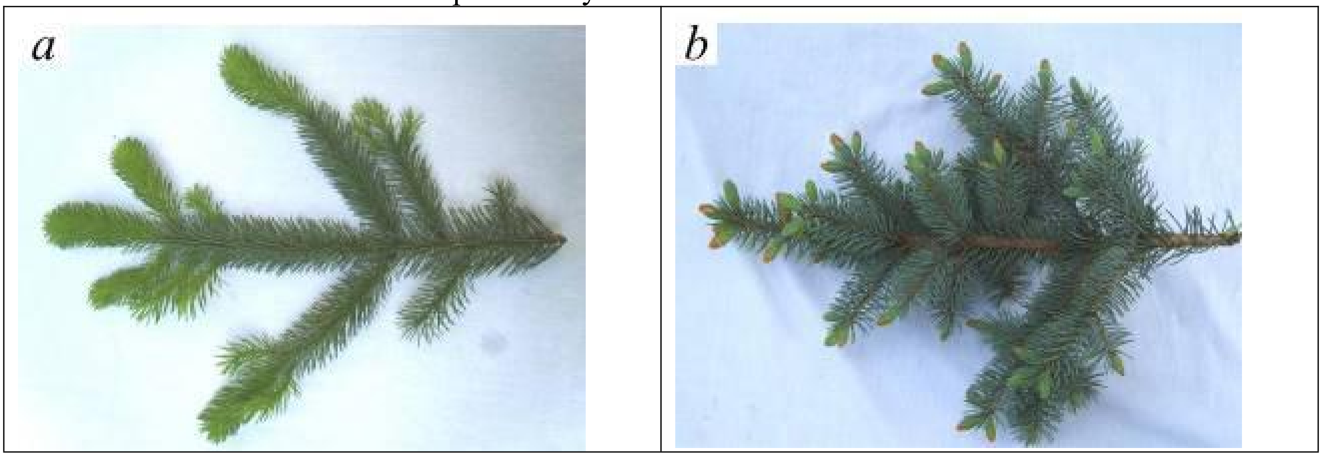


*Fig. 95. The shoots of the Ajan spruce - Picea jezoensis (**a**) and of the blue spruce - Picea pungens (**b**). Photos by V. Usoltsev.*

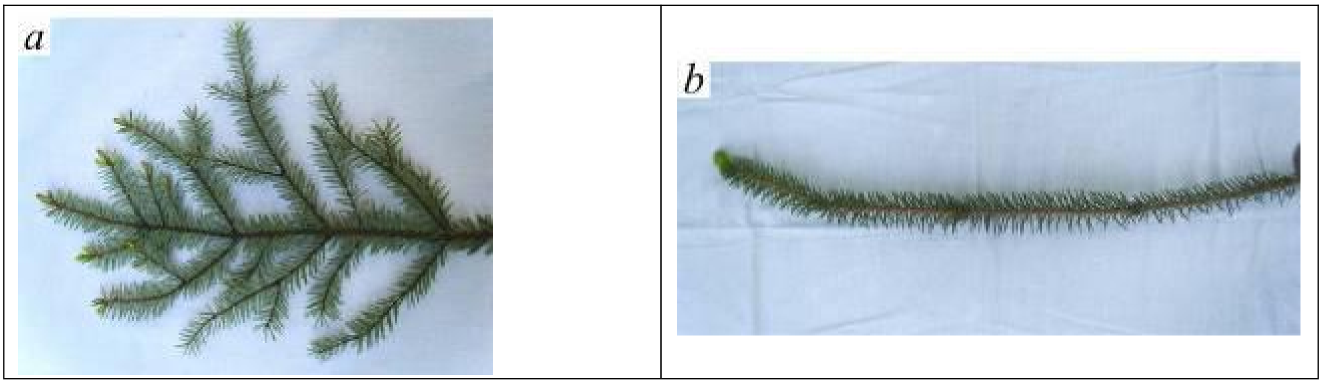


*Fig. 96. The shoots of the Serbian spruce - P. omorica (**a**) and the Snake-branched spruce - P. abies var. virgata* (Jacq.) Casp. *(**b**). Photos by V. Usoltsev.*

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Some bioecological characteristics typical for the *Picea* genus in general are of interest. Under the upland conditions on stony soils, spruce sometimes reproduces vegetatively, i.e. with layers (**Fig. 97**). According to Guman's data (1931), up to 30% of the fir and spruce trees of the Urals and Altai have vegetative origin. Spruce capacity of layering and forming "round shaped groups of associated trees around the parent tree" was mentioned by F. Arnold (1898. P. 435) and by several of his forerunners, where that entailed the common spruce in Germany.

In 2004 the internet dropped a bombshell: in central Sweden (the province of Dalarna), a supposedly 10 thousand year old spruce was found at 910 m elevation! It grows in a group of 20 spruces no less than 8 thousand years of age. In fact that age was defined for the root system (using the radiocarbon analysis), the trunk was only 600 years old: as soon as one trunk dies the root system reproduces a trunk "clone", i.e. a new trunk to replace the old one. A younger spruce was rising above each of these dead trees (**Fig. 98a**). Yuriy Linnik quotes, “a vegetative image of an eternal life. It is declared bright and unique among the Scandinavian moraine” (2015. P. 212).

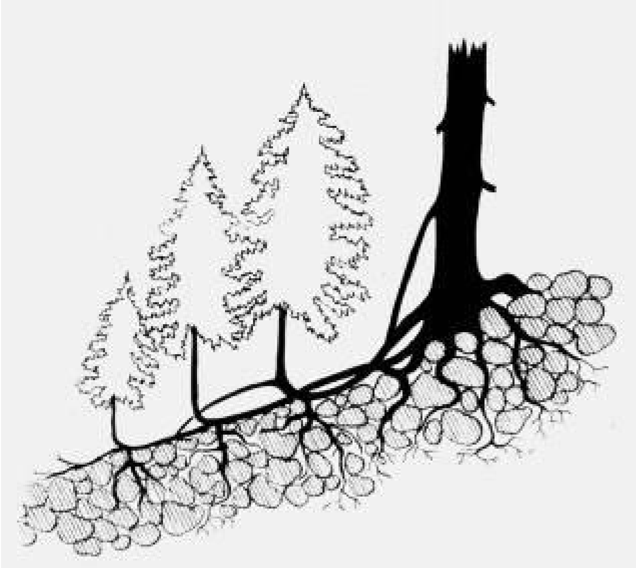

Fig. 97. Vegetative reproduction of the common spruce (Picea abies L.) on a rubble slope in the Central Europe Mountains (Jenik, 1987).

In general spruce life ending is very usual (**Fig. 98b**).

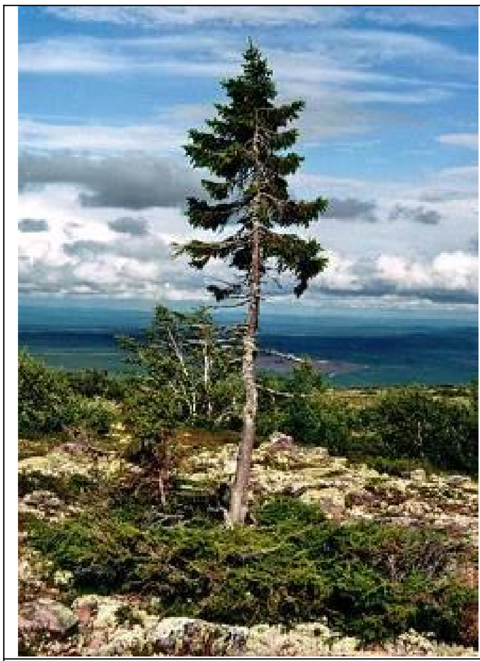

Fig. 98a. 600 year-old common spruce rising above the remains of the 10 thousand old parent tree in the Sweden tundra (http://kiev-services.info/forum/index.php?topic=1038.0#.U2yhO0_IOUk).	*Fig. 98b. Fatal case of the common spruce in the Moscow region. It has to die standing up… Photo by A. Tarko.*

Spruce is characterized by a wide diversity of shapes. Snake branch spruce (*P. abies f. virgata* (Jacq.) Casp.), with long sparse heteromallous branches and crowded shoots needles (**Fig. 99**) is marked out in the Carpathians and Alps. That is conditioned that being in the vegetative phase, the shoots don’t branch out. The mature tree reaches 10-12 m in height and 4-5 m in diameter. With the lapse of time the branches of the bottom crown part go down to the ground and spread around the tree like snakes. The weeping spruce (*P. abies* var. *pendula* Nach.), slender, hanging down and pressed to the trunk branches, the rounded-pyramidal spruce (*P. abies.* var. *erecta* and *pyramidalis* Carr.), the columnar spruce (*P. abies* var. *columnaris* Carr.) also occur there. By the cone color they distinguish a green cone spruce (*P. abies* var. *chlorocarpa* Purk.) and a red cone spruce (*P. abies* var. *erythrocarpa* Purk.) (Gensiruk, 1971; Tsurik, 1981).

Fig. 99. The snake branch spruce (Picea abies f. virgata (Jacq.) Casp.) *in the Botanical Garden of the Baltic Federal University (**a**) (http://www.kantiana.ru/garden/gallery/1231/30538/) and in the Botanic Garden of URAS (**b**). Photo by V. Usoltsev.*

In 2012 one of the specialists of the Ural State Forest Engineering University, Anton Opletayev, found a spruce in terms of shape resembling a cypress 15 km far from Artemovskiy town in the Ekaterinburg region, not far from the White Lake (**Fig. 100**). The branches hang down and seem like they hug the trunk in a spiral. Crown shape wise, the tree resembled the Serbian spruce (see **Fig. 91**) although the latter one has a completely different branching type and how would a Balkan native get to the Ural taiga? Most likely it was a mutant.

Fig. 100. "Artemovsk mutant" of the Siberian spruce. (http://www.artblog.tvwp-contentuploads201210KWv1ads1ss8.jpg).

Spruce distinguishes itself in the evident branching pattern differentiation that supposedly has a hereditary nature (N. Silven, quoted by N. Yurre, 1939). V. Sukachev (1938) singled out 5 forms of spruce by branching type. In some research, it was registered that spruce shapes by branching type have association with certain ecological conditions. Shishkov (1956), Nekrasov (1966), Ronis (1968) and Shcherbakova (1971) determined that in the Leningrad (St.-Petersburg) region, South Karelia, Latvia and in the Middle Urals, that the share of trees with a pectinate branching pattern goes up under the improvement of the site conditions, but in the Kirov region forests (Petrov, 1976) it decreases, and also this share decreases with the plantation age. In the Tver region and Belarus, the dependence between spruce shapes and side conditions is not determined (Yurre, 1939; Yurkevich and other, 1971). Shcherbakova (1971) thinks that a branching pattern depends on the coenotic position, where the leaders (I-II productivity classes) present pectinateand a comb-like corymbrose branching pattern and suppressed trees have flat branching patterns.

A distinct feature of the *Picea* genus is a defined shallow root system in consequence of white spruce always depends on the shallow horizon soil moisture that can easily die out even during a short dry season. From here it follows that the spruce is affiliated to moist sites and is absent (as well as fir) in the regions with very low winter temperatures followed by dry air (Sochava, 1956).

Kabanov (1940) noting the discrepancy between the prominent shallow root system nature of the Ajan spruce and its distinguished wind resistance in Sakhalin climate tries to find the explanation. He explains a high wind resistance of spruce in the mixed with Sakhalin fir (*Abies sachalinensis* Mast.) plantations by the compensation of the wind effect of the fir second growth; in the single spruce stands in the north part of the island he sees the reason of this occurrence in "a very tapering trunk and in a significant root swelling such that spruce takes more stable positions" (p. 36). That cannot be considered as an exhaustive explanation because the spruce wind resistance phenomenon in the mountains is commonly registered, but nowhere and no one associatedit with the vertical stand closure. Moreover, a distinct tapering as it's known, is typical exactly for understockings and in this respect a swelling lower part of a trunk protects the tree from the wind break but not from the wind fall. Obviously the reason of the phenomenon is in something else.

It was already mentioned above that the genus representatives has spread from the Altai-Sayan, Ural and Carpathian refugiums and in the East, the Tian Shan and Ajan spruce description they were characterized as typical mountain species. Their root systems shallow spread around large space successfully settle on underdeveloped stony and rank soils, which provides a good wind resistance to the mentioned species (Keppen, 1885; Arnold, 1898; Sukachev, 1938; Orlov, 1951, 1955). Andrievskiy (1915) characterizing the Shrenk's spruce writes the following "The Semirechye spruce is highly wind-resistant and doesn't have much of a windfall and even less of a windbreak" (p. 445).

In Orlov's opinion, (1955) tree species with an extensive shallow root system (the genus *Picea* in general) historically developed in rock habitat, on stony underdeveloped soils. On that basis he supposes that the common spruce and Siberian spruce shallow root system that conditions their insufficient wind resistance on lowland soils also characterizes them as typical mountain species by origin and their lowland habitat is an epiphenomenon (**Fig. 101**). Nat's examination (1915) during his study of the old-growth Siberian spruce forest on the western Ural slopes can confirm it: "… spruce in "parma" is more resistant in regards to the wind than the spruce on the lowlands in Kostroma, Vyatka and the south part of the Vologda region" (p. 557) that was distributed there historically much later. In the spruce and deciduous forest zone that presents "…a unique battle zone of the two forest vegetation types – taiga and broad-leaved ones" (Timofeev, 1936; p. 110) a 100-120 year old spruce can reach 36-40 m in height with 60-70 cm trunk diameter, but due to the massive fall, the growing stock doesn't get higher than 200 m^3/ha, which is about 60% to the growing stock of the III productivity class spruce of the same age on the sandy soil there (Timofeev, 1936). That's why for the spruce ecology researchers, an all-important question could've been whether the windfall phenomenon is the result of the spruce expansion beyond its natural historically conditioned area.

The biological characteristic of the genus *Picea* – the already mentioned association of spruce natural seeding to the so-called decayed logs i.e. to fallen old moss-covered tree trunks and stumps (**Fig. 102**) seems exceptionally puzzling. Spruce settled on a rotten stump, roots into "the core" (**Fig. 103**) however, if that happens on a relatively fresh and tall stump, so-called "stilted spruce" occurs there (**Fig. 104**). This kind of phenomenon is not typical for larch and its rooting on a stump (**Fig. 105**) took place possible only due to a hollow in the stump.

Fig. 101. Spruces growing on the rocky remnant of the Kurortnaya Mountain, the Middle Urals, Nizhnie Sergi. Photo by V. Usoltsev

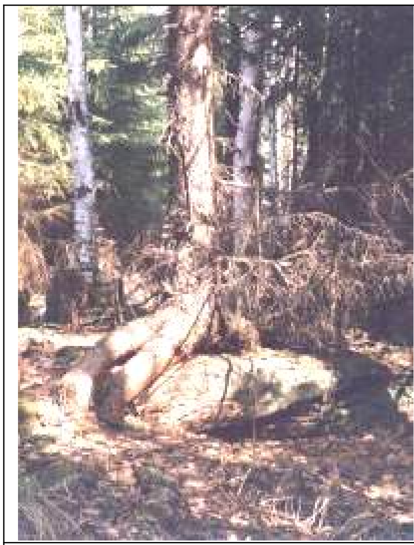

Fig. 102. Siberian spruce that grew on a fell larch trunk on the Ural Range, Bilimbay forestry farm, Ekaterinburg region. Photo by G. Terekhov.

Fig. 103. A young spruce rooted in a rotten stump on the Kurortnaya Mountain slope (Nizhnie Sergi, Ekaterinburg region). Photo by V. Usoltsev.

Fig. 104. Common spruce that grew on a tall and later rotten stump in the Shumava Mountains, Czech Republic (Jenik, 1987).

Fig. 105. Larch settled on stump on the Chuisk road side, Gorny Altai. Photo by V. Usoltsev.

The first mentioning of a “stilted spruce” (Stelzenfichten) phenomenon occurred in the 19th century (Teploukhov, 1850, quoted according to Molchanov, Shimanyuk, 1949; Geldt, 1858; Middendorf, 1867; Keppen, 1885). Arnold (1898) describes it in the following way “spruce trunk starts not by the ground surface but at a low height and it staked with its root so high that you can go under it slightly bent: by the first impression it seems that spruce clambers out of the ground. In fact, the origin of these spruces is the following: the tree seeds fell on a broken spruce stump or on rotten timber; both provide all favorable conditions for a conifers sprouting and usually a whole thick “nursery” of little spruce grows on them. Now with this growth, the roots spread more and more, going down the stump sides, that are already rotten too, to the ground, root in it, meanwhile the stump rots more and destroys…” (p. 435).

This kind of trees sparked some folk-beliefs in the old times. It was thought that the tree makes a connection between the worlds (**Fig. 106**) and that going up the trunk people can get to heaven and crawling under the root they could get to the other side. The basis to this belief was the assumption that the roots were in the underworld where the departed rested, the trunk stays in the world of people and the crown reaches the sky. Werewolves used these unique “under root gates”: crawling back under them and forcing people to turn into a wolf or a bear and vice versa (The Great Illustrated Encyclopedia, 2010).

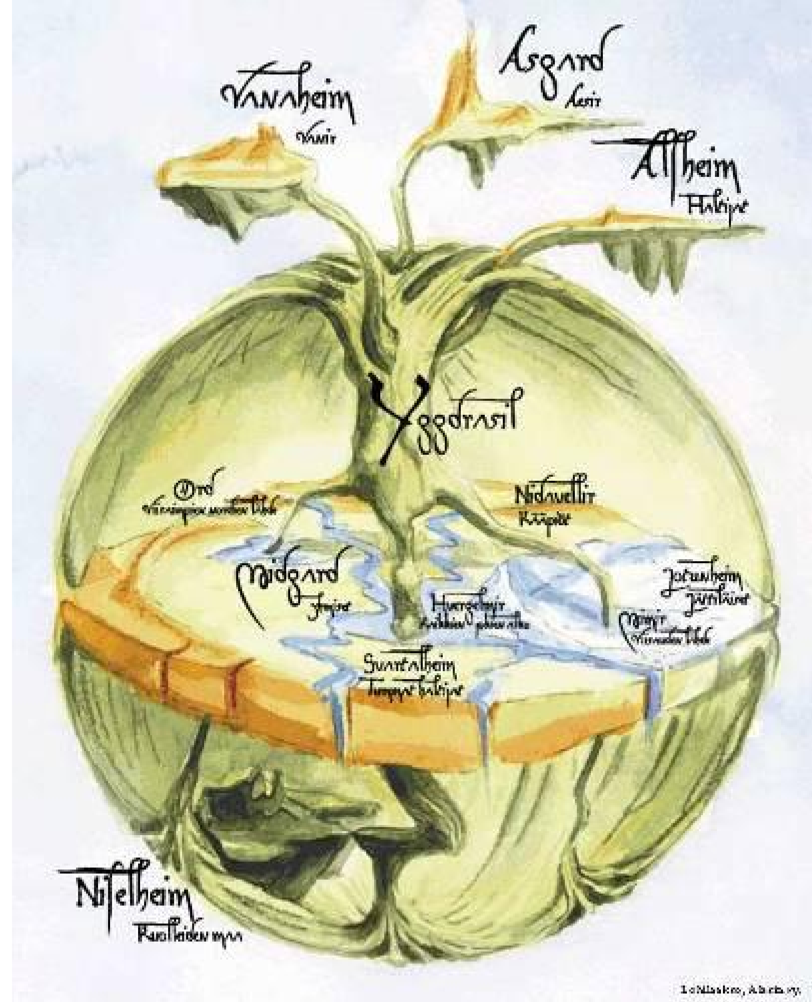

Fig. 106. The image of the World Yggdrasil tree that rises in the World Center and connects three cosmic levels – the Heavens, the Earth and the Underworld. Its branches spread above all the world and go higher than the sky. There is Asgard city by the tree top – the dwelling place of the Aesir gods and goddess. This world axis impenetrating the Universe and symbolizing its constant renewal is like a tree that sheds leaves in fall and covers with buds in spring (http://narodworld.ru/germantsy/germantsy-religiya.html).

In the west, more old-growth spruce forests of mid taiga, in the regions of the common spruce and Siberian spruce area combinations (Shenkursk and Velsk of the former Arkhangelsk province, 62°N, 42°E). Rozhkov (1904) describes a "common occurrence that seedlings more often and most likely emerge as beds on rotten breakage (p. 704). He notes the regeneration impossibility due to a high spruce canopy closure at least up to 150-160 years. "Only with the tree fall there is a light excess" for seedlings and "the rotting breakage itself provides more nutrients, is not as much cover with moss as the ground, more moisture accumulates on it and at the last it is higher against the ground level and well ventilated" (p. 704).

Under the south taiga of the former Petrograd province, Yatsenko (1916) acknowledges the all-around nature of spruce regrowth spread on slightly rising ground that wasn't necessarily formed by breakage or stumps however, the natural seeding "impresses with its abundance" only on the breakage (p. 996). Here is a typical picture described by Yatsenko, "Regrowth on rotten timbers appears in the form of a plantation tree row as it can be here abundant and lined up" (p. 996).

Tkachenko (1911) who first applied the quantitative distribution of spruce regeneration according to the micro-relief in the pristine spruce forests of the former Arkhangelsk province stated that 95% of the total spruce regrowth had rooted in felt moss-covered timbers and 5% on the ground. He thought that young spruces partly avoided a thick moss carpet on decayed logs and at the same time drier conditions in regards to the surrounding territories were established there. It corresponded with the Siberian spruce regrowth spread "… on old windfall trees or stumps" (Nat, 1915. C. 557) as the only way for the pristine "parma" regeneration in the north taiga, the Cis-Ural region in the case of 80 cm thick moss layer.

Sukachev (1921) and Tyulina's (1922) research does not confirm that spruce natural seeding choice of moss-covered decayed logs is a refuge from the continuous moss carpet under the spruce canopy (Rozhkov, 1904; Tkachenko, 1911; Nat, 1915). Under the middle taiga conditions on the common spruce and Siberian spruce contact line (Pinyug village in Kirov region, 60°30'N, 48°E) Tyulina discovered that "the most extensive moss development that appears as a continuous thick cushion is on decayed logs in evidence, and young spruces most commonly occur on the most moss-covered, i.e. most rotten decayed logs" (p. 165). Sukachev (1921) gives a wider interpretation to this phenomenon: "As the research in the Vyatka province showed, since in a spruce forest, decayed logs are usually covered with a heavy moss carpet that not only comes short of moss carpet capacity outside of decayed logs, but also often predominates over it, and since at the same time usually young spruce regrowth doesn't occur on the open spots with no moss carpet we can come to a conclusion that moss layer does not have a bad influence on the spruce regeneration but rather helps it along" (p. 75). He also considers that as the main reason of the spruce supplementation of other species.

Timofeev (1936) is at loss in regards to the common spruce dense regrowth on semi rotten decayed logs, whereas despite the heavy semination, the regrowth is completely absent on the rest of the land area with no turf forming marks. In this "battle field" of the taiga and broadleaf vegetation (the Bryansk forests), Timofeev assigns a pure technical part to rotting decayed logs in describing the phenomenon which is the role of "a mechanical role of leaves overthrown from heights which are represented by stumps and decayed logs" (p. 113). On the surrounding decayed logs, space oak and other broad leaf species, leaves pressed by rain and snow "form a continuous litter layer which is causing spruce sprouting to have a hard time getting out through; the layer presses them down, stifles them and is the main reason of the poor spruce regeneration in these stands" (p. 114). Orlov (1951) noted a similar occurrence on the border of the Caucasus deciduous and dark coniferous forest with the only difference that the litter there is formed with beech leaves that are an invincible obstacle for the Eastern spruce sprouting establishment but can be easily pierced with the vertically-aligned roots of Caucasian fir sprouting.

Obnovlenskiy (1935) determined in the spruce forests of the mixed coniferous-broad-leaved forest subzone (Moscow and former Western region), that out of nine examined forest types, 80% of spruce regrowth was concentrated on the rotting windfall at the ferns-herbaceous forest type on clay soils with the ground waters 1.0-1.2 m deep, at the rest of the forest types this number reached from 0 to 27% whereas dissembling how large the rotting logs under the canopy of the latter were. Merzlenko (1999) also states a distinguish affiliation of the spruce regrowth with semi decayed stumps and windfall at the same subzone (Klinsko-Dmitrovskaya Hills).

According to Sukachev's examinations (1921), in the Suvodskiy forest district of the Kirov region (present Sovetsk city, $57^0$30' N, 49^0E), under the south taiga conditions at the contact line of the common and Siberian spruces, the spruce regrowth affiliation with decayed logs is typical for the most humid habitats where "… spruce chooses more or less dry areas on the decayed logs surface (p. 75). Stratonovish and independently from him Uskov (quotation according to Dekatov, 1931), under the Leningrad region conditions, confirm the common spruce regrowth preferences of the organic loadings on the rotting windfall exceptionally on the stagnant moisture habitat while Yatsenko (1916) observed this occurrence in the same region with all the forest types. Also in the subzone of the Ural south taiga under the primordial dark, coniferous forest canopy regardless of the forest type 80% of the spruce regrowth root on the micro elevations of decayed wood covered with green moss and wood sorrel (Galtsev, Isaeva, 1977). The Ajan spruce in Kamchatka also prefers a rotting windfall in all the forest types (Man'ko, Voroshilov, 1978).

In the three types of the grass spruce forests are characterized by the different flowing moistening extent in the mid taiga subzone of the Vologda region "… the spruce regrowth spreads unevenly, it is limited to the "windows" and roots on micro elevations of rotten wood remains of fallen trees. In the different types of the spruce forests the number of young spruces rooted on over moistening micro elevations gets to 92% (Izvekov, 1962; p. 29). According to Kravchenskiy's statement (1911; cited by Dekatov, 1931), 90% of the spruce natural seeding in St. - Petersburg forest suburbs root on decayed logs and other kinds of micro elevations due to the over moistening, and only 10% - is on mineral soils. The universal phenomenon in nature is typical and alreadymentioned “parma” in the north taiga Cis-Ural region (Nat, 1915), as well as the old-growth spruce forests of the south taiga Cis-Ural region near Kudymkar city 59° N, 55° E (Vasiliev, 1935), all around the Perm region (Yurgenson, 1958) and on the western slope of the South Urals around Mikhaylovsk sity, $56^{0}30'$ N, 59^{0} 20’ E (Nesterov, 1887).

The selective capability of the common spruce sprouts in the former Petrograd and the Western province in regard to rotting windfall and micro elevations was explained with the need of aeration of the soil and nutrients by Geldt (1858), Yatsenko (1916), Guman (1931) and Obnovlenskiy (1935); in the Perm region - by Yurgenson (1958). “Spruce sort of avoids slightest over moistening and the lack of air access and … that’s why it does not develop on the lightest topographic low where there is at least a temporary water stagnation” (Yatsenko, 1916; P. 997). “Decrease of aeration in the low growth class spruce forests makes the spruce settle on elevations, near stumps, on stumps themselves, decayed logs and remaining areas (Guman, 1931. P. 60).

At the same time Tyulina (1922) did not regard to the need of sprout root aeration as the phenomenon reason because “on the stiff slopes with well grained soil, almost all the regrowth is concentrated on the decayed logs” (p. 168) and explained it with better light, temperature and nutrient conditions provided by the windfall. Danilik (1965) observed the spruce regeneration affiliation with the decayed windfall remains in the mountain forest of Tian Shan and the Urals, not only on the wet and humid soils, but also under the fresh site conditions on the well-drained slopes. More over Man’ko and Voroshilov (1978) give the following comment on the Ajan spruce regrowth spread on the decayed windfall: “Apparently a relative dryness of the surface layer blocks the rooting of the spruce outside of the windfall” (p. 131).

The explanation of the spruce sprouting affiliation with the rotting windfall by the drainage lack of the per humid sites does not find endorsement in the Eastern spruce plantations growing in the medium-altitude mountain belt of the north-west Caucasus on stony soils: everywhere the spruce regrowth prefers moss-covered windfall (6-10 years of age, 35 items per m^2) whereas the Caucasian fir regenerates better on the spaces with grass vegetation (Orlov, 1951). A similar explanation also doesn’t find endorsement in the Ajan spruce plantations on the cryogenic stony underdeveloped soils in the Amgun–Bureinsk interfluve where the spruce regrowth is also limited to rotting windfall and avoids the sites with thick ground vegetation (Orlov, 1955).

Man’ko and Voroshilov (1973) distinguished brush and mixed herbs, moss, cloud and polytric spruce forests in the Ajan spruce woods on the permafrost under the Central Kamchatka Depression. There are 1.1 – 4.0 thousand pieces of the spruce regrowth under the canopy, 84-100% of which is in the brush and mixed herbs spruce forests, 65-80% spreads on rotten windfall in the cloud and polytric spruce forests, and the spruce population resistance in the moss type forests directly relates to the occurrence of the rotten wood under its canopy: “The spruce positions in these type forests group are fairly steady however the regrowth number ranges on the specific sections and depends not only on the stand conditions but also on the occurrence of the old rotten windfall that serves as the main substrate for spruce rooting” (Man’ko, Voroshilov, 1973. P. 221).

The same thing happens in the Sakhalin Mountains without the permafrost conditions in the Ajan spruce of *Vaccinium* forest type on hillock tops and ridges where the extensive spruce regeneration “spreads in forms of trellis along rotting fallen trees” (Kabanov, 1940. P. 44) also drawing the lichen masses. Higher up the mountain slopes, the regeneration in the bilberry Ajan spruce forest “groups in the dents near the windfall” (p. 50). During the special research by Romanov in Sakhalin (cited by Vlasov, 1959), it was found that the mentioned phenomenon is proved for all the forest types with up to 80 samples of regrowth per 1 $m^2$of windfall. The regrowth root systems at the age of 8-10 years old is 4-5 times stronger than single fir samples (about 1 individuals per m^2) growing in the soil.

On the south of Finland, decayed wood hosted 63% of the spruce seedling although these microsite types covered only 28% of the land studies and that's why the regrowth has a significant group distribution. In the managed forests oriented on the natural spruce regeneration, it is recommended to create similar microsites to those created by natural disturbance, i.e. uprooting niches and decayed logs (Kuuluvainen, Kalmari, 2003).

All the spruce production is oriented on the natural regeneration in the Alps high-mountain spruce forests. The mineralized lands quickly get covered with herbs although spruce extensively roots on the windfall which find an explanation in a constant temperature regime and subtract humidity, shower protection and better rooting conditions and so on. The seedling preference of decayed logs is so evident that with the purpose of the natural spruce regeneration, it is recommended to place the windfall and wood remains there (Mai, 1998).

The distribution of the spruce regrowth on the micro elevations formed of rotting and loose wood makes the spruce natural regeneration and survival very successful in the old-growth forests; however in the managed forests it carries a threat of its existence. The case is that the regrowth roots do not hold hard in this kind pf substrate and can be easily pulled out with mild tension. That's why the spruce regrowth get harmed worse during the large people attendance and mechanical timber harvesting than the fir regrowth that has no regular affiliation with the microsites (Danilik, 1965).

Arnold (1898) summarizing his 50 year experience of the artificial common spruce cultivation in Russia explained the seedling failure as a result of the frost supplantation of the nursery stock. Kravchinskiy (1911; cited by Dekatov, 1931) and Yatsenko (1916) justified the spruce plantation issue through the disregard of the micro-relief and geometrical planting point arrangements, "along the line". Yatsenko (1916) "saw the main reason of this failure … in the complete neglect of the spruce seed sprouting principle in the relation to the micro-relief" (p. 997). Dekatov's experiment (1931) showed that there is no seedling frost lift phenomenon on the rotting wood in particular and structurally similar substrate to it and he recommended planting only on the positive micro relief element with the litter retaining.

On the U. S. Pacific northwest trunks, stumps and large wood remains have 6 to 14% surface of a projective cover, although they host 98% of the regrowth. The sprouting find a refuge on detritus from the developed moss and grass cover however, they root on the decayed logs only until the moss cover becomes too thick and aggravates the seedling rooting. The wood mineralization carries very slowly whereas the litter and earth humus cover forms a lot quicker on logs and provoke the seedling rooting on it without any opportunity for the roots to get established on firm undergrated wood (Harmon, 1987). Takahashi and other (2000) find it to be a paradox when pulled out tree roots and moss covered windfall become a more attractive sites for spruce regrowth establishment, however they contain too little nutrients for its following growth.

In the Carpathians on the headstream and the divide of the Tizsa and Pruth rivers (Rakhov, Yasinya, Delyatin), under the alpine stand canopy of the common spruce on the rotting windfall, covered with moss there are on average 34 pieces of sprouting and regrowth per 1 m^2, predominately 6 years of age (Gensiruk, 1971). The spruce regeneration also takes place on the moss carpet without the rotting windfall but only at the moss carpet of up to 5 cm thick. There is no spruce regrowth on the more than 10 cm thick moss carpet with no windfall and the litter of more than 7 cm thickness with no moss. Gensiruk (1971) accounts better regeneration growth on the rotting windfall than on the ground and its abundance here for rotting windfall in the predominant rank soil in the Carpathian Mountains as the only condition favorable for sprouting and regrowth occurrence and growth.

As the research result of the overall common spruce regeneration on the rotten wood remains in Norway forests, Mork (1927) came to a conclusion that the reason of this phenomenon was mostly the favorable substrate physical conditions and also the symbiosis of roots and mycorrhiza hypae that occurs on the sprouting roots as soon as they come out of the seed cover and helps the sprouting to use poorly decomposed nitrogen compounds.

In the old-growth forests of the Alps, (Brigels) a distinct light brown mycorrhiza forms on the roots of the common spruce regrowth that is concentrated on rotting logs. With the availability of the humus and moss carpet on logs, the regrowth phytomass is 4-20 times higher in comparison to the logs without a similar cover, and the correlation of root mass to the top declines twice respectively. The latter is clarified with the fact that the rotting wood substrate is provided with less nutrients than humus (Göbl, 1968). A relative nutrient poverty of the rotting trees and intensive spruce rooting on logs with the development of the moss carpet was also noted in the dark coniferous timbers on the Hokkaido Island in Japan (Takahashi, 2000).

In the Ajan and the Sakhalin spruce (*P. glehni* Mast.) stands on Hokkaido Island and in the central Japan nurslings successfully root on logs with the II (low) and V (high) decomposition degrees. There is no sprouting or regrowth on the new logs however, their number grows with the wood mineralization. Although the general log projective cover is about 21%, the logs with the III (mild) decomposition degree cover less than 4% of the space. That way the role of the detritus logs as a preferable spruce establish site is limited both in time and space. Nevertheless they play the key role in the spruce boreal and temperate forest dynamics (Takahashi at al., 2000; Narukawa et al., 2003).

A preferable common spruce regrowth establish on logs in the Nordic countries is justified with the optimal water and light supply, lack of competition of the other vegetative species and bacterial nitrogen fixation of rain and solid precipitation that gradually progresses with the wood mineralization and its humidity increases (Jurgenson et al., 1987; Hendrickson, 1991; Kuuluvainen, Kalmari, 2003; Brunner, Kimmins, 2003). The nitrogen fixation in the coniferous forest detritus of the Vancouver Island in Canada and in Oregon State in the U.S. varies between 1.0 and 2.1 kilos of N per 1 hectare a year and depends on the substrate mass suitable for nitrogen-fixing bacteria activity. The water contain (to the dry mass) in coniferous species detritus increase in the first 80 years and then stabilizes at 250% level in summer and 350% level in winter (i.e. it increases in comparison to the fresh condition in 2.5 – 3.5 times), and the wood density respectively decreases (approximately by 5 times) and stabilizes at 0.15 g/cm^3 grade (Sollins et al., 1987; Brunner, Kimmins, 2003). According to the polish researches' examinations in the subalpine Carpathian spruce forests the larger logs are more preferable for the natural seedling rooting than small woods (Holeksa, 1998), and in Japan, spruce almost doesn't establish on logs smaller than 20 cm thick (Takahashi et al., 1994).

The examined phenomenon of the spruce specific regeneration was also described in the studies by Krudener, Bitrich, Tyurin (sited by Dekatov, 1931), Melekhov and Alabysheva (1937), Molchnov and Shimanyuk (1949), Kapper (1954), Sochava (1956) on the space from the Belovezhskaya Pushcha (Belorussia) to the north east of the European part of Russia; it is typical for the common spruce in Sweden (Anderson, Hesselman, 1907), for the red spruce (*P. rubra* Link), the white spruce (*P. canadensis* Britt.) and the black spruce (*P. mariana* Britt.) in the United States (Dekatov, 1931).

In 1924 in order to figure out the mechanism of the phenomenon, Tkachenko initiated a special research in the Lisinsk experimental forestry (Leningrad region), in the typical for the north bilberry spruce forests of II-III productivity classes with inundation traces that was finished by Dekatov (1931). The quantitative record of the natural spruce regrowth, areal distribution against the micro relief, showed that 58% of the regrowth established on mineralizing wood and 35% rooted on the other elevated parts of the micro relief (Dekatov, 1931). Both the rhizosphere of the natural regeneration and the rooting zone of the special seeding under the different micro relief conditions under the canopy including beds were under the examination.

Obtained results (Dekatov, 1931) basically repeated the mentioned above Rozhkov's arguments (1904) and his explanation of the phenomenon of the spruce sprouting affiliation with the rotting logs and stumps: it's a high water capacity of the substrate that provides a needed aeration and smaller depth of the moss carpet. Dekatov (1931) conclude his research with the following statement: "without bringing the issue of the rotten substrate as a nutrient solution to a close, the stated results determine the meaning matter of the rotting wood in the spruce regeneration process and indicate that the matter lies in the elevated location against the soil surface that it takes and in its physicals" (p. 293). Danilik (1965) explains the spruce sprouting preferences of mineralizing wood by the high water capacity and rotting wood hygroscopicity.

Thus the whole picture of a typical for spruce regeneration phenomenon looks rather controversial. According to some evidence, spruce natural seedling uses decayed logs as a refuge from the moss carpet on the ground (Rozhkov, 1904; Tkachenko, 1911; Nat, 1915; Jurgenson, 1958), however according to the other research in the same region (the north-east of the European part of Russia), moss carpet is the most developed exactly on decayed logs (Sukachev, 1921; Tyulina, 1922).

Some authors (Nat, 1915; Yatsenko, 1916; Vasilyev, 1935) emphasize the general nature of the spruce regrowth preferences to decayed logs that is typical for all the forest types in this region, and the others (Dekatov, 1931) give the data of this phenomenon only in the forest with the excessive stagnant moistening. However it is unknown whether the dryer sites were provided with the windfall to the same extend as humid ones, i.e. whether the forest types were compared by the rotting wood availability there.

According to the earlier phenomenon studies of the spruce regeneration on logs (Geldt, 1858; Rohkov, 1904; Yatsenko, 1916; Guman, 1931; Obnovlenskiy, 1935) the higher nutrient content in them was registered, but later mostly foreign research did not support that and by contrast stated that rotting windfall substrate had a poor nutrient content in comparison to the moss carpet and humus (Göbl, 1968; Takahashi et al., 2000). Hence the phenomenon reason depends not on the nutrient content but something else.

Under the European Russia conditions, the common and Siberian spruce regenerate on decayed logs since the regeneration is not possible on the rest of the space due to the excessive stagnant moistening (Rozhkov, 1904; Tkachenko, 1911; Yatsenko, 1916; Dekatov, 1931; Obnovlenskiy, 1935; Jurgenson, 1958). Nevertheless, Ajan spruce on the stony underdeveloped soils both on permafrost in the Amgum – Bureinsk interfluve and Kamchatka and without it in the Sakhalin Mountains, Norway spruce (*P. abies*) in the Alps and the Carpathians and Eastern spruce in the Caucasus (Kabanov, 1940; Orlov, 1951, 1955; Gensiruk, 1971; Man'ko, Voroshilov, 1973, 1978; Mai, 1998) anyways regenerate on decaying organic matter however, there is no stagnant moistening and sometimes there is a moisture deficit there (Man'ko, Voroshilov, 1978).

The moisture content in detritus at 250-350% level under the appropriate substrate porosity is apparently the optimum conditions for spruce regrowth. That's why the regrowth chooses logs both in more humid and drier habitats. Since the majority of the other species does not lean towards the windfall would it mean that this kind of substrate moisture is pessimal for them?

The moss presents on detritus is a necessary condition for the spruce natural seedling rooting (Göbl, 1968; Takahashi et al., 2000) however a too thick moss carpet can keep it under (Nat, 1915; Harmon, 1987). Evidently a certain moss carpet thickness is optimal for the spruce regrowth. Since the majority of the other species does not establish on logs would it mean that this moss carpet thickness is pessimal for them?

In the "battle zone" of the taiga and broadleaf vegetation, the common spruce prefers decaying logs since the regeneration is not possible on the rest of the space due to a typical dense layer of broadleaf species foliage (Timofeyev, 1936), but as it is known, the broadleaf species do not grow on the deep-frost soil, however the Ajan spruce still regenerates there on decaying windfall (Orlov, 1955; Man'ko, Voroshilov, 1973).

It follows from what just been said that the spruce natural seedling finds favorable conditions for rooting and the further development in the decaying windfall as a result of a physical factor complex - humidity, porosity, temperature and lighting. Yet with few exceptions mentioned characteristics of a decaying windfall are not appealing to the other species. Further we can say that an extensive mycorrhiza formation is due in no small part to this occurrence (Mork, 1927) but it is also well known that almost all tree species and not just spruce "like mycorriza". All that is mentioned above conveys the suggestion that this phenomenon nature doesn't have an ecological but biological and biophysical habit.

Comparing the root architectonics of the two spruce regrowth samples in the **Fig. 107** that was taking from the Dekatov's research (1931) two obvious facts draw our attention:

1) the regrowth on the decaying fallen trunk wits a 30 cm diameter since the first years forms extensive branched healthy root systems spread along the trunk. The regrowth upon that avoids mineral soils (Dekatov, 1931) forming a lateral root system typical for spruce;

2) a seedling root established in a wet micro depression, in unfavorable conditions stretches to the nearest log and forms there a branched system of absorbing root endings that raises up to the log to the seedling crown level. It seems that on some kind of grounds spruce seedling "feels" near by the necessary habitat for its survival over a distance. If the phenomenon of species cooperation, for instance, by the means of their biofields (Marchenko, 1995) or released phytosides (allelopathy phenomenon) (Kolesnichenko, 1976) is known, why can't we suggest that we observed a similar phenomenon above? If larch roots spread preferably towards nearby spruce roots, why can't we suggest that young spruce biofields and decaying wood radiance (radiant "touchwood") cooperating on some energetic level or that certain microorganism outflows (miasma, saprolins and other) decomposing dead wood is not inhibitors but attractors for the spruce seedling roots? We will revive the plant biofield issue in the next chapters.

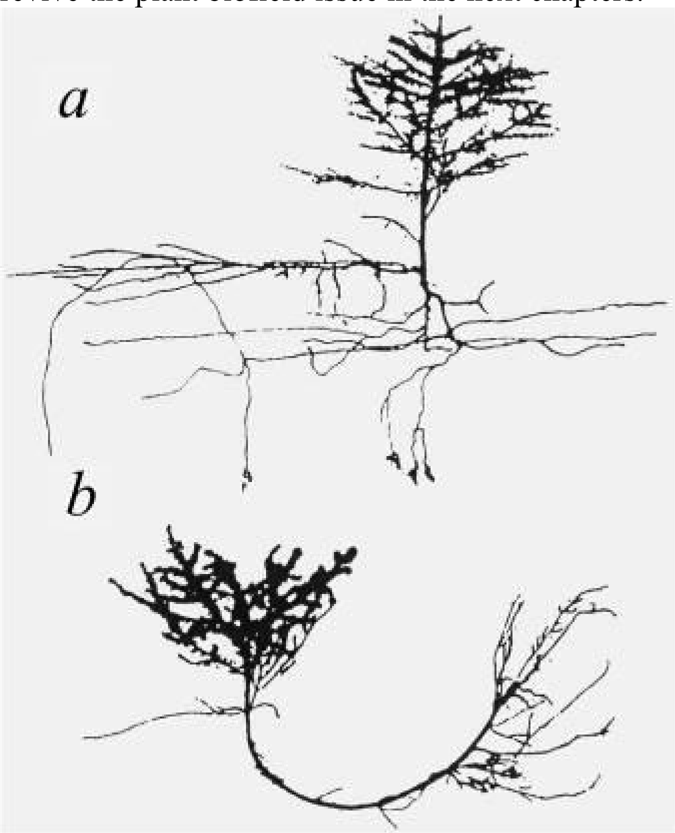

Fig. 107. Spruce regrowth root system in haircap-moss and bilberry spruce forest of mid taiga on heavy clay loam growing (a) on a decaying log and (b) on in a wet micro depression near a log where the root developed (Dekatov, 1931).

The question now arises of whether the two typical for *Picea* genus characteristics – meaning the lateral root system habit and regeneration affiliation with decaying organics – have a common nature and history going back to the past? It is fair to assume that under the alpine conditions of *Picea* genus origin places on stony underdeveloped but relatively humid soils the capability to regenerate on windfall as well as the capacity to establish on these kinds of soils by the means of lateral long roots were developed as a necessary condition for survival and were consolidated genetically by several spruce regenerations over thousands of years.

The philosopher Yuriy Linnik (2015) has a dialectical approach to this phenomenon: “here you unwittingly start reflecting on life and death relations in the forest world perspective. Here they are comparative. This rotten stump kind of presents us an entropy triumph. But look carefully – it has become a nursery for a sprouting spruce seed; it nourishes and supports it. The generation connection, the unity of ancestors and descendants presented to us visually”. Yuriy Linnik comprehends this unique case of tropism (see **Fig. 107b**) a la Fedorov turning it into an allegory: “The dead invests in the live ones and kind of arises in it. This decaying trunk and young regrowth on it – we see a whole complex, something similar to *symbiosis*. However, in spite of the definition the cooperation takes place between the living and the dead. What is the benefit for the dead? The benefit of the living world as a whole!” (p. 211).

Was it this regeneration characteristic together with spruce unusual shade tolerance and noted by Nat (1915) and Sukachev (1921), the capability of a mutually beneficial coexistence with a heavy moss carpet let the spruce not only widely spread on Eurasia lowlands but also, as it was mentioned by Keppen (1885), displace other typical alpine species as larch and cedar pines (for example in the Swiss Alps)?

This issue, as well as interspecies relations in general, that significantly determine a distribution behavior of woods in the Northern Eurasia deserves an individual research. The issue is complicated by an extreme variety of the local site conditions that often does not let them reveal relatively common patterns. For example, in the middle taiga subzome (Kostroma region) the displacement of larch to pine was registered (Keppen, 1885), and a little north in the middle taiga (Shenkursk and Vel’sk of the former Arkhangelsk province) pine was throughout displaced by spruce (Rozhkov, 1904). Morozov (1900. P. 558) writes that “Only within Voronezh province itself we have on one hand Khrenov pine forest where there is no… pine natural regeneration and it is displaced with oak, but on the other hand there are Uglyansk forestry and Borovsk “datcha” in Voronezh forestry farm where vice versa pine displaces larch species”. Partially we will revive back to the mentioned issue in the following chapters.

4. Fir (the genus *Abies* Mill.) is a taiga companion of the Siberian spruce.

There are about 40 fir species in the Northern hemisphere. Fir is a regular spruce companion and is a typical representative of dark coniferous forests. There are three of the most common fir species in Eurasia – Siberian fir (*Abies sibirica* Ldb.), silver fir (*A. alba* Mill.) and Khingam fir (*A. nephrolepis* (Trautv.) Maxim). (**Fig. 108**). According to Keppen (1885) Siberian and silver fir originated "… from the same ancestor that grew in the central and eastern Asia mountains and by its characteristics was close to the occurring nowadays balsam fir (*Abies balsamea* L.) in North America" (p. 420). He refers to the Altay and contiguous ranges as the place of silver spruce origin. From here its original form in the Tertiary era distributed to the south west and then along the high mountain range to Asia Minor. It formed a new species Nordmann fir (A. *nordmanniana* (Stev.) Spach.) in the Caucasus, from Asia Minor it came to Europe – to the Balkans, Alps and the Carpathians and then further to the Apennines and the Pyrenees.

Sukachev characterizes Siberian fir (**Fig. 109**) as a 30 m tall tree with and up to a 55 cm stem diameter, reaching up to 250 years of age. Due to its secure root system, a distinct major root and a narrow crown fir is windfall resistant. Dence crown needle, up to 10 years of needle longevity, poor self-pruning witness of Siberian fir high shade tolerance, which only falls short of the other trees. It is highly sensitive to forest fires even to small ground ones due to its thin bark.

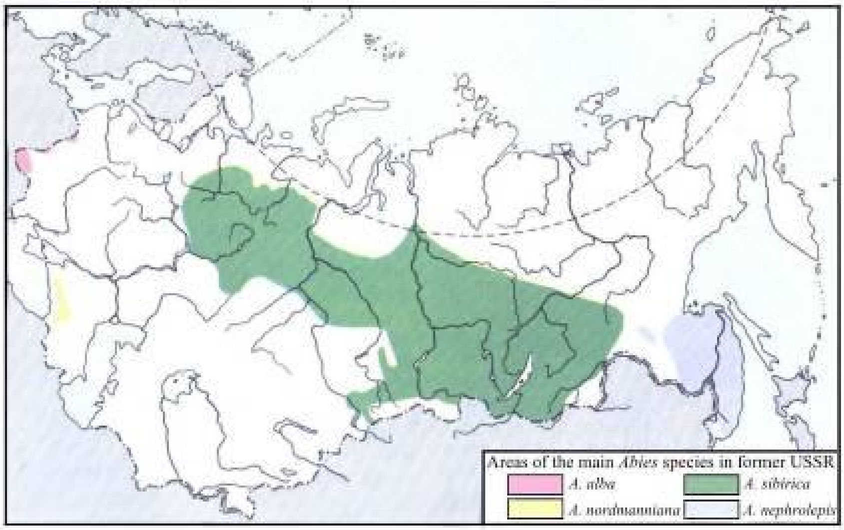

Fig. 108. Main fir areas in the former USSR (Forest encyclopedia, 1986).

Fig. 109. Siberian fir (Abies sibirica Ldb.): 1 – general tree view, 2 – a branch with male strobiles, 3 – a branch with female strobiles, 4 – macro strobile (seed scale with two seed buds), 5 – a mature cone, 6 - central axis of broken strobile, 7 – seed (Forest Encyclopedia, 1986).

Seemingly, fir timber resembles spruce timber with the exception of the absence of a gum duct; it is homogeneous white in color and has a typical fir balsam scent coming from the bark. Unlike all the other Siberian coniferous species, fir has no gum in the timber and a low wood density and that's why it does not last long. Fir trunks are exposed early to fungal diseases, and often begin to rot at the age of 100-150 years and by 220-260 years of age usually break off (Falaleyev, 1982) (**Fig. 110**).

Siberian fir yields well up to a great age but not yearly: in the Urals, every 3-4 years in the east of western Siberia, every 6-7 years and in the Eastern Sayans every 10 years. Unlike spruce, fir cones are concentrated in the extended upper part of the crown and during mast seed years tree tops loaded and completely covered with cones they break in the wind. Several new branches are forming from a lateral branch to replace a broken top. A multiple top phenomenon is very typical for large fir trees (Falaleyev, 1982) (**Fig. 111**).

Fig. 110. Overmatured silver firs (A. alba) in the Czech Republic. The days of this fir queen are numbered (Jenik, 1987).

Fig. 111. Asketch of a Siberian fir with a broken top in Tsarskoye Selo Park outside of St. Petersburg (Arnold, 1898).

Wings seeds are distributed with the winds for 10 km. Unlike spruce, fir regeneration does not give preference to windfall and adapts to the grassy clearing, forest margins and canopy gaps. Vasiliev (1935) stated that fir formed stands with its domination mainly around villages. He explains that by the fact that windfall favored the spruce and due to that it takes a dominating position, got trampled down by cattle and picked up as firewood by people in these kinds of areas, in turn eliminating fir's main competition.

In comparison to the other species of *Abies* genus, the Siberian fir has the largest area (see **Fig. 99**) spreading from the basins of the Northern Dvina and Mezen Rivers on the west to the Upper Aldan on the east. The northern limit in the Pechora river basin and north from the Lower Tunguska River reaches to the polar circle. The largest alpine Siberian fir stands are related to the Altay and Sayans Mountains where they form a so called pristine ("chernevaya") taiga forest. Advancing to the east, fir share in the forest composition declines and in eastern Siberia, fir forests are very rarely situated as a thin line in the river valleys. The largest number of Siberian firs occurs in the taiga zone of Siberia and the Urals (up to 40-50%) in the mixed spruce and fir forests. On the area borders, fir depopulates and does not grow as a single trees but in small groups that are located for example along the Upper Sukhona River and the floodplain of the Usa River up to the Polar Circle.

The nature of the dark coniferous forests of the north-west (faced Lake Baikal) marcoslope of the Khamar–Daban range (1700 m A.S.L.) with the fir bergernian type forest dominance is unique (**Fig. 112**). It is linked to the unique Siberian climate conditions – the combination of a heavy annual rainfall (1000-1200 mm) and moderately cold winters due to the softening Lake Baikal influence. Many researchers consider the local vegetation as the most ancient forest formation in the region.

However in the last decades, a progressive drying out of the Baikal Lakeside forest that mostly spread on the fir population (**Fig. 113**). In some regions of the north-west macroslope of the Khamar–Daban Range, there are fir forests with local brown needles. The studies showed (Voronin et al., 1986) high scrape content in brown needles. Needle longevity of the damaged trees decreased by 3 times, its weight and size went down by 20-30%. Annual wood growth of the fir forests in general declined by 40-60%, pollen sterility went up by 4 times and the number of empty seeds doubled. At the early stages the dieback of 65% of female cones was registered which outnumbers the norm twice. The growing stock decay rate (tree transition from "irretrievably weakened" to "dead tree" category) has reached 50% per year.

Fig. 112. A general view of the north-west slope of the Khamar–Daban Range (1700 m A.S.L.) from the Lake Baikal side. The photo was taken on the Upper Bolshoy Mamai River (1200 m A.S.L.). Photo by Agafonov.

Fig. 113. Brown discoloration of fir needles on the Khamar-Daban Range. Photo by Agafonov.

It should seem that the main reason of the fir forests degradation is the pollutant emission of Baykalsk Paper and Pulp Mills (**Fig. 114**), since among all the conifers, fir is the most sensitive to the air pollution. However numerous soil tests and air analysis do not reveal any departures from MPC. A similar situation of fir forests (*Abies fraseri* (Pursh) Parret) drying out takes place in the Appalachian Mountains, USA (**Fig. 115**) away from any pollution sources, and the researchers from the University of North Carolina also cannot figure out the drying out reasons, at least the main one has not been revealed among the confirming facts complex (Hollingswworth, Hain, 1991).

Fig. 114. Baykalsk Paper and Pulp Mills. Smog over the lake. Photo by Agafonov, 2009.

Fig. 115. Fir forest damage (Abies fraseri (Pursh) Parret) *in the Appalachian Mountains (http://en.wikipedia.org/wiki/Fraser_Fir).*

Siberian fir is a very winter-resistant species and can survive -50°C. As a species requiring rich soil, it is a weak competitor for spruce. Spruce as a podzol formation element causes an impoverishment of soil and thus suppresses fir. As a result, fir does not yield well and slowly transition to the asexual propagation reproduction getting weaker every year. The trees as a result of layering are earlier exposed to fungal diseases accompanied with decay and die before reaching sufficient sizes (Falaleyev, 1982).

Tyulina (1922) give the following comment to the phenomenon: "… Perhaps excessive moisture and poor aeration of soil that apparently fir is more sensitive than spruce are the reason behind abnormal fir development. Yet here is a question – why doesn't fir escape from excessive moisture to logs as it was noted with spruce? There is no fir regrowth on logs anywhere. It is possible that this phenomenon is more complex, and the answer lies somewhere deeper" (p. 169).

On the northern area line, Siberian fir has the form of a prostrate tree (**Fig. 116**) limited to humid and water-logged dark coniferous forests with heave moss carpet. This moss carpet and excessive moisture eliminate a seed regeneration of fir (whereas spruce keeps successfully regenerate on logs). Bottom fir branches get covered with moss, produce an adventitious root and lose the connection with a parent tree, spread through a moss carpet at a distance up to 5 meters (**Fig. 116,a**). In the case of adventitious roots reaching the inorganic soil, shoots take a vertical position and become a regular although, stunted regrowth (**Fig. 116,b**). Although in comparison to spruce, fir is a more thermophilic species, nevertheless it occurs in the Urals and Siberian Mountains even among the alpine tundra where it forms a unique prostrate type. This alpine type, as it was called a "special ecotype" by Korchagin (1936) forms a timberline in Altai (**Fig. 116,c**) and is different from Siberian fir by the external features: it does not get taller than 1,5 m, there are very few cones and they are smaller in size.

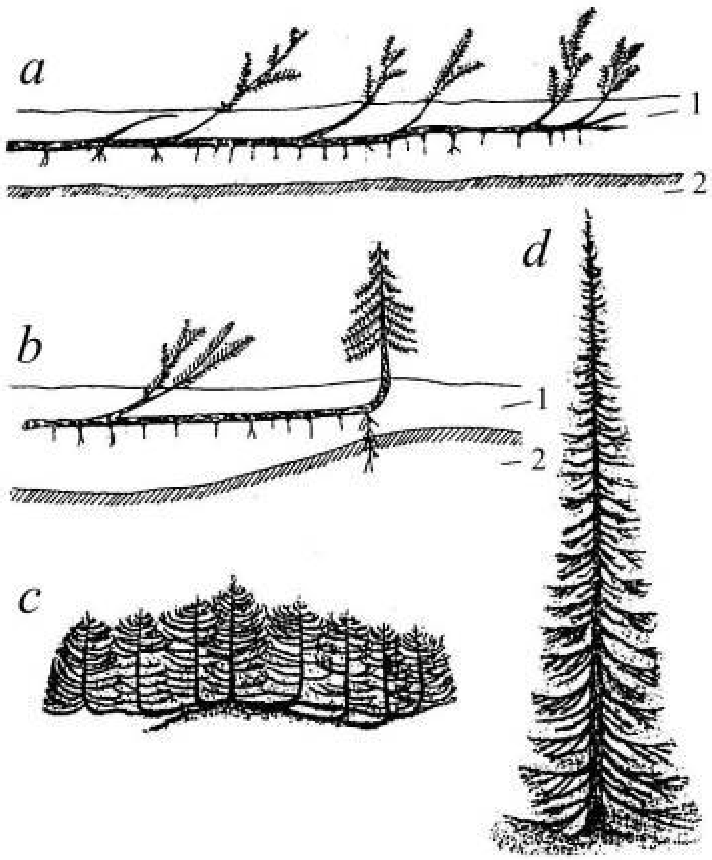

Fig. 116. Shrubby type of Siberian fir (Abies sibirica Ldb.*) on the northern area line in the north-east part of European Russia in the form of a prostrate in a moss carpet vegetative shoot with adventitious roots (a) or rooted in regrowth soil (b) (Korchagin, 1936) and an alpine form of A. sibirica f. alpine* Polijak *of a seed origin on altitude zonal limit in Altai (c) in comparison to the common form of Siberian fir (d) (Polyakov, 1931); 1 –moss carpet, 2 - inorganic soil.*

People who happen to be in the dark coniferous taiga for the first time usually confuse fir with spruce. It has similar cones and needle foliage and a narrow conical crown shape. However unlike spruce, fir does not have a small scale but smooth blue and grey bark, and cones do not hang down but point upward vertically (**Fig. 117**). As it was already mentioned, unlike other coniferous species, firs have no gum in its timber. Therefore in the bark in special vessels (gum pockets) there is a fragrant turpentine rich gum that is used for fir balsam production that out into use in the optical industry and medicine. The balsam has high microbicidal properties that wood choppers working in fir forests prefer always ready fir gum from freshly chopped resin galls to a first aid kit in case of an open cut. Fir needle oil is produced from the needle foliage by means of steam treatment that can be used in medicine, perfumery and camphora production.

*Fig. 117. When maturing unlike spruce cones (see **Fig. 74, 75**), fir cones keep an "upright" position (Petrov, Dorozhkin, 2002).*

Fig. 118. Gum pockets are well seen on Siberian fir smooth bark (Petrov, Dorozhkin, 2002).

Silver fir (*A. alba* Mill.) is distributed in Western Europe from the Pyrenees and Apennines to the Carpathians, occurs on Corsica Island and also in Belovezhskaya Pushcha. The tree is 30-50 m tall with up to 1 m in stem diameter, with a conical shape crown, smooth reddish grey bark (**Fig. 119**). Silver fir is sensitive to cold and dry weather and consequently its cultivation in eastern Germany is challenging, and outside of Moscow it is frost nipped and does not develop to a mature tree (Arnold, 1898).

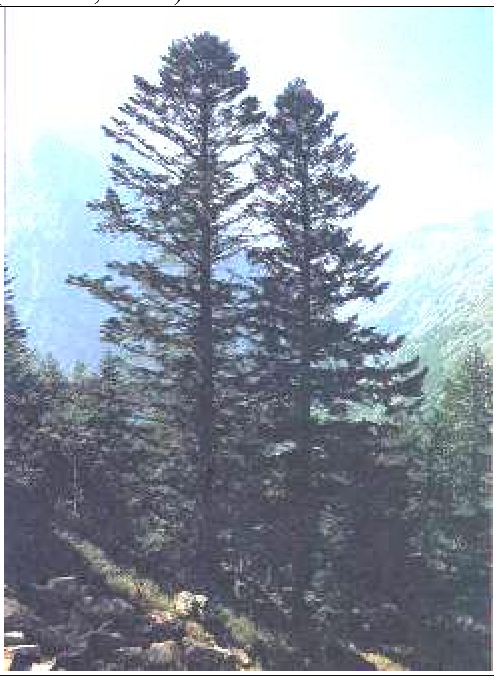

Fig. 119. Silver fir (A. alba Mill.) (Komaskella, 2002).

Fig. 120. Silver fir coppice growth on its own stump (Kurdiani, 1908).

If in the alpine conditions due to the special relief the stand canopy is broken and the conditions are favorable for silver fir regeneration, then on lowland under the heavy canopy there is either no fir regrowth or it is extremely stunted: being only 5-9 cm tall the regrowth is 80-120 years old. There is no fir regrowth on large grassy clearings but by a different reason – due to the high lighting intensity and soil drying out. Regrowth only survives on the grassy clearing of 230-450 m^2 in area (Yatsenko, 1916). Similar grassy clearings in old-growth forests often appear as a result of the fall of one or two over mature trees on which decaying trunks silver fir regrowth found favorable conditions unlike Siberian fir regrowth in dark coniferous taiga (Shenberg, 1904): "As time goes by, the trunk disappears and only straight lines of trees can testify of their development" (p. 871). Sometime silver fir can reproduce vegetatively but not by the means of layers but start a coppice growth from stumps (**Fig. 120**).

In the Khabarovsk and Primorsk territories and also in the north-east of China and The Korean Peninsula, there is the East Siberian fir (*A. nephrolepis* (Trautv.) Maxim.) (**Fig. 121**) – an unfailing companion of the Ajan spruce. The tree is up to 20-30 m tall up to a 50 cm trunk diameter, with rich narrow pyramidal shape, crown and smooth and very light bark with numerous gum pockets. It doesn't form a single species stands, it is distributed in the floodplains on rich soils. During the first 20 years it grows faster than the Ajan spruce. East Siberian fir requires a lower temperature for growth than spruce. That's why its share in the mixed with spruce forests goes down advancing from the south to the north and with higher altitudes (Orlov, 1955).

There is also the Manchurian fir (*A. holophylla* Maxim) (**Fig. 122**) on the south of the Primorsk territory and in the north-east of China and the Korean Peninsula. Manchurian fir is a large tree of 30-40 m of height and with a narrowly conical crown; mature trees have a flat top. In the south of the Primorye they call it black fir; it forms black fir and deciduous forests with a hornbeam share or single black fir forests that are typical glen forests (Bobrov, 1978).

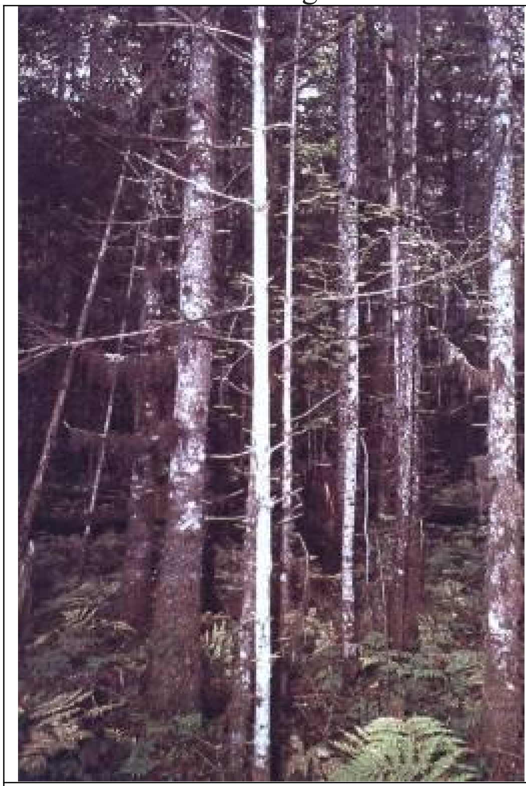

Fig. 121. East Siberian fir (A. nephrolepis) in the Far East (Forest encyclopedia, 1986).

Fig. 122. Manchurian fir (A. holophylla Maxim) (http://pihtahvoya.ru/chvoynie-derevya-i-kustarniki-dalnego-vostoka/rod-pichta/).

If the most common in Northern Eurasia types of firs – Siberian, silver and East Siberian fir – belong to a group of smooth bark, scrub trees reaching up to 200 years of age, then growing in the Caucasus endemic Caucasian fir (*A. nordmanniana* (Steven) Spach) (**Fig. 123**) belongs to the group of tall trees with friable bark reaching up to 500-650 years of age (Orlov, 1951). Caucasian fir survived in the Caucasian glens since the pre-glacier period and during the pre-glacier period it formed present fir forests (Krylov et al., 1986). The area of the species spread from the western part of the Greater Caucasus Mountain Range and along up to Caucasus Minor rounding the Black Sea coast (see **Fig. 108**).

Fig. 123. Caucasian fir - A. nordmanniana. (http://geophoto.ru/?action=show&id=177882).

Caucasian fir is a haughty tree becoming "a subject of wonder and delight of European foresters" (Arnold, 1898; c. 463). Together with oriental spruce (*Picea orientalis*) (see **Fig. 85**), Caucasian fir forms Caucasus dark coniferous forests. Caucasian fir has a rounded shape crown attached to the upper third of a trunk. When a tree is young the bark is smooth, grey; approximately at the age of 90 years old it becomes lateral, friable and by the mature age it turns into a grey and brown color with deep grooves. It is a very ornamental tree being superior to Siberian and silver firs in beauty and size. Single species fir forests prevail on the North Caucasus, regrowth is spread more evenly than spruce regrowth in fir and spruce stands which in the last case explains spruce regeneration affiliation with decaying windfall.

Caucasian fir is a purely alpine tree. This species is wind resistant with a deeper than spruce root system: in mature stands 80% of the root weight is located in a 0-40 cm thick layer whereas the oriental spruce root go only 0-20 cm deep (**Fig. 124**). The stem reaches up to 52 m in height and up to 2 m and more in diameter, stem volume is up to 39 m^3, growing stock is up to 2,000 m^3 per 1 ha (Orlov, 1951).

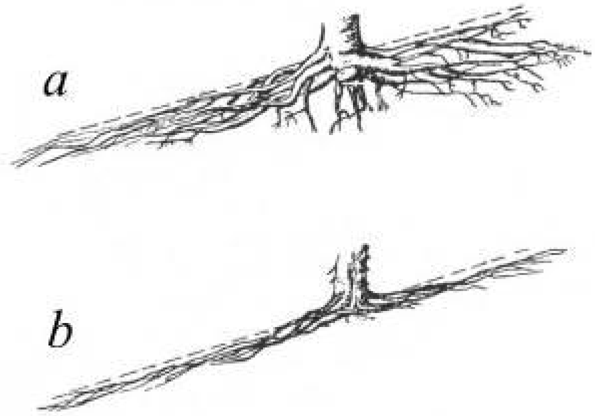

Fig. 124. Root systems of Caucasian fir (a) and oriental spruce (b) on the northern slope of the Caucasus Mountain Range (Krasilnikov, 1951).

The Tien Shan dark coniferous forests are equally formed with Tienshan fir (*A. semenovii* B. Fedtsch.) and Schrenk's spruce. Their canopy density is not that close and they have a park appearance, occupy mountain forest belts at the altitudes of 1600 to 2500 m. Tienshan fir survived in the mountain refuges of western Tien Shan since the pre-glacier period (Krylov et al., 1986) and usually occupies northern slopes. It is an up to 40-50 m tall tree with a stem diameter of up to 1 m with a pyramidical shape crown and smooth grey bark (**Fig. 125**). A total forest area of this fir species is 4000 ha and the regeneration goes very slow (Bobrov, 1978).

		
Fig. 125. Tienshan fir (http://www.plantarium.ru/page/image/id/9758.html).	*Fig. 126. Sakhalin fir (http://www.vashsad.ua/encyclopedia-of-plants/coniferous/show/131/).*	*Fig. 127. Abies mayriana* Miyabe *et* Kudo *(http://kvetok.ru/rastenie/pikhta-maira).*

Sakhalin, the south islands of Kuril Ridge and Hokkaido Island (Japan) make the area of Sakhalin fir (*A. sachalinensis* Fr. Schmidt). The tree is up to 30-35 m tall with a pyramidal and pointed shape crown and relatively smooth grey bark, when mature bark cracks (**Fig. 126**). This fir species together with the Ajan spruce forms dark coniferous forests however, it has a subordinated status in the stand as underwood or regrowth. Sakhalin fir often occurs with Stone birch (*B. ermanii*) in the upper mountain belt. It often dominates on south Kurils and sometimes forms single species fir forests. The share of East Siberian fir and Sakhalin fir in the Far East dark coniferous forests does not go higher than 40% (Sochava, 1944; Bobrov, 1978).

Abies mayriana Miyabe *et* Kud*o* is distributed in the south of Sakhalin and on the majority of Hokkaido. The tree is up to 25 m tall (**Fig. 127**). The species is close to *Abies sachalinensis* but is different by the oval, dull-shaped crown, smooth throughout the life bark, shorter and narrower needles, on strobiliferous shoot by a rounded or situated tip and extending bent backwards scales. Together with the Ajan spruce, it forms dark coniferous forests and frequently is the dominating species (Ovsyannikov, 1934).

An absolutely unique and only forest island on the eastern Kamchtka shore in the Creek of Semlyanchik River that discharges into the Kronotskiy Bay is formed with the Kamchatka fir (*A. glacilis* Kom.). The growing stock is about 100 years old and is located down the glen slope hidden from onshore winds. It is the most cold-resistant species among the other fir species. It is a preglacial relict developed in the harsh conditions of the Ice Age due to the ground-water discharge moderating the climate situation. It is believed that it is a sample of ancient forests ruined by the volcanic explosions in prehistoric times (Falaleyev, 1982).

Poor capability (V productivity class) is considered as a hereditary feature of the Kamchatka fir. Despite the small natural seeding radius only slightly overcoming the stand, the fir island extend its borders and single trees can occur in the joint stone birch forests (**Fig. 128**). As well as silver fir regrowth, the regrowth of the Kamchatka fir also prefers decaying logs (Turkov, Shamshin, 1963).

The area of the relict groove is about 15 ha whereof 7 ha were preserved in the natural state. Long since the local community considered it sacred, however, it didn't stop timber harvesting to fell 8 ha out of the total 15 ha area. This only Kamchatka fir forest is under strict protection as a natural monument, as a relict island (Sokolov et al., 1977).

Fig. 128. Kamchatka fir (A. gracilis Kom.*) regrowth outside of the relict groove on the eastern Kamchatka shore (Turkov, Shamshin, 1963).*

Consequently fir species, despite their almost universal distribution with spruce species have their own historical development characteristics and biological and ecological features. Fir is warm, water and nutrient dependent thereby its area limits goes southward while spruce area is limited to the north and usually lower – along the vertical profile in highlands. It forms a shrubby type of seed origin on the area altitude limits whereas on the latitude limits on the lowlands of European Russia, not being able to compete with spruce and moss formation it degrades and switches to vegetative reproduction shaping a layering form without cones.

Fir has a deeper root system than spruce which makes it more wind resistant on lowlands and needs a better soil aeration. Unlike spruce, fir cannot exist next to excessively developed moss formation. It does not survive a stagnant moistening and is not generally attached to decaying windfall for reproduction. If Siberian, Caucasian and East Siberian firs do not regenerate on decaying logs and stumps giving the preference to surrounding areas often covered with a heavy grass canopy, then the Kamchatka and silver fir seeds find favorable conditions for regeneration on a decaying organic substrate.

5. Pine (the five-needle subgenus *Haploxylon*) – "the Russian forests tsar"

The most ancient center of the pine species formation was located in The Himalayas and Plateau of Tibet, where in the Pre-Cretaceous time the south pine ancestor (*Cedrus* Trew.) originated from. With the climate aridization and cooling three-, four- and five-needled, pine spread from the Himalayan and Tibet center to the north to the mountains of Altai and Sayans. The latter, the five-needled pine, originated the present Siberian species, *Pinus sibirica* Du Tour (**Fig. 129**). In the Cretaceous and Tertiary periods; in the Preglacier period a separate branch of the Siberian species found its way to Europe and originated the arolla pine - *P. cembra* L. (Krylov et al., 1983).

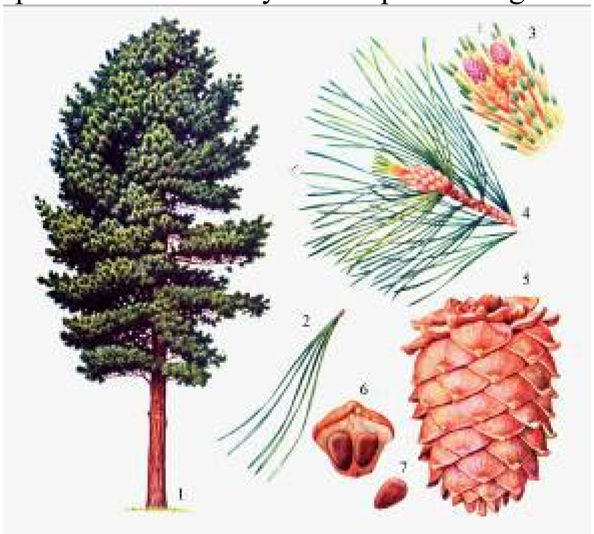

Fig. 129. Siberian stone pine (Pinus sibirica Du Tour): 1 – tree general view; 2 – a brachyblast with five needles; 3 – a long shoot top with an ovulate strobile and developing needles; 4 – a shoot with staminate strobiles; 5 – a mature cone; 6 – a sclerotic seed scale with two seeds; 7 – a seed (Forest encyclopedia, 1985).

All the five-needled species of the *Cembra* section are alpine by origin and are the most ancient from the gymnosperms group (**Fig. 130**). This old area partially accounts for the mountains of Central and South-West Asia, Europe, Siberia and the south Urals. The younger part of the area went down to western Siberia swampy plains from the mountain refigures in the Postglacial period where pine was forced out with fires from better sites to sphagnum bogs making a scrubby form (*P. sibirica* f. turfosa Gorodk.) (Smolonogov, Zalesov, 2002).

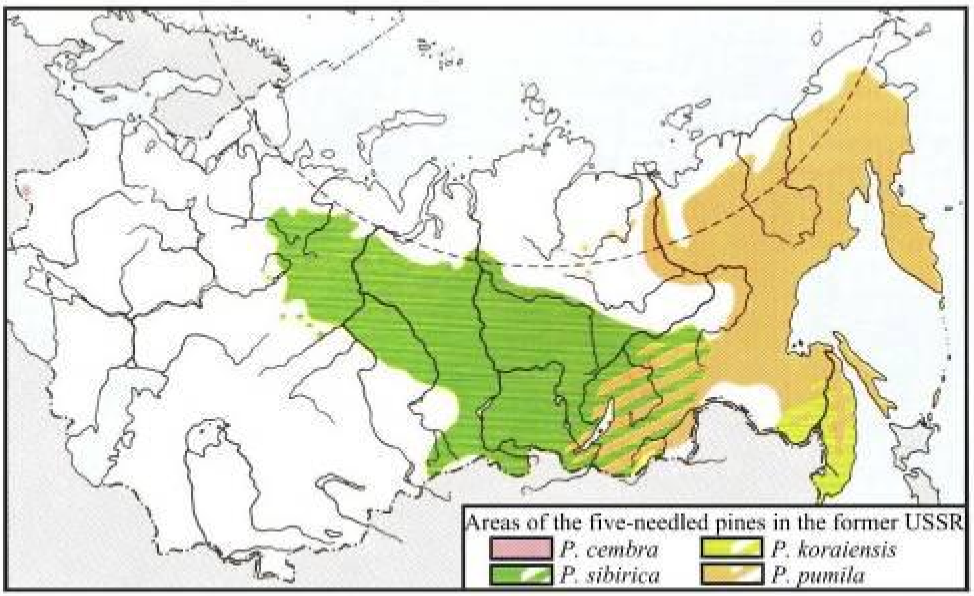

Fig. 130. Main areas of 5-needled pines in the former USSR (Forest encyclopedia, 1985).

Siberian stone pine – the national species of Russia - characteristics should be presented with the list of its main "fellows" in a five-needled *Cembra* section. Out of the "north" pine number which distinctive feature is the present of eatable wingless seeds or nuts, along with Siberian stone pine we can also name the Cembra pine (*Pinus cembra* L.), Korean stone pine (*Pinus koraiensis* S. *et* Z.) and dwarf stone pine (*Pinus pumila* (Pall.) Regel). All these species belong to *Pinus* genus (pine) and apparently were named wrongly, supposedly in an easy Kazaks' state of mind: "The Kazaks arrived to the Urals and captivated with a view of a powerful and wonderful needle tree that was never seen before and named it a great cedar of Lebanon that represented might and beauty to them" (Keppen, 1885).

Cembra pine (P. *cembra*) is close to Siberian stone pine but is distinguished from the latter by a shorter height (15-20 m), smaller cones and seeds. It grows slower than the Siberian stone pine, is shade-tolerant and requires humid air and soil however, originally as a mountain tree can also grow on a rock outcrop (**Fig. 131**). It is distributed in the mountains of France, Italy and Switzerland and also in the Balkans and Carpathians reaching altitudes of 1500-2000 m A.S.L. The oldest registered tree is 1215 years of age (http://alanles.ru/dolgovechnost-derevev.html).

Fig. 131. Cembra pine (P. cembra L.*) on a sheer cliff in the High Tatra Mountains (Jenik, 1987).*

Bobrov (1978) included the Korean stone pine (*P. koraiensis*) in the *Koraienses* species sequence of the section *Cembra* Spach. It is a large straight tree up to 60 m tall and up to a 2 m trunk in diameter. This species has the largest cones of 13-17 cm long. It is distributed in the Far East and also in north-east Chinese Mountains, Korea and north Japan; it usually grows on mild and stiff mountain slopes and it is wind resistant (**Fig. 132**).

Ovsyannikov (1934) emphasizes two characteristics of the Korean Stone pine. First, it is its lateral root system (**Fig. 133**). There is no pronounced major root and there are a number of almost horizontal powerful lateral roots with the help of which pine entrenches well on lithosolic soil of mountain slopes and on a drift soil of creek and mountain valleys. It fills rock ledge cracks with its roots and roots tight on rock deposits.

Fig. 132. Korean stone pine stand (http://forest.geoman.ru/books/item/f00/s00/z0000002/st016.shtml).

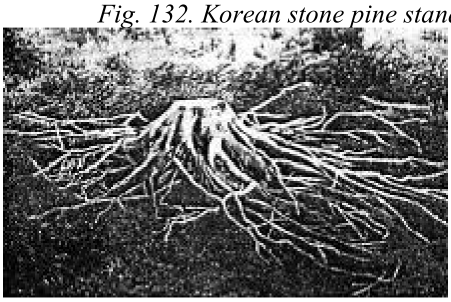

Fig. 133. Korean stone pine roots - P. koraiensis S. et Z. (Koldanov, Solovev, 1960).

The second characteristic is an observed multiple top crown. At a mature age, several tops growing vertical and almost parallel to each other occur. This phenomenon is explained with the need of the tree of the fertile top enlargement with the aim of large cone area formation on the more enlightened upper part. Yet Ovsyannikov (1934) supposes the more possible reason for the crown "layering" is the damage of the original normal tree top under the wind influence and the large cone weight during fruitful years.

Dwarf stone pine (*P. pumila*) is the main representative of the dark coniferous forests in north-east Siberia from Lake Baikal to Kamchatka and Sakhalin (**Fig. 134**). The range also covers the Far East, the Great and Small Khingan Mountains, the high mountains of the Korean Peninsula and Japan. Unlike the other mentioned species, it is a shrub with a crooked stem, with widely spread branches and extended thin and rarely foliated shoots with small cones. It now has industrial value but plays an important ecological and biological role (Utkin et al., 2001).

In the specific extreme conditions, dwarf stone pine has developed an ability to bend to the ground in cold weather, and when it warms up it raises up to the original height forming a dispersive photosynthesis canopy that is adapted. These characteristics explain a phenomenal vitality of dwarf stone pine and its capability to grow under extremely poor conditions. It is soil and soil moisture undemanding. It is distinguished by its shade tolerance and that's why it can grow in an understory staying small and has a relatively straight trunk tree (Tkachenko et al., 1939; Kotlyarov, 1973; Bobrov, 1978; Krylov et al., 1983). However according to Mezhennyi (1978), dwarf stone pine almost does not bear fruit and often dies in the suppressive conditions; he names the lack of light under the mixed forest canopy as one of the reasons preventing its spread west of the area.

Fig. 134. Dwarf stone pine (http://www.farmaia.ru/sosna-stlanikovaya-kedrovyj-stlanik/).

Bobrov (1978) includes dwarf stone pine to the *Pumilae* species group. Pallas first described it in 1786 as a subspecies of cembra pine – *P. cembra* L. var. *pumila*. The independency of the *P. pumila* species was problematic until later. Kolesnikov (1956) splits up *P. pumila* shrubby coppice into two type groups: the seaside coppices on sandy beach ridges and hummocky peat bogs on the shores of the Sea of Okhotsk, the Gulf of Tatary and the Sea of Japan north of 46°N and the subalpine coppices making the upper line in all the mountain ranges. Dwarf stone pine gets to altitudes of 500-800 m in the north and up to 1600-2000 m in the south area. A total area range from the west to the east is more than 2.5 thousand km, and from the south to the north is over 2 thousand km (Bobrov, 1978; Krylov et al.,, 1983).

The “south” or the “true” pines are the representatives of the genus *Cedrus* Trew. They are the cedar of Lebanon (*Cedrus libani* A. Richard) growing in Lebanon and Turkey (**Fig. 135**) and reaching up to 3 thousand years of age (Matveyeva et al., 2003), Atlas cedar (*C. atlantica* Carriere) distributed in the mountains of Algeria and Morocco and Himalayan cedar (*C. deodara* G. Don) growing in The Himalayas and the mountains of Afghanistan and Pakistan. Unlike the northern types, they don’t bear eatable nuts and look more like Siberian Larch. They have been cultivated in Europe and Russia since the middle of the 19th century (**Fig. 136**). There are relatively small seeds with wings in cones similar to Scots pine seeds. In ancient times south pines were considered as sacred (which didn’t stop humans from extirpating them on large areas). For example, Himalayan cedar was cultivated around temples (deodara means divine tree) and some goods were made out of the cedar of Lebanon wood found in Tutankhamen’s tomb (Petrov, 1951; Matveyeva et al., 2003).

Fig. 135. Cedar of Lebanon (Cedrus libani A. Richard) in the natural site conditions (Komaskella, 2002).

Fig. 136. Cedar of Lebanon on the streets of Old Prague. Photo by Usoltsev.

In Russia Siberian stone pine ranges, on the area of 36 million ha, with a total growing stock of about 7 billion m^3, from foothills of the northern Cis-Ural region on the west to the Lena and Amur rivers basin divided on the east and from the lower reach of the Yenisei in the north and to the Mongolian border in the south. However some relict Siberian stone pines of an automatic origin occur in the forest steppe foothills of the South Urals, on the Kola Peninsula and even on the White See islands. Regarding the latter, is that there is a hypothesis of their origin “from some unknown oasis's” (Vasiliev, 1964b; Smolonogov, 1990; Mitrofanov, 2005).

Siberian stone pine is a large tree with candelabrum-like lifted branches and relatively thin bark, up to 40 m tall and with a 1.5 m trunk diameter. In the Urals and Siberia, “pine life is over 400 years” (Keppen, 1885. P. 30), but around Verkhoturye a 700 year old tree was found, and in Siberia some pines reach up to 850 years (Krylov et al., 1983).

The optimal for Siberian stone pine are sandy loam, clay-loam, and well drained soils; however it also grows on dry sand and rocks among its distribution range. Popov (1957) characterizes pine as “a cold and humid climate tree, rather than a tree of fogs; soil moisture is less essential for it than air humidity” (p. 8). Siberian stone pine root system is well developed on drained soils, but under any conditions Siberian stone pine is more wind resistant than Scots pine (Sukachev, 1938; Tkachenko et al., 1939).

Siberian stone pine rarely forms a single species forest and taking into account its higher value in comparison to other species, forest inventors refer stands with relatively low pine composition share (15-35%) to stone pine forest category (Semechkin, 1971). Foresters wrote about this Siberian stone pine feature already in the beginning of the last century: "…In Shishansk forest district spread on the northern slopes of the Sayans, pine only occupies 93% of the forest floor on the area of 111,000 destines (*desyatine is a land measure equivalent to 2.7 acres).* Despite the area immensity where pine grows in Siberia, there are just a few *single Siberian stone pine forests* similar to pine forests, and we can understand a single Siberian pine forest under "cedar forest" (Baryshevtsev, 1917. P. 44).

By its habitus (appearance), Siberian stone pine is a rather polymorphic species, i.e. it can have a crown of a different shape depending on the age, site conditions and height (Nikolaeva et al., 2011). **Figures 137, 138 and 139** shows three main habitus types respectively:

		
Fig. 137. Immature Siberian stone pine forest (Krylov et al., 1983).	*Fig. 138. Old-growth Siberian stone pines forest (Krylov et al., 1983).*	*Fig. 139. Siberian stone pine forest near a village. Photo by Sedykh.*

• Under the tree layer continuum conditions at a immature age but already with a "candelabrum like" crown (see **Fig. 137**);

• In an old-growth Siberian stone pine forest where a live crown survived only on the most upper part and there are only halfway dead branches down the trunk (see **Fig. 138**), and

• In Siberian stone pine forests (that produce up to 600 kilos of nuts per 1 ha) appearing near Siberian villages as a result of human economic activities during decades and hundreds of years (Nekrasov, 1971). Those trees have spreading low set crowns (see **Fig. 139**). In Ekaterinburg, young Siberian stone pines of this habitus type grow in the city center, on the Plotinka (Little Dam), in stark contrast against nearby "crooked" larches. Among the coniferous species, Siberian stone pine is considered to be the most smoke-resistant tree and is recommended for the urban greening in large industrial centers (Ignatenko, 1988).

Baryshevtsev (1917) wrote the following about Siberian stone pines growing near villages: "Farmers from Tobolsk… see Siberian stone pine as a *fruit tree*, as one of the sources of income and treat it with due care considering it as a "precious" tree. Therefore cutting down other species trees in nearby forests with Siberian stone pine mixture they create favorable conditions for young Siberian stone pine crown development… In the protected Siberian stone pine groves for the sake of its seeds, crowns develop a splendid heavy oval shape; in solid low land forests Siberian stone pine is not a beautiful tree by any means; a crown survives only on the top and lower, only dry branches stick out" (p. 45).

An original Siberian stone pine crown habitus can form on the timberline, in the alpine tundra. On the **Fig. 140** you can see a three-storey crown formed on the Western Sayans Mountains limit at 1950-2000 m A.S.L. due to the very harsh climate conditions and poor rank soils, trees grow separately and are wind-swept. Like Scots pine, Siberian stone pine habitus can be deformed with a "witches' broom" and their "symbiosis" can last for hundreds of years (**Fig. 141**) (http://росхвойные.рф/index.php?page=user&login=gorosh).

Nature created a special value complex in the Siberian stone pine forests:

- Pine seeds (nuts) are a food concentrate including seed oil (60%), protein (20%) and carbohydrates (12%); pine nuts contain about 70% of the natural seed oil stock of Russia (Petrov, 1949; Smolonogov, Zalesov, 2002);
- soft resin that is more valuable by its chemical makeup in comparison to pine and regular ones; and
- timber with unique characteristics (light, firm, nice texture and great sounding properties).

Fig. 140. Siberian stone pine three-storey crown formed under the interfacing snowstorm influence in the surface layer when winter wind transfers small ice crystals with a high speed destroying all flesh. A naked trunk spot forms in the middle part of the crown and a heavy "cushion" of healthy undamaged branches that survived winter under the snow forms in the bottom part. The top part of the tree is represented with a regular flag-shaped crown formed under the wind influence. Goroshkevich is standing next to the tree (http://росхвойные.рф/index.php?page=user&login=gorosh).

Fig. 141. "Witches' broom" on a Siberian stone pine. Southern Transbaikal, Alkhanay Mountain, 1600 m A.S.L., upper part of the forest belt. The tree is 350 years old, "witches' broom" is 250 years old. Goroshkevich is sitting on the "broom" (http://росхвойные.рф/index.php?page=user &login=gorosh).

Siberian stone pine timber sanitizes the air in rooms. That's why the interior décor with Siberian stone pine planks and blocks is popular, not just because of the beautiful texture and color, but as a sanitizer having a good impact on people's health. Siberian stone pine timber releases essential oils, it is easy to breath in a house made of this kind of timber. In a house planked with Siberian stone pine timber, there are always less mosquitoes and blood-sucking insects which are highly important for Siberian conditions. Milk does not turn sour longer in dishes made of Siberian pine timber, berries and mushrooms are preserved better in it. Moths never appear in Siberian stone pine timber closets and bees feel better in beehives made of Siberian pine timber (Chizhov, Bekh, 2014).

Petrov (1973) describes a funny story regarding the resonating characteristics of Siberian Stone pine: "The resonating characteristics of Siberian Stone pine for musical instrument manufacturing were duly appreciated in pre-war Germany. For pianos and grand pianos, German firms started using Siberian stone pine boxes in which butter from Siberia was exported… There is an official record where trading firms made a condition for the Siberian butter exporters to double the thickness of the planks that the boxes were made of" (p. 18).

The healing properties of Siberian stone pine timber and forests were confirmed with a lot of research. Ignatenko (1988) writes that, "Siberian stone pine is a pharmacologist tree… Siberian stone pine world is the world of wonder and mystery" (p. 10). For a long time Siberian pine took the name of a "bread tree" because since the time of Ivan the Terrible and later during several following centuries, pine nuts had commercial value and were the export subject. Baryshevtsev (1917) confirms that "tradesmen from Biysk measured a total amount of nuts obtained in Siberia –

1,200,000 poods (*1 pood is 16 kilos*); and more than 40,000 accounts of poods on the Altaic nuts along" (p. 47). The fruit-bearing of Siberian stone pine in closed stands begins at the age of 40-50 and a bumper seed crop accounts for the age of 60-100. Grafting stimulates the fruit-bearing start (Titov, 2007) (**Fig. 142**). Siberian stone pine bears fruit up to the great age. The periodicity of fruiting is typical for Siberian stone pine depending on the genetics, age, climate, weather conditions, site conditions and other factors (Goroshkevich, 2008; Velisevich, Petrova, 2009). Bumper seed crops among Siberian stone pine population in the Urals come in every 7-9 years (Smolonogov, 1990). In Eastern Siberia this period is shorter – 4-5 years (Bratilova et al., 2014).

Fig. 142. Fruit bearing of a grafted Siberian stone pine on a seed plantation. Altai Mountains. (Photo by Usoltsev).

However with a rare downtime (in Siberian pine forests near villages), annual crops of a different intensity occur (**Fig. 143**). Plant breeders stood out samples on which cones grown as a bunch of 5-9 pieces and called it a "cone bunch" like form (**Fig. 144**) (Bratilova et al., 2014).

Siberian stone pine being a nut-bearing species by means of a food web is also an important regulator of habitat and abundance dynamics of many types of taiga birds and animals. On the other hand, only due to these food webs, the natural regeneration of Siberian pine is possible on deforested ("scalped") regions and its expansion in the geographical space. The agents contributing into Siberian pine seed spread are for the most part a nutcracker, a Siberian chipmunk, a squirrel, a Siberian jay; in a less extent – a capercaillie, a bear, a nuthatch and etc. 23 types of birds and 10 types of mammals take part in this cooperation (Reimers, 1956a; Smolonogov, Zalesov, 2002).

Fig. 143. A fruitful tree of a Siberian stone pine.

Fig. 144. Multiple cone form of a Siberian stone pine (Bratilova et al., 2014).

Yet the main role in this process belongs to a nutcracker (*Nucifraga caryocatactes macrorhinechus* L.) related to the crows genus; size wise it is smaller than a jackdaw and has a dark brown coat with white spots (**Fig. 145, 146**). Namely a nutcracker should be given credit for Siberian pine regeneration and preservation as a species for several million years. An observation of the famous traveler and great scientist of Lomonosov's school, the academician Ivan Lepekhin (1814) in the Urals climbing the Pavdinskiy Stone is remarkable: "A puck forest changes from a broadleaved to a coniferous one where we saw the great power of flying nutcrackers; and it seemed that this forest was meant to be just these birds" (p. 108). This symbiosis plays such a significant role in the species evolution that the bird size correlate to the cone size: in comparison with the Siberian pine habitation, a nutcracker is half the size of the Siberian dwarf pine area and twice the size of the Korean stone pine (Smolonogov, Zalesov, 2002).

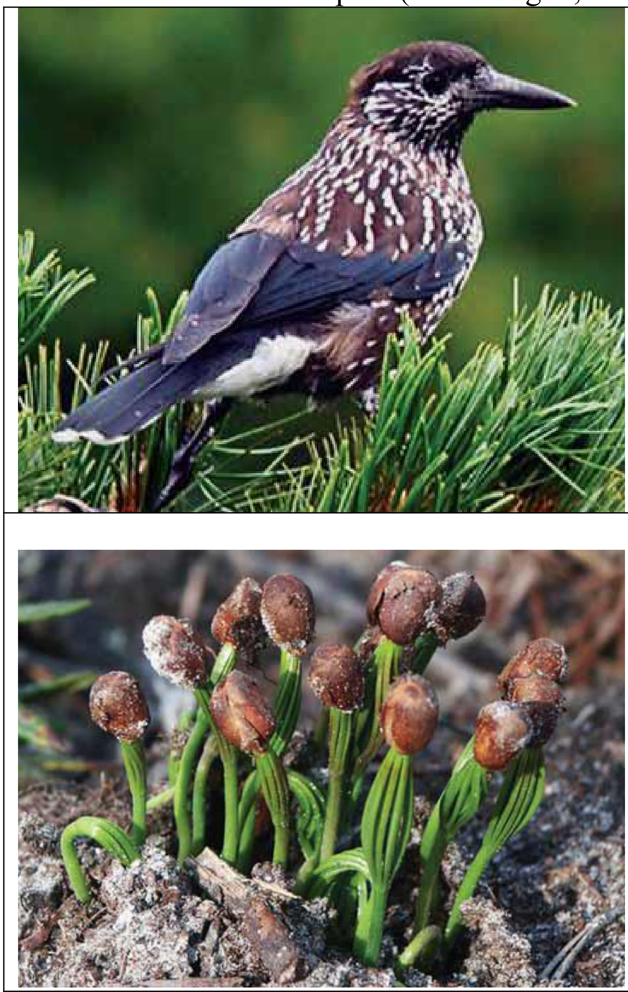

Fig. 145. A nutcracker and the results of its forester activities – a bunch of Siberian stone pine from the nutcracker's unused savings (Chizhov, Bekh, 2014).

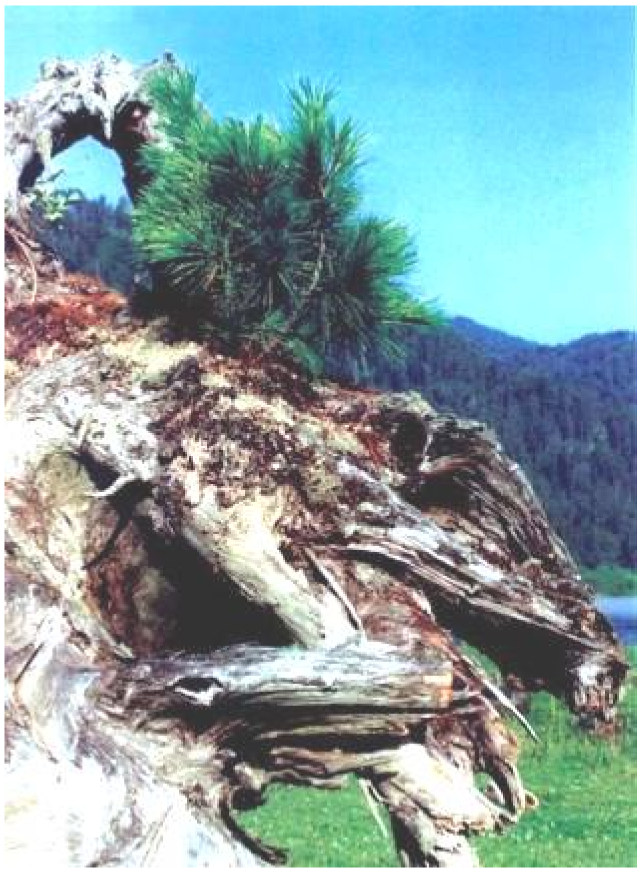

Fig. 146. The results of a nutcracker as the forester activities: 5 years ago it put off some pine nuts on a submerged stump and forgot about them (Usoltsev, 2008).

The nutcracker spread seeds over a distance of 10-15 km (Smirnov, 1957) and can store as many as 30,000 nuts per hectare in single spots. During the fall time this bird can make up to 20 thousand of layings, and 35% of them will wind up in winter under the deep snow due to its visual memory (Bekh et al., 2004). Pulling out nuts, the nutcracker stores them in a unique sack located between the mandible bones. After that the nutcracker flies for a long distance with its load (from 50 to 120 nuts) and hides nuts in small bunches, covering them with a light litter or moss (Krylov, 1971; Talantsev et al., 1978; Petrov, 1982). Ovchinnikova (2003) in the Western Sayans taiga stated that the majority of the Siberian stone pine regrowth was concentrated not under the aspen or fir stand, but under the birch canopy. She finds the better regeneration conditions are under the birch canopy however, she does not explain the motivation of such a preference from the nutcracker's side.

Thus the nutcracker choses the Siberian stone pine establishment space. It stores nuts on emerging micro elevations so it can easily find the food under the snow, but for young Siberian stone pine it can cause a fatal outcome (see **Fig. 146**). Usually in that case, developed over thousands of years and a genetically steady strategy of survival in this unique symbiosis with the nutcracker recovers Siberian stone pine (**Fig. 147**).

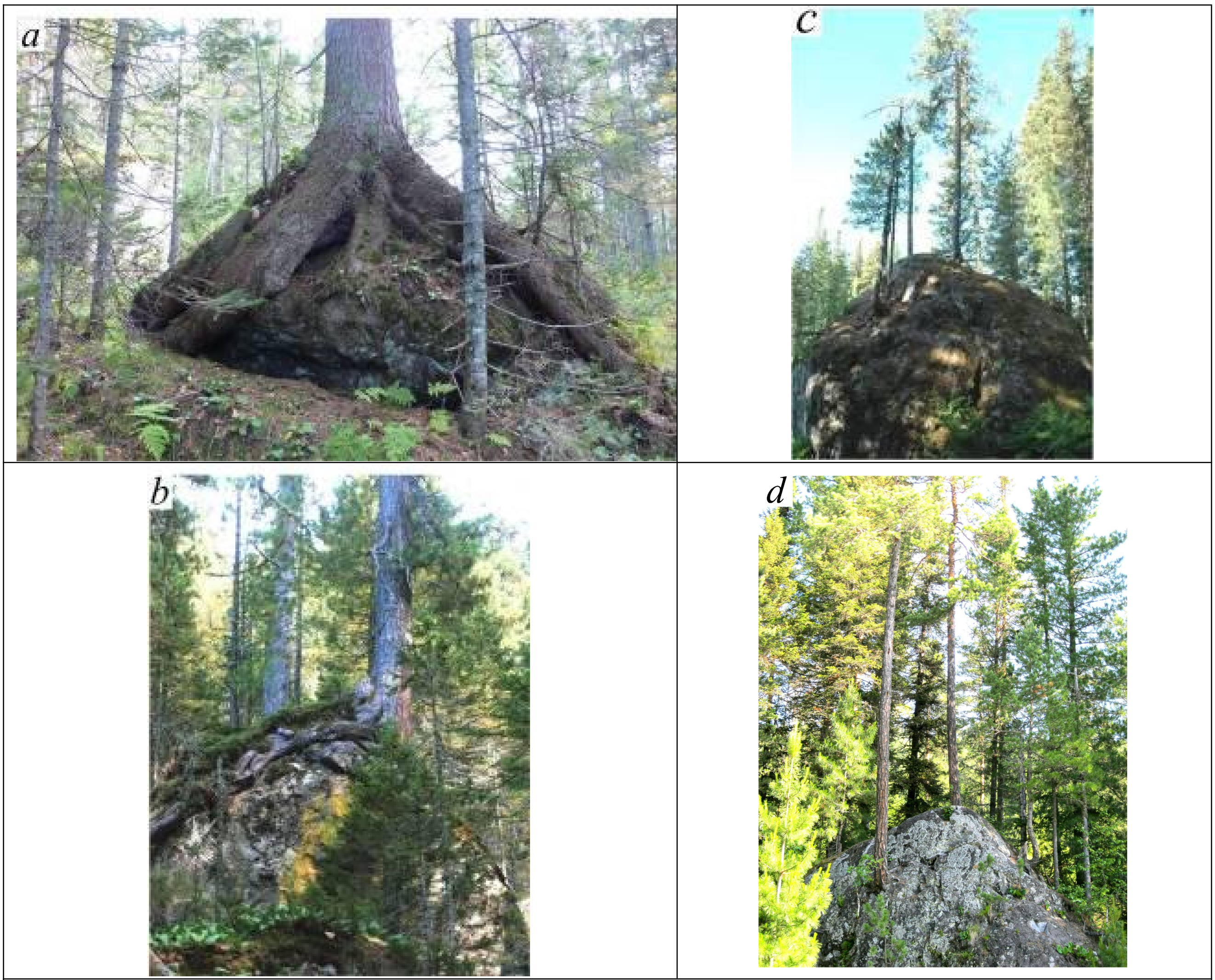

Fig. 147. Siberian stone pines settled on large rocks by the will of nutcrackers. ***a, b*** *Left – on Khamar-Daban range;* ***c, d*** *right – in the Altai Mountains. Photo by Usoltsev.*

The nutcracker prefers to store nuts on burnt areas and cutting areas carrying them from trees that survived fires and felling in the micro depressions and on water-logged areas. The regeneration dynamic alternatives of Siberian pine forests are diverse (Smolonogov, Zalesov, 2002). Many note the primary occupation of the mentioned areas with small-leaved forests where the nutcracker forms the regrowth that step by step turns into a main stand (Reimers, 1956b; Talantsev, 1971; Smolonogov, Zalesov, 2002; Ovchinnikova, 2003). Ignatenko (1988) writes more specifically about it: "Siberian stone pine grows better under the alder and birch canopy. The best forest density of such kind of alder and birch forests is 0.3-0.5 where Siberian stone pine grows successfully and is not harmed with *Pineus cembrae Cholodkowski* " (p. 150).

The competition between closed broadleaved canopy and Siberian pine regrowth does not always end in favor of the latter and in that case it leads to a species change. Something similar was noted and apparently first described by the academician Lepekhin (1814): "… Those who saw burned areas in coniferous forests knows that a coniferous forest always replaces with a broadleaved forest such as aspen, birch, rowan and other. The reason is that during forest fires coniferous trees with their fruit disappear; seeds of other species cannot be delivered to burned areas due to its weight; unlike seeds of weak trees, it can be spread and seeded on open and burned areas, later becoming stronger and overgrow pine and other coniferous species if in any case were seeded there, for example with the help of birds" (p. 71-72).

People's presence in forests scare away tenants of the wood and that's why hardly anybody sees their "activities" in the real life. Unique "sketches of the nature" made by different witnesses are even more valuable, and it makes sense to describe some of them here.

Here is Belousov's (1917) description of a "working" nutcracker, "A jay, a nutcracker and a cuckoo… furiously rub a Siberian stone pine forest collecting provision for winter. The nutcracker worked extra hard. On September 16th, 1915 on the split near the outlet of the Kenzelyuka River we witnessed an interesting fact. A thin line of the split connected a small island with the coast. From a far we saw a monstrous animal dragging along from the coast to the island. Having gotten closer to it, we realized that it was a nutcracker, barely moving with incredibly huge head, neck and prothorax. Having noted us and decided that it won't be able to move far with such a heavy load, it found an old elk's footprint and spat out some pine nuts, dug them up with its nubs and trotted away to the island. Having stored the rest there, it flew back to the forest for a new portion. We found 57 pine nuts in the footprint. Since the nutcracker got slimmer, only a short time after the procedure was it able to carry around 200 pine nuts" (p. 442).

Petrov (1982) described his encounter with a Siberian chipmunk "Once in the logged area, 100 meters away from a Siberian stone pine forest a forester and tracker Konev noted a running chipmunk with puffed up cheek pouches. It was holding dry rolled aspen leaves in its mouth… Then it hid under a rotten aspen log. When we lifted up the log we found an entrance hole leading to a globe-shaped cell…The whole cell was carpeted with dry aspen leaves and filled with pine nuts almost up to the brim… The chipmunk was extremely nervous during the pine nuts "confiscation". Not going more than 3-4 meters away from the destroyed cell it was continuously running, sniffing the ground that had been dug up, picking up remaining pine nuts and rashly shoving them back into its cheek pouches. Several times it got as close as a half of a meter to the people and shaking, stood up on back legs" (p. 58).

Siberian stone pine forests are squirrels' all-time favorite site. Since there is not enough food for everyone in the seasons between cone years, squirrels can come to more productive Siberian stone pine forests from a far overpassing water barriers. Petrov (1982) describes this kind of crossing the following way: "Some kind of black ribbon was running from a far shore. It was drifted downstream but it slowly moved towards the shore… And now it was already possible to see that thousands of casted up squirrel tails were flapping above the water. They swam not too fast but wilfully, with confidence. Their eared snouts, narrow lines of greyish and sliver backs and rose up right fuzzy tails were seen from the cold water. The river was teeming with squirrels and the hunger urged them from their home". After the crossing, squirrels "ran straight to our hut and ravened the cone piles ignoring our presence" (p.56).

As it was already mentioned above the nuthatch also feed pine nuts however its role in the Siberian stone pine regeneration process is contradictory. According to Petrov's research (1982), unlike the nut cracker and jay, the nuthatch hides pine nuts not under the ground litter but in bark cracks leaving almost no chance for pine nuts to sprout. The newest research in the Far East pretty much equalized the nutcracker and nuthatch role in the regeneration of Korean stone pine: "Most of all the nutcracker and nuthatch hide pine nuts on sunny slopes, on low mountain passes, by tree bottoms or stumps in loose soil 4-5 cm deep or in the forest litter" (Alekseyenko, 2005. P. 3).

Capercaillies and bears also feed on pine nuts without brining anything to the Siberian stone pine regeneration. However the most harm comes from mouse-like rodents that eat as much pine nuts as all the other taiga tenants together (Barsova et al., 1961; Talantsev et al., 1978).

The most part (up to 80%) of Siberian stone pine sprouts and young regrowth is bias towards half-decayed or decayed stumps and windfall (Smirnov, 1953, 1957; Talantsev et al., 1978). In this regard Smirnov (1953) writes that "the wood remains (stumps, windfall and etc.) have a beneficial effect on the Siberian stone pine regeneration process. They create micro elevations under the forest canopy where Siberian stone pine regrowth can establish its habitat on the mineral soil layers appear to be unfavorable. Whereas on stratum and other open areas near decaying wood, Siberian stone pine regrowth finds more steady humidity conditions and protection against gramineous plants" (p. 15).

Here we recognize again the complicity and diversity of the population symbiosis of the Siberian stone pine and nutcracker which was already mentioned, plays the main role in the evolution of both species. We see the priority "chain" guaranteeing the regeneration of their populations.

The latest research that took place in the Siberian stone pine forests in the North Urals stated that Siberian pine regrowth distribution on felling areas had a connection not as much to the distance from the seeding sources as to the nutcracker preferences of growing media for the regrowth establishment (Tantsyrev, 2007). In other words, the nutcracker favours above-ground micro elevations for its "funds", primarily logs, which eases the removing of pine nut from under the snow in winter time. This phenomenon has a primary role in the Siberian stone pine forests regeneration. Siberian stone pine sprouts adjustment to survive on logs and large rocks plays a secondary role in this process and traces back to its mountain origin history, and most likely also has as expected in regard to spruce biological or biophysical nature. An indirect proof of it is the fact that this phenomenon isn't typical for the most part of the younger and truly mountain origin wood species. However, with a good reason this author's point of view can be commented on with academician I. Lepekhin's (1795) statement that refers to one of his arguments "I'm standing outside of the forest and can only see its skirt".

Nowadays some researches reason the Siberian stone pine affiliation with logs by the nutcracker choice of those places for its "funds"; others see the explanation in a better sprouting conditions for seeds and their development. In view of this it's clear why Talantsev and his co-authors (1978) believe both explanations can take place.

A primary mountain origin of a primeval *Cembra* section has already been mentioned above. Sochava (1927, 1930) repeatedly emphasized a better adaptation of the "north" pines to the alpine conditions. Based on that we can conclude that the reason of the spruce and pine regrowth is limited to old stumps and logs that has the same nature, namely its mountain origin and related to it biological features of these species. That's why we can't agree with the unknown author of the photo (see **Fig. 146**) that presented the phenomenon taking place on a pulled out stump as a mistake of a bird the forester. Based upon the above-ground part of Siberian stone pine seedlings, they are 5-6 years old and have already rooted well on the stump and have a good chance to survive.

Taking into consideration the above mentioned uniqueness of Siberian stone pine, we can't slip over the issue of its future. Beyond a doubt, perspectives and possibilities of the Siberian stone pine cultivating on the forest useful areas are great, however initially it's more important and it should seem easier to save what we already have. Historically Siberian stone pine was treated differently from other species. It found its way into the literature. Alexander Pushkin's contemporary regional ethnographer and natural scientist Dmitriev (1818) admiringly wrote about this unique tree: "What magnitude there is, the bearing of this tree, what sacred shade there is in the bushiness!" In the middle of the 19th century Yagov (cited by Baryshevtsev, 1917) gives the following characteristics to Siberian stone pine: "That's the beauty and the *tsar* of the boreal forest. Rich and wide-shadowy foliage, spreading branches, its power and colossal figure stands in contrast with a prolate, thin and the same shape of spruce, pines and other simple northern trees. There is a good reason that similar groves were called sacred in the far Islamic East. They call up something mysterious in their impressive silence, in their mystic shadow. A Russian Old Believer with the Old Ritualist Gospel found refuge in these groves" (c. 53).

Keppen (1885) emphasized an aesthetic role of the Siberian stone pine: "A magnificent splendor of Siberian pine groves remarkable in Siberia particularly inspired lots of spectators to a poetic outpour" (p. 26-27). Petrov (1949) quotes the Ural writer Dmitry Mamin-Sibiryak: "Dark Siberian pines are especially good, they stand here and there on a shore like boyars in green velvet coats" (p. 24).

Supporting this tone Baryshevtsev (1917) writes: "The Siberian pine forests of the native Siberian Toboslk, Tomsk and Yenisei provinces, spread around the settlements, often above rivers full of special elegiacal beauty, that inescapable deep sorrow that Levitan's best unfading painting is charged with. Sometimes Siberian pine groves are embraced with some heavenly peace". Noting further "the royal splendid and sadly silent beauty of the Siberian pine" Baryshevtsev at the same time bewails "The tsar of the Siberian forests, our Siberian pine still has not found its own song writers or painters" (p. 53-55).

At the same time it is known that long since Siberian pines were often simply felled and kept being felled for its nuts, especially in remote outland parts of taiga. A so-called mall hammer is a huge wooden hammer on a long pole that was used to hit a tree trunk and later people picked up fallen cones. The instrument is also not harmless for trees – it damaged a trunk and allowed an infection to get inside of it.

Yatsenko (1917) wrote the following about this Siberian pine status dualism: "Here in Russia there are two opposite attitudes in regard to Siberian pine getting along: on one hand, unquestioning love to it is obvious, but on the other hand, there is a severe hunting. This internal conflict finds an explanation to a great degree in an illusive yet accepted view of our forests' sustainable abundance. The reality totally clashes with this idea, at least what regards to the forest of the European part of Russia" (p. 376).

The scientists in the 18th century were already conscious of the need to preserve forests. Getting to know the mining industry, Urals academician Lepekhin (1795) noted: "It's necessary to look back at the forests that truly are endless. Now our neighbors, the Swedes, sigh about them and start favoring them more than iron" (Part 2. P. 271). At that time the forest policy was already oriented to sustain Siberian stone pine forests. Melnikov (1982) reports that more than 200 years ago Demidov's factory workers had written in the contracts: "We shall fell these trees except Siberian pines" (p. 18). The reason apparently was not only to sustain pine nut business. The academician Pallas (1786) traveling being in the Urals wrote that "Siberian pine forests served as a home for sables and that way the supreme order it is prohibited to fell them".

Petrov (1982) notes that before sables used to harbor in the dark coniferous – Siberian stone pine taiga in the north of the Cis-Ural region, however the sable native range were the Siberian stone pine forest of Pelym–Konda region of the Urals. The sable business prospered, the capital collected the tribute paid off in sable fur from all over Siberia. "By the end of the first half of the 17th century the Muscovite state sable exchequer accounted about one third of the income budget" (Petrov, 1982. P. 64).

Yet since the 19th century, Siberian stone pine felling has started speeding up with the industrial development of the country until in the middle of the 20th century in Russia when the executive orders of an integrated use and Siberian stone pine forest conservancy were passed; the industrial Siberian stone pine wood production was prohibited (Matveyeva et al., 2003).

Nowadays according to the World Wildlife Fund, about 20% of the wood in the Russian Far East is harvested illegally mainly in the favor of China and the South Korea which includes the felling of Korean stone pine. According to the Russian nature-protection organizations, the illegal felling scale is a lot higher – no less than 50% of stated (Isaev et al., 2005). By now the areas occupied with Korean pine have decreased 70 times in comparison with the year 1919 (Yaborov, 2000). Using current technologies, poachers fell the best forests having no mercy on Siberian stone pine basically felling the gene resources of the Russian forests. Siberian stone pine, which is a forest unique, cries for mercy.

6. Birch (the genus *Betula* L.) is a poetic symbol of Russia

Three decades ago professor Harald Thomasius, when a director of the Forestry Section in Tharandt (former GDR) reviewed my monograph addressing the biological productivity evaluation of birch forests, noted with a grain of sarcasm that "you Russians romanticize and sentimentalize birch trees a lot and we treat it as a pest species". Long since, a complete different treatment of birch has developed in Russia and it has a long history.

Albert Domatsevich (2008) introduces his essay "In the smiles of crying birches" with an interesting tale. Having lost the common language while building up the tower of Babel and having to give up communicating with each other, ancient people started leaving this unfinished building and settling in other places. At the same time from the surrounding hills, numerous birch groves, the favorite resting places of people, started disappearing without a trace. …In the next moonlight night one birch grove suddenly rocketed up as a flock of white-winged birds and having circled farewell above the sleeping hills, it silently sailed away beyond the horizon. Meanwhile far in the north, large and small settlements of green-eyed smiley white-trunked birch beauties started appearing on the territory of the future Great Russia. People followed birch trees…"(p. 104).

The word "birch" existed already in the Proto-Slavic times and related to the verb "guard" because the Slavs thought birch had been a gift from the gods that guarded people. Earlier people certainly planted birch trees close to their houses since they believed that during epidemics the "birch spirit" would guard them from sickness. The Carpathians attributed this tree with the ability to guard their houses from lighting (http://knigazdorovya.com/bereza/). Among the Slavs, birch is a symbol of light, spring, purity and femininity. It was thought that from Easter time till Trinity Sunday spirits of dead people, including mermaids were sitting on leaves and branches. The Trinity Sunday tradition of "waving" a birch – to decorating a tree and making "mermaid swings", since namely birch relates to mermaids – young ladies who passed away before marriage, refers to that (The Great Illustrated Encyclopedia, 2010).

Today common birch occurs in the countries and continents where it never grew before, for example in faraway Argentina and other western countries in villas nostalgic about the Mother land Russian emigrants. Without going deep into the roots of that unique treatment of birch in our country, the "land of birch chintz"according to Sergey Yesenin, as an element of the Russian mentality, we will limit ourselves to just several poetic examples.

Afanaci Fet A sad birch stands by my window, and in a whim She is decked with frost. Like a cluster of grapes from the vine, the ends of the branches hang,- and joyful for such a view Is all mourning attire. I love the morning star's game as I tend to remark about her, And it will be a pity to me, if the birds Shake the beauty of the branches.
Sergey Yesenin

The birch tree
Just below my window
Stands a birch-tree white,
Under snow in winter
Gleaming silver bright.
On the fluffy branches
Sparkling in a row
Dangle pretty tassels
Of the purest snow.
There the birch in silence
Slumbers all day long
And the snow gleams brightly
In the golden sun.
And the dawn demurely
Going on its rounds
With a silver mantle
Decks again the boughs

Translation cited from https://notesfromarussiangarden.wordpress.com/2013/09/17/the-birch-tree/

Nikolay Rubtsov

I love the rustle of the birch tree,
When from the birch tree leaves are falling.
I listen - and the tears running free
From my unaccustomed to the tears eyes they rolling.

Unwittingly the memory will come alive,
It 'll answer to the heart and blood.
It will be, somehow, painful and joyful,
As if someone whispering of love.

Only, often the prose is winning,
As if the wind will blow, on a gloomy day.
After all, the same birch tree rustling
Over my mother's grave.

The bullet killed my father in the war,
And in our village by the wall
Like a hive, with rain and wind will roar,
The same yellow autumn fall...

My Russia, I love your birch trees!
I lived with them and grew from infant years.
That's why the tears are running free
From my eyes, unaccustomed to the tears...

Translation cited from http://lyricstranslate.com/ru/%D0%B1%D0%B5%D1%80%D1%91%D0%B7%D1%8B-birch-trees.html#ixzz3xfUS7855

Vsevolod Rozhdestvenski

As a little sunshine warmed the slopes
The forest grew warmer,
And from the birch tree's thin branches
Hung green braids.
Entirely dressed in white,
With earrings and laced foliage
She meets the hot summer
At the edge of the forest.
Whether thunderstorms blow over her,
A marshy mist nestles,
Or she is shaking off the rain,
The tree still smiles, and her cheer remains.
Her light garb is wonderful,
There is not a tree as precious at heart,
And with many thoughtful songs
The people sing about her.
They share with her their joy and tears,
And her days are so good,
That it seems in the sound of the birch,
There lives something of the Russian soul.

In 1844 in the "Forest Journal" (Lesnoi Zhurnal) G. Bode writes that "everyone knows the best birch tree and forests are in Russia, in the true homeland of this wood species; and this Northern Maiden enriches our gloomy dark coniferous forest with bright and nice green of its right top and the bark whiteness of its straight trunk" (cited by Guman, 1930. P. 3).

The genus *Betula* L. belongs to the family *Betulaceae* C. A. Agardh. and includes about 120 species, 40 of which are presented in Russia. Birch is a very polymorphic species, i.e. it has a wide range of changes namely in leaf shapes (**Fig. 148**).

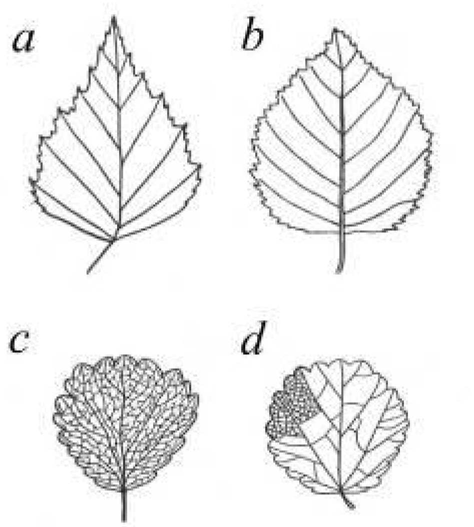

Fig. 148. Birch leaves: a) European white birch (B. pendula Roth.*), b) Stone birch (B. Ermani* Cham.*), c) Betula tundrarum* Perf.*) and d) Dwarf birch (B. nana* L.*) (Ponomarev, 1933; Vasiliev, 1969).*

There are several species in the common birch category from the section *Albae* Rgl.: European white birch (*B. pendula* Roth.) (**Fig. 149**), Downy birch (*B. pubescens* Ehrh.) (**Fig. 150**), *Betula microphylla* Bunge, Mountain birch (*B. tortuosa* Ldb.), Japanese white birch or Siberian silver birch (*B. platyphylla* Suk.) and *Betula cajanderi* and etc.

Fig. 149. European white birch (B. pendula Roth.): 1 –a general view; 2 –an autumn branch with formed leaf and staminate buds; 3 –a winter branch; 4 –a spring branch with commenced to germinate leaf and staminate buds; 5 –a branch with staminate (bottom) and pistillate (top) catkins during powdering; 6 –a staminate flower; 7 - pistillate flower; 8 –a branch with fruits catkins; 9 –a mature fruit Catkins; 10 –a fruit –a wing nut (Forest encyclopedia, 1985).

Yet the two first species morphologically differ essentially (compare **Fig. 150** and **151**), biologically they are a lot alike and were included in one species, common birch (*B. alba* L.) by Carl Linnaeus. However there are attempts to assign the last Latin name only under downy (white) birch (Vasiliev, 1964a; Mamaev, 2000). The mentioned two species are the most common in Russia (**Fig. 152**).

Fig. 150. Spring awakening of downy birch. Painting by Gennadiy Mosin.

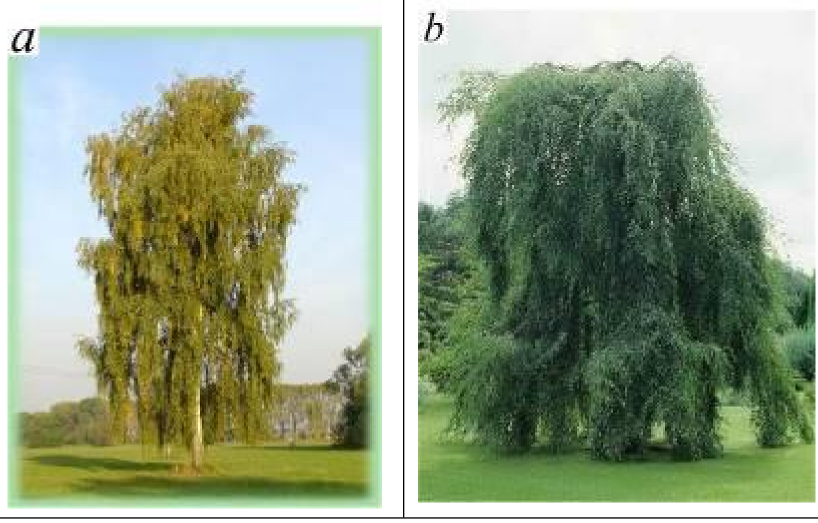

*Fig. 151. European white birch (B. pendula Roth.) (**a**) and its "weeping"(mourning) (f. tristis) sub-type (**b**) (http://knigazdorovya.com/bereza/; http://www.moysad.ru/catalog/id/1841/).*

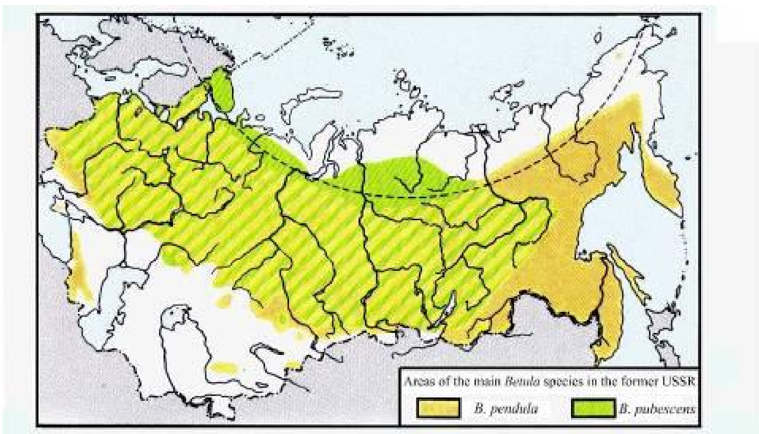

Fig. 152. Areas of the two common birch species in the former USSR (Forest encyclopedia, 1985).

Let's list a few common features of common birches thanks to which they deserved special treatment. First of all, white birch is the only species in Russia with white bark, however sometimes mutants with yellow, grey and even black bark occur (**Fig. 153**).

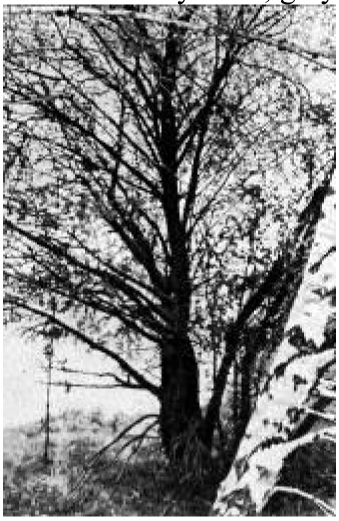

Fig. 153. A tree of black-barked birch in the surroundings of white-barked birches, Semiozerniy forestry in Kostanai region in Northern Kazakhstan (Danchenko, Budaragin, 1976).

Birches widely range all over the Northern hemisphere. In Russia, 60% of broadleaved species area and 15% of total forest area is occupied with birch. By occupied space it takes the third place following larch and pine (Feklistov, Amosova, 2013). On a large space of Northern Eurasia, downy and European white birch often grows together on the same area providing a natural hybridization with different transitional forms.

Birch with abilities to adapt to the different soil and climate conditions are one of the reasons of its numerous shape formations. By bark types Danchenko (1982) distinguished four forms of each species and some of them are presented in **Figure 154**. It is found that some timber quality indices and growth features are closely related to the bark type (Makhnev, 1965; Danchenko, 1989).

Fig. 154. Forms of European white birch (top row) and downy birch (lower row) by bark types: 1 –rhombic and fractured; 2 –coarse-barked; 3 –knar-barked; 4 –white-barked; 5 –urged-barked; 6 – fibrous-barked (Danchenko, 1982).

European white birch occurs in all forests of northern Eurasia up to the Krasnoyarsk region. Downy birch is distributed even wider: in the north it reaches the forest border with tundra; in the east it goes over the Stanovoi Mountain Range. European white birch grows faster than downy birch on sandy and humus soils but slower on clay-loam soils. Downy birch tolerates ground bogginess better, yet the best growth is registered on drained soil. European white birch is more drought-resistant and salt-tolerant but it does not stand well the ground water lever highstand perhaps as a result of half the capacity of an adventitious root formation (Denisov, 1974).

Under North and Central Kazakhstan conditions, European white birch has wider ecological range comparing to downy birch. In case of a joint growing at the same site, the water regime of the European white birch is characterized by lower indices of irrigation, transpiration rates, water deficiency, cell sap concentration and greater water-holding capacity of leaves in comparison to downy birch (Markvart, 1978). These two species are notable for a great photophily however, downy birch is more shade-tolerant than European white birch.

In the Ice Age, on one hand, birch played a role of an Avant-guard following melting glaciers first and preparing the soil for spruce and other species, and on the other hand a role of a screen leaving ahead of the approaching glaciers front last. Birch forms assemblages located on ecologically unfavorable limits for the most species and reflects not only the main crucial climate changes but also the human intervention into the sites in general (Denisov, 2002).

Although common birch is considered as the pioneer species yet in taiga forest, where no human has ever set foot on, it is hard to find since there is not enough light under the coniferous tree canopy; it is a light-demander. On surrounding grassy glades, a grass canopy does not allow small birch seeds to root, and if they do then the sprouting cannot compete with grass vegetation. Birch follows people when developing new lands and is their special companion: as soon as the main growing stand gets cut down and dies during fires, there are the conditions for birch seed sprouting and growth (Kravchinskiy, 1905). Therefore it is hard for birch to win new lands however if it gets established somewhere it can retain the land due to its uncommon vitality and regeneration capacity (Atrokhin, Solodukhin, 1988).

It is known that the needle litter of dark coniferous species such as spruce forms a so-called raw humus, which reduces soil forest growth capacity. The leaf litter, on the contrary, creates mild humus, and thereby by joint growth with spruce birch plays a soil-improving role. A positive impact of birch and spruce mix was first noted back in the 18th century by the Russian scientist Mikhail Lomonosov (1940).

Birch is characterized by an abnormal vitality and site condition unpretentiousness: it can be found on rock outcrops (**Fig. 155**) and even in absolutely unexpected places like on old house moldings and walls. Due to the desertisation on the south forest line, common birch is found in the transition zone between forest and desert under the harsh site conditions (**Fig. 156 and 157**).

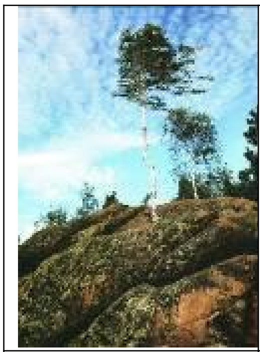		
Fig. 155. Birch on Ural outcrops. Photo by Domantsevich.	*Fig. 156. Akkuma sands near the Southern Urals. Photo by Chibilev.*	*Fig. 157. Medveditskaya ridge in the Middle Don, the anomaly near Zhirnovsk city (http://podonu.ru/forum/index.php?topic=240.0;prev_next=next#new).*

One of its subspecies - *Betula microphylla* Bunge (small-leaf birch) – tries to survive even on sand dunes in the Middle Asia deserts. In the photo (**Fig. 158**), there is such kind of birch outlier, apparently out of bare necessities of life, it looks really sad. It is found in the valley of the Ili River (Altyn-Emel national park of Almaty region) between the Small and Big Kalkany mountains; these mountains are the natural inhabitation for birch. The process of a valley desertisation, i.e. desert advancement of forest, and as a result, birch happened to be in unnatural living conditions. In the photo there is a birch in front of a gigantic "singing"sand dune that is remarkable for its deep vibrating rumble, only vaguely resembling the sound of a jet plane (Dzhanyspaev, 2006).

Fig. 158. Betula microphylla Bunge in front of a gigantic "singing"sand dune found in the valley of the Ili River between the Small and Big Kalkany mountains; Altyn-Emel national park of the Almaty region. Photo by Belyalov (Dzhanyspaev, 2006).

Fig. 159. Abundant field overgrown with birch trees and blooming daisies (http://www.diary.ru/~asat/p60645493.htm?oam).

The deagrarianization in the beginning of 1990s resulted in a situation where large agriculturally used areas had been stopped being used and were overgrown with wood species (**Fig. 159**). In Bryansk, Pskov and other regions of central Russia, the most part of this kind of land is occupied with birch trees (Balashkevich, 2006; Utkin et al., 2005).

Birch tolerates soil salinization better than any other species. On the south forest area margin, in Naurzum coniferous forest (Kustanai region, Kazakhstan), common birch grows on the salt lake (sors) coasts, including dry lakes (Shakhov, 1948). In Freiberg's opinion (1969), in the forest steppe, Trans-Urals birch is capable to grow even on alkali soils and is recommended for its occupation. Due to the growth condition unpretentiousness, birch made a good showing in the forest shelter belts in steppe and forest steppe (Deryabin, 1953), i.e. in the extremely hard conditions when the necessity of maintaining "openness", or in other words windswept of those belts causes the disturbance of the typical forest environment under the stand canopy and enhances water deficit.

Along with pine trees, birch intensively "occupies" industrial waste discharges (**Fig. 160**) including the ones that appeared after the coal-mining in the Middle Urals (Mikryukova, 2006), mining and concentration and cooper and sulphur plant dumps in Bashkiria. Furthermore birch forest conditions are better compared to other species (Kulagin, 2006). The artificial recultivation of the ash dump of Reftinskaya thermal power plant with birch in the Middle Urals showed that over a 10 year timespan after planting, there were no signs of birch degradation (Makhnev, Terin, 2002). Birch plantation successfully developed in the emission zone of "Magnezit" Plant in Satka and in the South Urals for 25 years; and Zavyalov and the co-authors (2006) recommend the artificial birch cultivation even in the intense magnesite contamination areas upon the condition of organic manuring.

Fig. 160. Step by step refuse dumps are being linked with European white birch roots (Jenik, 1987).

After the mature forest stand felling in the taiga zone, if there are any remaining of birch or birch regrowth on a logging site, then the further coniferous species planting without following gradual birch removal is unproductive: fast growing birches crowd seedlings and step by step form the main canopy (**Fig. 161**). However, shade-tolerant spruce, Siberian pine and fir pretty often naturally (by natural seeding) form an understory under a birch canopy and with birch aging and extinction they slowly reach an overstory, thereby proving a forest crop rotation.

When planting coniferous species with birch mix the future of the first ones also has no chance to succeed: birch suppresses the coniferous species in both overground canopy and the root range (**Fig. 162**). Birch absorbing roots captivate the top and the most benign layers pushing coniferous species roots to the lower soil layers (Oleinikova, 1962). In the mixed birch and larch or linden plantings, birch suppresses their growth not only in the root competition zone for nutrients and water but also through the biochemical effects of its phytoncids (Kolesnichenko, 1976).

However the main reason of birch suppressive influence on the coniferous species may be completely different. An inhibitory action of birch crown was already mentioned before, but not through the mechanical whipping, but by means of its bioelectrical field impact. It is referred to as "the existence of the arboreal plants distant interinfluence though *intrinsic* emission"(Marchenko, 1983. P. 11). Unlike "the exotic" bioluminescence of jelly fish, bacterias, fire-bugs visible to unaided eye (Zhuravlev, 1974), the mentioned bioelectrical field (biofield) is a UV-radiation of growing tissues in mid spectral range (from 1900 to 3200 Å) of low-intensity (several thousand photons/cm^2·sec) inherent to all flesh. This is so called "mitogenetic" radiation by means of biochemical processes energy discovered by Gurvich in the first two decades of last century and confirmed by the following research (Gurvich, 1944; 1968; 1977; Gurvich A., Gurvich L., 1945; Kirlian V., Kirlian S., 1964; Inyushin, 1968, 1970, 1973, 1997; Kaznacheev, Mikhailova, 1981).

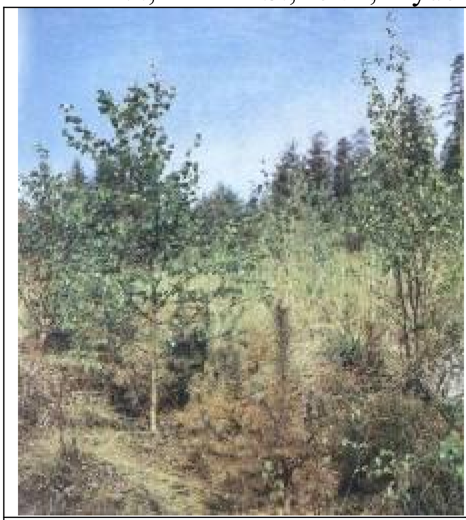

Fig. 161. Common birch main canopy formation on Scots pine plantation area (Bush et al., 1989).

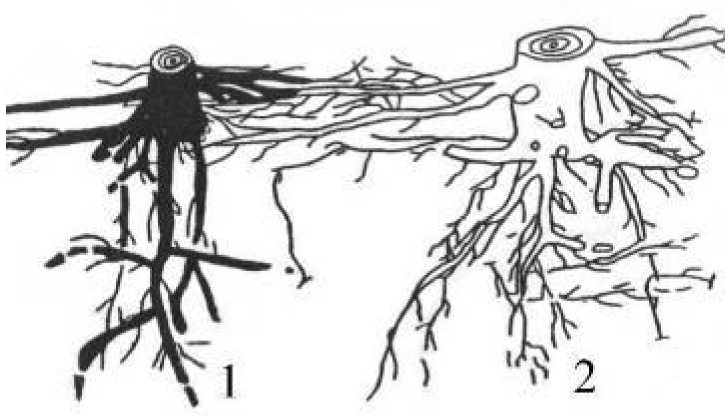

Fig. 162. Expansion of the common birch roots (2) to the root range of the Siberian larch (1) (Frickel, 1978).

The biofield theory sources origins to post-WW II France, when in January 1945, after the repost of the soviet engineer Grishchenko at École normale supérieure in Paris dedicated to the human nature as a manifestation of the forth state of matter, the school director Nicolas Bourbaki named this condition "cold plasma"(Yarovoy, 1974; Grishchenko, 1997; Usoltsev, 2010b).

The discovery of the mitogenetic bioluminescence (bioplasm) in an induced RF field built between capacitor plates that was made by a married couple's research Kirlian (1964) from Krasnodar, became the method that allowed proceeding from theoretical constructions to an experimental proof of bioplasma fields existence. Since in this case mitogenetic radiation becomes visible, it allows getting a photo of it, the so-called "Kirlian effect" (**Fig. 163**). After numerous experiments in plant biofield registration, the Kirlians came to a paradoxical conclusion that the leaves outline fulfils an electric-physiological function of the carbonic acid gas ionization for the purpose of its transfer to leaves, i.e. a function of a special gas "extra nutrient".

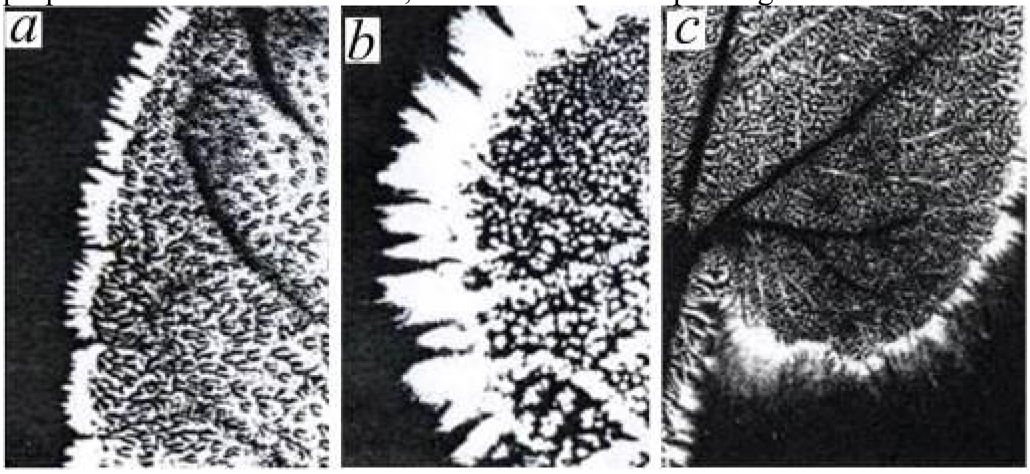

Fig. 163. A picture of field ion emission of violet leaves (a), geranium leaves (b), and ageratum leaves (c) in the oscillative circuit of a balanced output generator (S. and V. Kirlian, 1961).

Inyushin and Grishchenko joined their forces and started conducting research with the application of a high-frequency (90,000 Hz) pulse oscillator of the Kirlian construction (1961) in the University of Kazakhstan. The results are published in the book named "On the biological implication of the "Kirlian effect" that the authors forestall with the following introduction: "Addressing a complete new conception of, something besides solid, liquid and gaseousness states, the existence of a fourth, or plasma, state of matter in a living body, we would like to draw researchers' attention to this understudied living system substrate" (Inyushin et al., 1968. P. 4).

Performed plant and animal experiments let the authors come to the conclusion: "In living tissues, there is a whole system of charged particles - electrons, protons and ions –that can be considered as an individual essence–biological plasma. In the biological range conditions, the fourth state of matter, or plasm, takes on a lot of new, unbelievable from a physics perspective properties such as, first of all an organized nature and resistance under relatively low temperatures, under thermodynamic disequilibrium position"(Inyushin et al., 1968. P. 31). In the further experiments, the bioplasma burst of activity was registered: upon the application of heat to fresh vegetables and fruits in a jar of water at reaching 60-65^0 C the bioplasm machine registered a power burst of light emission by destroying all bacteria. That meant the bioplasm kills all the bacteria under a significantly lower temperature than a deadly one (100^{0}C); its premortal burst is a burst of the "fourth state of life" (Yarovoy, 1974).

Using the Kirlian's method (1961, 1964) the forester Marchenko (1975, 1995) took lots of photos of a discharge emission in tree crowns and stated that biofields of different species do not "recognize"each other. The experiment was carried out when in spring a branch of nearby spruce was factitiously implemented on a birch crown. By autumn the birch literally ejected this "uninvited guest" from its crown. Marchnko (1983) writes that the effect of a needle "blow-off" (**Fig. 164**) by a close growth to birch could have been explained by phytoncide release, if there were no contradictions in those cases, when a coniferous tree grew under a birch crown and its needles were not pointed up but down. If pine, spruce or fir grows next to birch, then their needles are turned to the opposite side to a white trunk beauty. The explanation for the biochemical influence reaches a stalemate also while considering the experiment results on shoot growing screened with quartz and lime silicate glasses. Why does it happen?

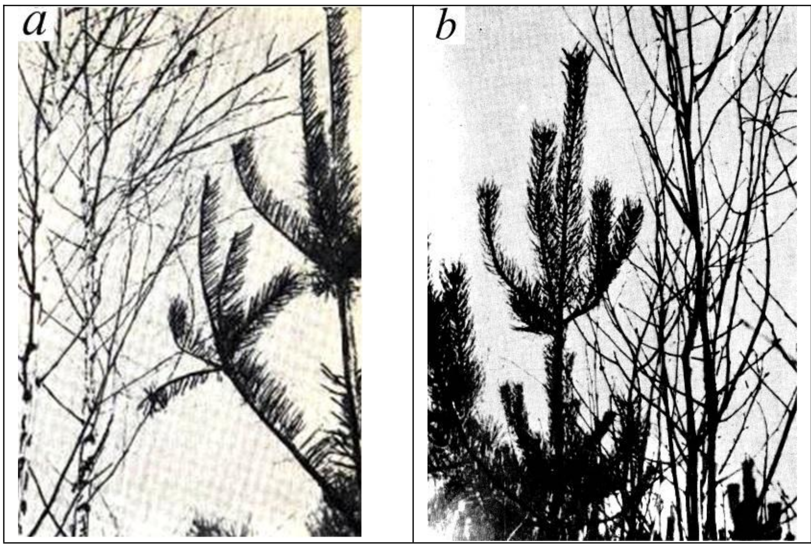

Fig. 164. Orientation of spruce needles growing next to a birch: (a) flag-shaped when a birch is alive and (b) symmetrical when a birch dried out (Marchenko, 1976).

During the evolution process, birch has developed a habit to shed leaves and part of small "needless" branches or its top part throughout a vegetation period and the most part of these branches account on suppressed trees (Usoltsev, Danchenko, 1981). The question arises, why does birch tries to get rid of its own branches besides "foreign" spruce ones? On the basis of the biofield theory, every wood species fills the surrounding space only up to a particular value. In other words it is impossible to fill it up with living matter more than it's measured by the field. Otherwise it takes its own measures –it restores the balance by means of a repulsive effect. A crown density is adjusted with the biofields of separate branches, leaves and trunk. In the wake of their growth, the field density goes up and therefore the repulsive forces. Slowly this effect reaches the values that a tree rejects some branches. As a result, the biofield density goes down, "discharged" space fills up with new branches next year and they in turn will lead to other branches rejection. This cycle process lasts during the whole life of a tree (Marchenko, 1981).

The foresters Kairyukshtis and Yuodvalkis (1976) defined the critical distance value between tree crowns when 2-3 years before the crown closure, in a growing tree canopy plants "feel" each other and decrease their growth. Sometimes tree biofields' interaction is manifested in absolutely unbelievable phenomenons. In Mosin's interview (1985), Marchenko describes the following experiment: deep vertical cuts were made on the trunks of the two closely growing young ash trees in a way that the "wounds" faced each other. Several months later it was found that each tree trunk turned around 90^0 and the cut width was twice as narrow. Therefore the process underwent an intense trial: a side branch that did not let the trunk turn, bent so hard that the bark split. This phenomenon was demonstrated and strongly indicated in an educational film made in the Bryansk Institute of Technology.

About 20 years ago based on student practices of the Ural State Forest Engineering University (Severka village) we retried this experiment: using a hack, we cut off the bark of two small birches located 20 cm from each other. "Bare patches"of 30 cm long were made on the inside, i.e. facing the trunk sides. Two years later we obtained similar results described above for the ash trees.

How do trees learn about each other cuts? What makes their trunks turn about their axis? Why does the process stop after the "turn"? These questions can be answered if it is granted that trees have biofields and its main features are the gravitation and repulsion. A biofield around a scattered tree weakens with distance from a trunk, and biofields of surrounding trees repulse making the trunks part way for a certain distance so that they can strike a "peaceful balance" (see **Fig. 82)**. When the cuts appear, trees turn on a defense mechanism, metabolic and cell fission processes speed up and subsequently the biofield potential around the affected area rises sharply. The biofields can't bend the trunks but misshape them in a spiral direction (i.e. twist) up until the former balance is resolve.

Marchenko sees an encouraging outlook in the use of distant interaction in recreational forestry by means of bioenergetic trail arrangements in parks and suburban forests. Since experiments proved that plans react to human being field changes (Inyushin, Chekurov, 1975), there is a strong possibility that people can experience tree biofield impact as well. Based upon Zalesskiy's report (1992), with the help of the portable "Blinkov's detector" (that was constructed based on the electrical circuit resistance tester) different species distant actions towards people can be registered, which will allow the trees to determine the donors and avoid trees vampires. Zalesskiy predicts the situation when this detector may become people's integral item like a watch or a tooth brush.

In open forests, birch shapes a crooked trunk under the wind, snow and external actions. Sometimes this "crookedness" looks very odd (**Fig. 165 and 166**). "Who is the choreographer of these dance bands?" - Yuriy Linnik would like to know (2015. P. 210). In closed seed origin forests, birch forms relatively straight slim trunks, well self-pruning on the bottom (**Fig. 167a**).

It is known that the vegetable world evolve with time and one of the main evolution achievements is seed propagation –a dominant type of species reproduction. Birch enters a bearing season early and bears fruit abundantly and almost every year, however the number of viable seeds is low (Bagaev, 1963). Yet nature gets very creative so that a plant could leave behind a numerous and well provided rising generation (Yusufov, 1972). That's why, besides the seed propagation, a vegetative regeneration plays a great role in some species lives including birch.

Fig. 165. "Dancing"birches on the Lake Borovoe in North Kazakhstan. Photo by Kuydin.

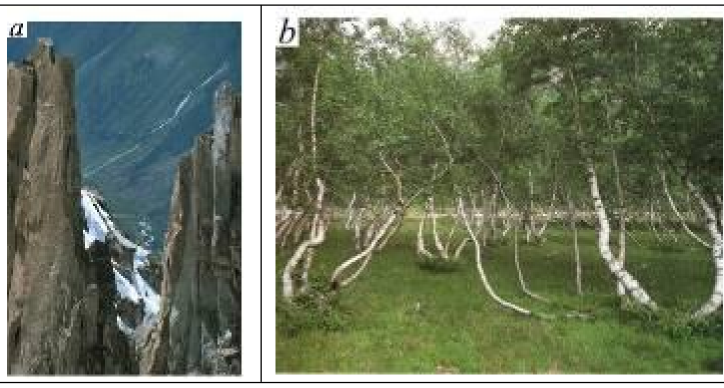

*Fig. 166. Uzunkul River in west Caucasus (**a**) and "dancing" birches in its floodplain (**b**). Photo by Sedelnikov*

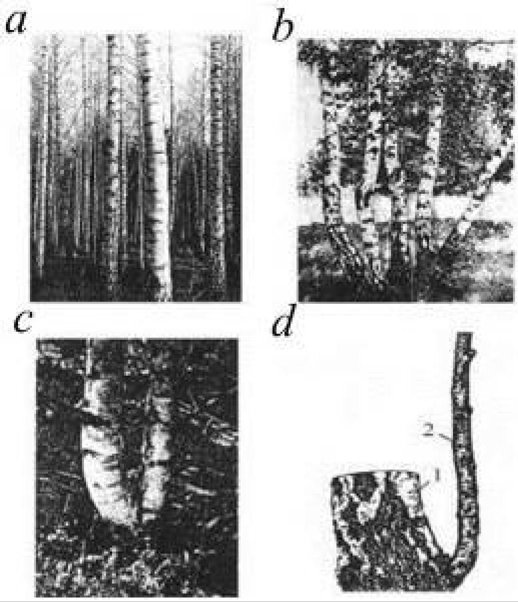

Fig. 167. Common birch of a seed (a) and vegetative origin: (b) –a group of cone-shaped situation of vegetative acinaciform trunks, around a mother tree stump, (c) a multistem tree formed from an auxiliary bud of a dead oppressed seedling and (d) –17 year old sprouting (1), grown out of a suppressed bud of 2-3 year old regrowth tree (2); the latter is 24 years old in the picture, and despite 7 year age advantage it is yet size wise behind its "offspring" (Kudryavtsev, 1955; L'vov, 1964; Danchenko, 1982).

Vegetative birches are less longevous than seed origin ones, they slow down the growth faster and age earlier (Popov, 1961). Historically, a common perception of vegetative reproduction population regression (Krenke, 1950) was brought into question in later research (Yusufov, 1972) and it was shown that vegetation forms reproducing vegetative ways are not evolutionary without prospect. Nevertheless the development of a close complete forest already after the second coppice regeneration is unlikely (**Fig. 168**). By the age of 60-80 years birch growth usually stops (**Fig. 169**).

After felling, birch reproduces through suppressed buds located by a collar root that fall on a stump of a cut tree. The number of stumps providing a coppice growth reaches 60-80% by the time the tree is 50-60 years old and then slowly decreases (Guman, 1930). In spite of fast coppice growth by means of mother root system, the quality of birch coppice is lower than a seed reproduction, one due to a specific sabre shaped trunk (see **Fig. 167b, 170**).

It is common that a terminal bud of an old birch natural seedling, which is 2-3 years old, dies during autumn and winter cold spells and sometimes repeatedly. As a result, this kind of natural seedling starts forming a shrub, i.e. forms several additional lateral shoots from auxiliary buds that turned into a multistem tree (see **Fig. 167c**). Unlike coppice shoots formed from a cut tree stump and fanwise located around the stump (see **Fig. 167b**), it is easy to verify that a multistem tree has one common base (Lvov, 1964).

Fig. 168. An over-mature coppice birch forest, bent "birch yokes"near the science campus in Krasnoyarsk. Forest openness, the absence of undergrowth and low potential for the next coppice regeneration leave the future of this birch forest with no chances for a natural regeneration. September, 2014. Photo by V. Usoltsev.

	
Fig. 169. Age-related breakdown of downy birch. This tree already won't leave behind any young generations. Photo by Tarko.	*Fig. 170. "The Twelve Apostles" birch in Vodlozero National Park, Karelia (Linnik, 2015).*

Frequently after felling of a mature stand birch regrowth, the growth is checked due to drastic habitat condition changes, but the sprouting develops from suppressed buds by the undergrowth base and its shoots are 2-3 times taller than the main stipitate (Kudryavtsev, 1955). Consequently in young stands formed on cut-over lands, a preserved regrowth stipitate 1.5-2 m tall, and coppice from its base is 5 meters and taller (see **Fig. 167d**).

Long since, common birch as "companion" has met plenty of household need of people. At the beginning of 11th century in Ancient Russia, a birch silver bark as a writing material, replaced linden boards flowed with wax and the birch bark writing period lasted for 4 centuries, i.e. up to when in the 15th century people started having a preference of paper (Zaliznyak, Yanin, 2007). Up to now birch silver bark is widely used in everyday life of villagers for different kinds of container production. Wood tar is a medicine and perfume product material made out of birch bark. Birch is the main species for ply wood, furniture and ski production. 150 kilos of furfural can be produced out of 1 m^3 of birch wood, and out of that furfural, 60 kilos of synthetic fabrics, rubber and plastic. Birch firewood has a high caloric capacity. Charcoal made out of it is used for a silicon production and some very valuable and pure metal. Today annual charcoal manufacture is over 7 million tons. According to the Department for Regional Development, the Russian charcoal demand is 2 million tons per year.

In medicine birch buds are used as a medicinal product; birch bud teas and infusion can treat almost any disease. Antiscorbutic agents are made from birch leaves and a birch bath besom is a indispensable attribute of the Russian sauna admires. Not only birch namely, but also a parasitic chaga mushroom (**Fig. 171**) is in strong demand: people living in taiga use it as tea, and in medicine it is used for visceral disease treatment. An outside part of the mushroom is biologically more active. The chaga mushroom appears on mechanical trunk damage spots and can live up to 15 years (Danchenko, 1982).

The "spring sap exudation" is a typical feature of birch, maple and linden. Their roots become physiologically active before the foliage expansion. As a result an excessive pressure is built inside of the trunk and under its impact at a slight trunk damage, transparent sap drops come out resembling tears. One birch tree can produce up to 3 liters of sap per day and up 70 liters during the whole sap flow season; birch sap is a very valuable health improving polyvitaminic forest nectar containing grape-sugar and also potassium, iron, calcium salt and other elements (Orlov, 1963; Ryabchuk, 1973; Minaev, 1975; Orlov, Ryabchuk, 1982; Nikolaev, Kositsin, 2001; Feklistov, Amosova, 2013).

Fig. 171. The chaga mushroom on common birch trunk. (http://www.healthycafeshop.com/2013/12/).

Fig. 172. Karelian birch –B. pendula var. carelica (Petrov, Dorozhkin, 2002).

Despite the similarity of common birches, some of its species have some unique differences. Karelian birch (*B. pendula* var. *carelica*) –one of the European white birch species –is often called a birch “queen” because it has no equal for wood texture beauty and that’s why it is used for artistic articles and furniture production (Atrokhin, Solodukhin, 1988). It stands out from a regular European white birch for its “crooked” trunk shape, as well s trunk and large branches thickenings (**Fig. 172**).

Betula microphylla, which was already mentioned before, is unique in its own way. In reference books (Trees and shrubs of the USSR, 1951; Kachalov, 1970) 15 birch species were pointed out in Central Asia, Altai and the Sayans: *Betula kirghisorum*, *B. tianschanica*, *B. turkestanica*, *B. pamirica, B. procurva, B. schugnanica, B. rezniczenkoanum, B. kelleriana, B. korshinskyi, B. saposhnikovii* etc. However in the later edition (Sokolov et al., 1977) they all were included in one birch species *Betula microphylla* Bge and its area is showed in the **Fig. 173**.

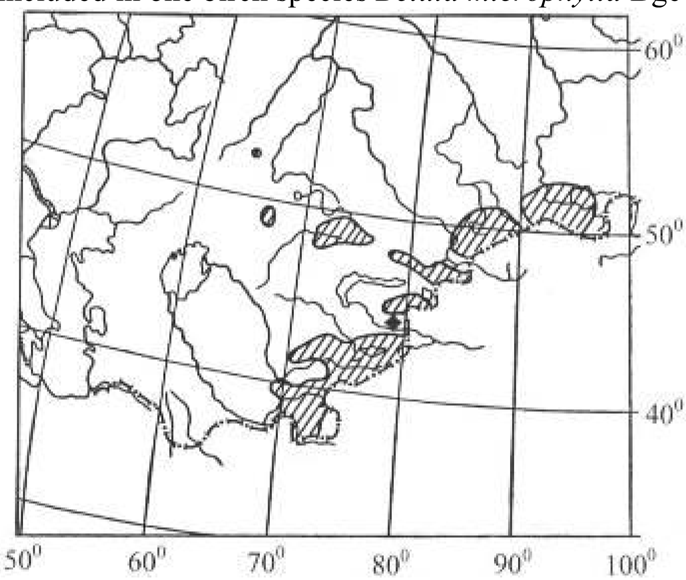

*Fig. 173. Distribution area of Betula mucrophylla Bge. in Central Asia (Sokolov et al., 1977). ‘Singing”sand dune location is marked in a square (see **Fig. 158**).*

This species stands out among common birches (although some research questions its affiliation to common birch) for higher adaptiveness to dry climate and ground waters salinity up to 0.24% (Krupenikov, 1940; Shakhov, 1948). Being associated with arid climate regions, it grows in shallows and river valleys by ground-water discharge places and other like areas. Almost everywhere it occurs in forms of isolated grooves, bio-groups or strips along rivers. The vertical distribution limits are from flatlands of Turgay Depression up to the Western Pamir Mountains (3500 meters A.S.L.). *Betula microphylla* is a deciduous tree up to 18 meters tall, frequently short and scrub, sometimes almost shrub like. The tree has a dusty white color bark, covered with grey bark blotches up to 1 cm in diameter. Unlike European white birch, white bark goes down to the trunk base without forming a thick crust. The crown is loose; branches stand up straight or sidewise and do not droop (Ponomarev, 1933; Sokolov et al., 1977).

Another unique species –Mountain birch (*B. tortuosa* Ldb.) refers to common birch and to a large extent it represents the forest tundra of Kola Peninsula within the specific northers communities and bogs (**Fig. 174**). In the west sparse forests of this species side with mountain birch forests of Northern Scandinavia developing under humid oceanic subarctic climate conditions, broken relief, on shallow rank soils. Birch forests go up to 500-600 meters A.S.L. on Nordic slopes and on the south-east slope they associated with the subalpine zone above taiga forest belt (Isachenko, Lukicheva, 1956). Mountain birch also grows in the Ural and Altai Mountains and reaches 12 meters tall. Morphologically it is similar to common birch, however its trunk is crooked (Mamaev, 2000). Unlike oddly crooked trunks of common birch pictures in **Fig. 165** and **166,** crookedness of mountain birch trunk is not a pathology phenomen but instead a norm for it.

Fig. 174. Mountain birch – B. tortuosa Ldb *on Kola Peninsula (Forest encyclopedia, 1985)*

Fig. 175. Stone birch –B. Ermani Cham. *on Kamchatka (Forest encyclopedia, 1985).*

Besides common birch of the section *Albae* Rgl., large areas of Eastern Siberia and the Far East are occupied with stone birch forests (**Fig. 175, 176**). Erman's birch or stone birch of the section *Contatae* Rgl. (*B. ermani* Cham.) is distributed on Kamchatka, the Commander Islands, Sakhalin, the Sea of Okhotsk shore and Kuril Islands. Its bark is dark grey, brown, and chestnut grey, rose-grey or yellow grey in color and peels. It is one of the main forest forming species, takes 70% of the forested area, cold resistant, shade tolerant and does not demand fat and wet soils. It received its second name for its ability to develop on rank soils where other birch species do not survive. It appeared there approximately 12 thousand years ago (http://www.ecosever.ru/?area=articleItem&id=14946&mode). It is a unique vegetative community with a specific tree habitus, crooked trunk of an abnormal shape, with a lighted and transparent crown canopy, with an extensive grass canopy development and almost a complete absence of regrowth. The latter is associated with mostly decayed logs of fallen trees and by 30-50 years of age it reaches 1 to 8 meters in height.

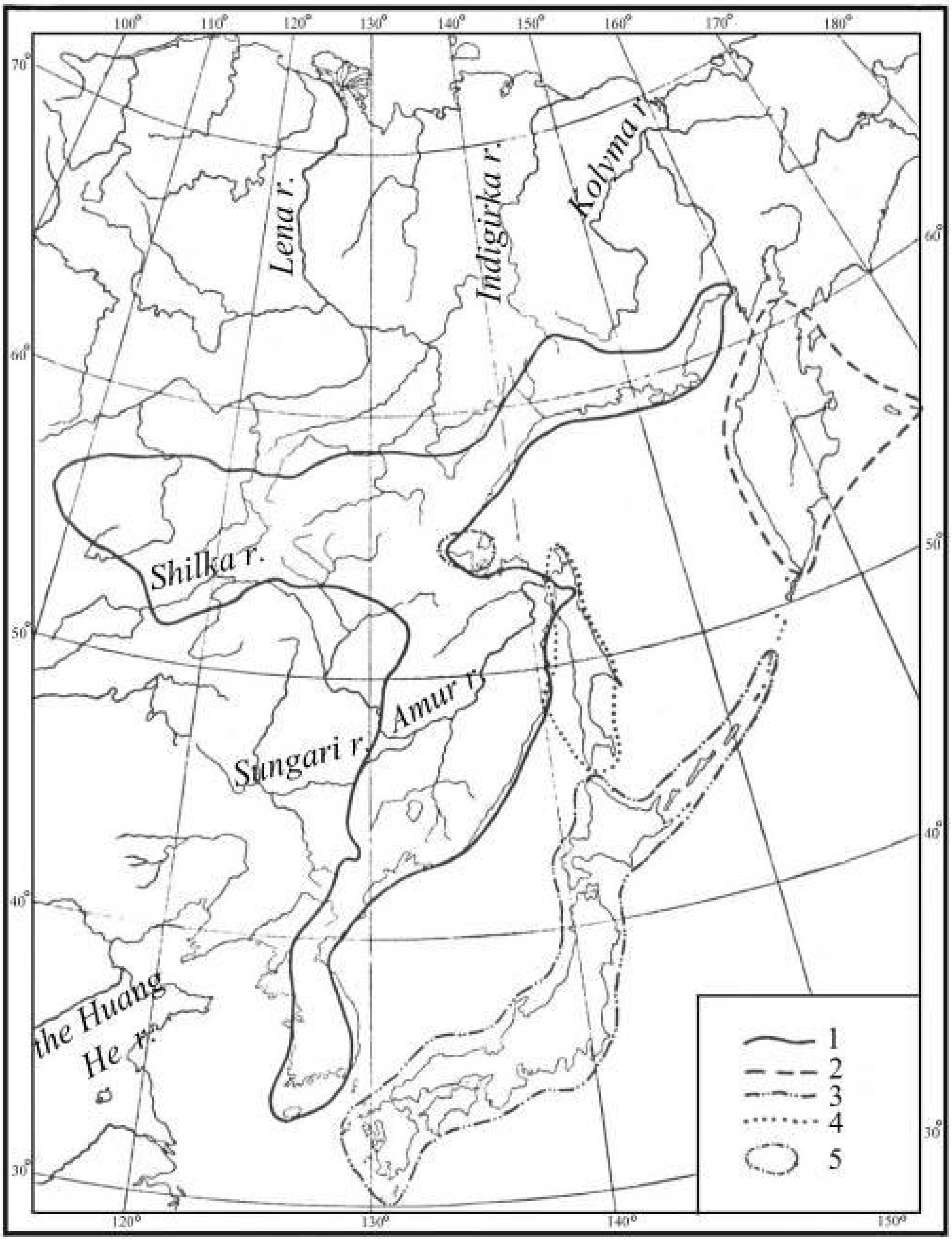

*Fig. 176. Distribution of stone birch forests in the Far East: 1 - Betula lanata (*Rg.) V.Vassil.*, 2 –B. ermani* Cham. *s. str., 3 –B. ulmifolia* S. *et* Z.*, 4 –B. paraermani* V. Vassil.*, 5 –B. velutina* V. Vassil. *(Vasiliev, 1941).*

Stone birch is an alpine species affiliated with a stony substrate and is marked by an unusual longevity- up to 350 years and more –and also by its original competitive root interaction. If a mutual root interference is typical for common birch (see **Fig. 162**), then stone birch growing space of each tree is not overlapped with nearby tree roots: having crossed the line of a crown cover and reached a zone fully used by nearby tree roots, roots break to smaller roots, die off or come back to their zone (Alekseyev, Shamshin, 1972; Man'ko, Voroshilov, 1978).

In Kamchatka in the Valley of Geysers on the space of the Kronotsky Nature reserve, there is a 300 year old stone birch, 14 meters tall and has a 3.5 meter trunk in diameter (**Fig. 177**). Due to its specialness it was named "Wildlife Monument" (http://eco.ria.ru/nature/20110804/411832916.html).

Other species of the section *Costatae* Rgl. are distributed in the Far East; they are Dahurian, or black birch (*B. dahurica* Pall.) (**Fig. 178**), Siberian yellow birch (*B. costata* Trautv.) (**Fig. 179**), Schmidt's birch, or Iron birch (*B. schmidtii* Rgl.) (**Fig. 180**). Dahurian birch is a light-demanding tree, has a spreading crown with branches sticking up at an angle. Its timber is yellowish and reddish, heavier and firmer than downy and European white birch wood. At a young age bark is light and dark brown or brown when mature with small longitudinal splits.

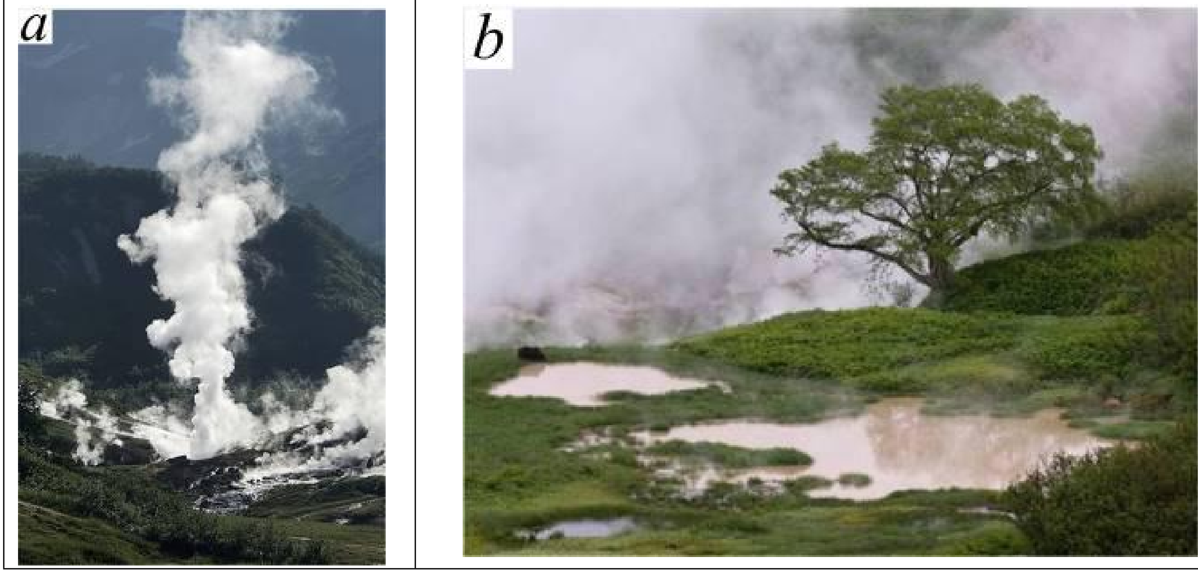

*Fig. 177. The Valley of Geysers in Kamchatka (**a**) (http://newsreaders.ru/showthread.php?t=2296) and a unique old stone birch (**b**)*

Fig. 178. Dahurian, or black birch (Forest encyclopedia, 1985).

Fig. 179. Siberian yellow birch. Photo by Dyukarev.

Fig. 180. Schmidt's, or Iron birch in "Cedar Fold" ("Kedrovaya Pad") Nature Reserve. Photo by Dyukarev.

Siberian yellow birch is a large tree up to 30 meter tall and with a trunk up to 80-100 cm in diameter. It is one of the most common broad-leaved species in the south of Far East; it reaches to the city of Komsomolsk up along the Amur River in the north. It is adapted to the harsh growth conditions. One of the distinct features of the species is a unique shade tolerance: young trees are only capable to develop in a shade.

Schmidt's birch is a remarkable tree; it grows in the Primorye Territory and lives for 400 years. This is the most long living birch of all birch trees on the planet. A bullet can ricochet from its trunk. The wood is a lot firmer than cast iron and can replace metal. Therefore the wood has an advantage to metal: it does not corrode and decay; if it was possible to build a house out of this wood, a house would have lasted forever since Schmidt's birch wood cannot be damaged even with acids. Nevertheless, this tree wood belongs to a well fire-resisting wood category. However, Schmidt's birch is very rare; grows in "Cedar Fold" *("Kedrovaya Pad")* Nature Reserve and is protected by law (Kurentsova, 1968).

On the north forest line of Eurasia, dwarf birch formations of the section *Nanae* Rgl birch trees occupy a great part of tundra and forest tundra. Dwarf birch (B. *nana* L.) occurs from Scotland on the west and up to the Yenisei River on the east. It is a deciduous prostrate shrub up to 1-2 meter high. They grow in a form of a complete thicket on poor bog, tundra and goltsy soils. It is found at 1300 m A.S.L. elevations in the North Urals and at 2400-2700 m A.S.L. in Altai. Further east, dwarf birch is replaced with *Betula exilis* Suk. that is similar to the dwarf birch *B. nana* species but is distinct in thick resinous and glandular branches. Both species are typical subartic shrubs, have a mutual source of origin, they are noted for stunned growth and branch longevity (Kudryavtsev et al., 1973). Eastward, *Betula middendorffii* Trautv. *et* Mey is distributed in the Far East tundra. *Betula tundrarum* Perf. is close to dwarf birch species; it is a shrub up to 30 cm high and often found. Obovate leaves are situated fanwise (Vasiliev. 1969). Tundra dwarf birch formations are mostly found where they are provided with snow defense in winter and shrub stratum itself supports snow capture.

The mentioned above birch species are far from limiting the list. However described here and mostly distributed species give an impression of an extremely significant diversity of the genus *Betula* L. and of how large the birch distribution space is in Northern Eurasia. Certainly attention was mostly given to common birch –to a truly Russian wood species that grows with a large zonal range from tundra to steppe with a minimum capacity in extreme natural zones and with a maximum capacity in the south taiga and forest steppe subzone.

Recently the Russian scientists set up transgenic tree plantations and already cultivated thousands of genetically modified birches. These GM trees grow 25% faster and provide up to 40% more wood ("Izvestia" newspaper issue of March 23, 2015 izvestia.ru›news/584358), although this transgenic forest cultivation is prohibited in Russia. What kind of surprises and fantastic metamorphosis can this GM birch reveal? What is in the **Fig. 181**? Is it a transgenic birch as a biotechnology master piece? Will Adonis be reborn? Commenting, Marcantonio Franceschini's "The birth of Adonis" (**Fig. 182**) Yuriy Linnik suggests that Ovid was present at the birth and here is what he discovered about the new morther's past:

"Her solid bones convert to solid wood,
To pitch her marrow, and to sap her blood:
Her arms are boughs…"

(Ovid. 1977)

Fig. 181. A birch of the future or a freak of nature? (Forest newspaper. 2015. No. 47. June 20th; (http://www.southwalesguardian.co.uk/).

Fig. 182. "The birth of Adonis", Marcantonio Franceschini, 1700. (http://skd-online-collection.skd.museum/imagescreate/image.php?id=289959&type=gross).

In conclusion two weird and almost mystic nature phenomenons should be mentioned that by an odd coincidence are associated with the Ural land occupied by birch. One of them is some kind of "mystic anomaly" (55°53' 7.83″, 60°49' 3.38″) that was discovered on a satellite image near the city of Kasli. This is the concentric circles formed with the growing on a rock fill trees (**Fig. 183**). The origin stays unknown. Normally Mother Nature does not trace such perfectly accurate circles. Can it be the aliens again? Officially this zone was declared "the radio technics examination range".

Fig. 183. "Kasli anomaly". The concentric circles in the eastern part of Kasli overgrown with birches. (http://maps.google.ru/).

Summer 2012, another anomalous zone was found by a worker of the Ural State Forest Engineering University, Mr. Opletaev, 15 km far from the village Artemovskiy (Ekaterinburg region). A fire-up appeared on the forest site and the scorch marks on birch trunks up to the level of 6 meters high could confirm that; the trees were thrown out making a circle split with about a 30 meter radius (**Fig. 184**). There is no crater from the explosion however there are three deep holes in the ground that have been burning for a long time making a 40 cm thick layer of yellow ash on the surface. It is not the turf or slate that is burning but a clay loam that can't burn by definition! (http://www.obltv.ru/news/society/ufologi_obnaruzhili_anomalnuju_zonu_pod_artemovskom/).

Fig. 184. The place of a mysterious explosion in the forest near the village Artemovskiy (near Yekaterinburg region). In the foreground – one of the three holes (http://ляльчук.рф/?p=574).

Perhaps it is one of the plasmoid types –a lighting ball that has exploded? Or might it be a UFO? Similar three holes were found in the Orenburg region after the landing and disappearing of the UFO, although it could be one of the Russian "flying saucers" produced by SPA "Strela" in Orenburg. Indeed "there are more things in heaven and earth, Horatio, than are dreamt of in your philosophy!".

7. Putting in a work for the poor aspen (the genus *Populus* L.)

The genus *Populus* L. (poplar) belongs to the willow *Salicacear* L. family and includes about 110 species distributed in the moderate climate of the Northern hemisphere. The northern distribution limit of poplar aligns with the northern tree line and the south one reaches to Northern Africa, goes through Iran and the Himalayas and the south China mountains.

Poplar belongs to old genera of angiosperms. Some species were found in the flora fossil residues of the Cretaceous period, and the Tertiary and Quaternary times are defined by the presence of numerous poplar species. There are three subgenera of poplar; *Turanga* Bge., *Leuce* Duby and *Eupopulus* Dobe.

It was believed that the genus *Populus* appeared in the high latitudes and spread to the south. In the Oligocene and the Miocene (in the timeframe from 34 to 5 million years ago) all of Kazakhstan and Western Siberia were covered with continuous deciduous type forests where tertiary species of poplar, that departed back to the south due to the following cooling, were widely presented there. The variety of poplar species and forms in Central Asia suggests that this is the place of one of the new origin centers of the genus *Populus* (Krishtofovich, 1934; Usmanov, 1971).

Poplars are the trees up to 60 meters tall and with a 1 meter diameter, with an A-tent-like, egg-shaped or pyramidal crown. The trunk bark is fractured, brownish grey or dark grey in color, the branch bark is smooth grey or an olive drab color. Female parents produce a large amount of seeds (up to 500 million seeds per hectare) with silky hair fluff. Poplars reproduce by means of seeding, grafts and root suckers. The fast growth of poplar usually lasts up to the age of 40-60 years and then slows down. Some species reach 120-150 years of age however, they start rotting early. Poplar root systems are strong yet usually lateral, spreading far beyond the crown projection; nevertheless these trees are wind resistant. They are a rich soil, aeration and light remanding and do not resist the genesis of bog soils (Trees and shrubs of the USSR, 1951; Smilga, 1986).

The genus *Populus* is an example of a particularly evident disparity between the potential organic matter production and its actual implementation in the forest area. Today the genus *Populus* cultivation has become a worldwide issue. National Poplar Commissions were founded in many countries; more than 20 countries are members of the International Poplar Commission within the framework of the Food and Agriculture Organization of the United Nations (FAO). In Italy and France, poplar share in the total woodworking industry which accounts for 80%, and these countries are the world leaders in the poplar wood harvesting. In Canada, *Populus* share in the hardboard and particleboard production is 100% (Tsarev, 1985).

A tremendous need in paper, cardboard and board materials open almost unlimited opportunities of the genus *Populus* wood economic use. By density and cellulose content, poplar wood does not come up short to the coniferous species. Despite the slightly shorter ground wood fiber of poplar in comparison to spruce, modern technologies make the first class production of paper, cardboard and wood board materials out of this "disgraced" species possible. By means of the hydrolysis of cellulose, 1 ton of absolutely dry wood makes up to 200 liters of ethyl hydroxide, which is a feed material for the chemical rubber production.

The cultivation of the gigantic (triploid) forms and the implication of the heterotic effect during the different species hybridization takes the genus *Populus* to the number of the most productive species not only in terms of economic matters but also in the global ecological terms: having an extremely high photosynthetic efficiency, *Populus* can make a great contribution to the carbon and oxygen balance settlement and stabilization in our urban lands. There are already attempts of modeling an ideal breed, the stand volume of which at the age of 20 years under the inundable conditions from forest steppes to semideserts have to reach 600-900 m^3/ha (Tsarev, 1982). Specifically decorative properties of pyramidal hybrids make them more attractive for the urban greening and the landscape architecture in comparison to some other species. There is some data that poplars are the intensive radionuclide absorber.

The implementation of the developing sustainably concept forces to use the renewable energy sources and namely to create so called “energy” plantations where a primary role is assigned to the genus *Populus* hybrids, combining the capability to form a sound wood and an incredible growth power. The biological productivity of the energy plantations of *P. ‘robusta’* near Voronezh on average is 12 tons/ha of a bone-dry solids per year at the optimal 2-3 year cutting rotation (Tsarev, Mironenko, 1997).

The aspen, or *P. tremula* L. (**Fig. 185, 186**) is the most common native to Russia species of the genus *Populus* that belongs to the subgenus *Leuce*. This species occurs everywhere except the tundra and deserts; however it obtains the most spread and better growth in the zone of 53^0- 60^0 north latitudes. Southward in the steppe zone, the aspen is distributed in a form of forest islands associated with horizontal flat water-parting areas and crateriform depressions. On the other part of the south area limit, in the Northern Caucasus, the aspen becomes a typical mountain species and spreads up to the upper mountain belt. In the South-West Siberian Mountains, together with fir, the aspen forms taiga forest; and moreover Polyakov (1931) considers the aspen in Salair as an earlier comer in comparison to fir.

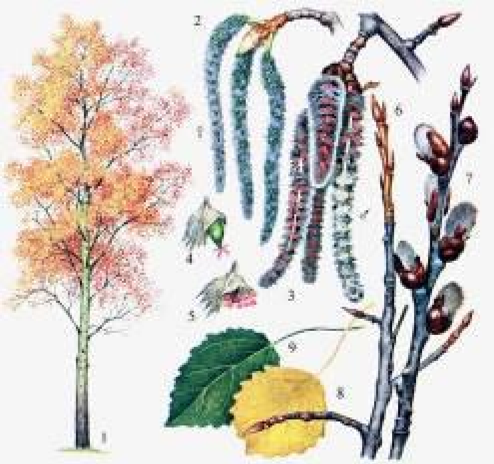

Fig. 185. Aspen: 1 –a general view in autumn; 2 –a blooming shoot (pistillate catkins); 3 –a blooming shoot (staminate catkins); 4 - pistillate flower; 5 –staminate flower; 6 –a winter shoot; 7 –spring shoot; 8 –an aspen leaf; 9 –a sprout shoot leaf of aspen (Forest encyclopedia, 1986).

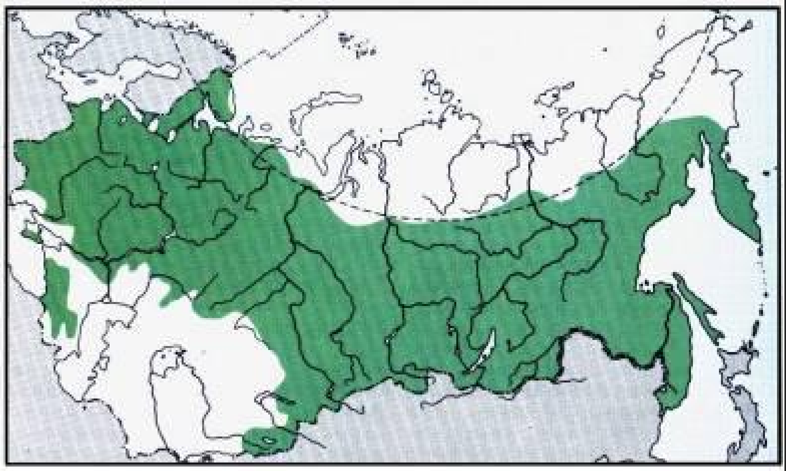

Fig. 186. The aspen area in the former USSR (Forest encyclopedia, 1986).

The aspen occurs all over Siberia in the range between 23^0 to 60^0 N mainly dominating in the taiga zone; it also grows in Minor and Central Asia, Mongolia, China, Far East and the northern part of Japan. Yet there are almost no aspen forests in the harsh continental climate (Yakutia). In the forest-tundra and steppe zone they occur in a shrub forms, in other geographical areas –as a tree of a second magnitude, but in the favorable growth conditions as a tree of a first-magnitude.

On young trees, the crown has a narrow conical shape and in old stands it becomes roundish or egg-shaped, open, permitting lots of light through. Branches are arranged scattered in a spiral in relation to the trunk, on average at a 60^0 angle, and the higher they go, the shorter they are. Branches are thick and very fragile. An autumn branch fall is typical for the aspen. The tree purposefully gets ride of “extra” thin live 18-20 cm long branches. An abruption surface is smooth and roundish resembling a nail-head. A similar phenomenon was already described before from the biofield theory perspective.

The aspen bark is light, green, olive-green and grey, smooth and only on mature trees it is dark grey on the base with lateral fractures. The bark contains carotin (provitamin A) at a rate of 14 mg/kg of a dry matter (Usoltsev, 1973) and takes an active part in a photosynthesis process along with leaves: American aspen (*P. tremuloides* Michx.) bark photosynthetic productivity makes up

11-25% of the leaf photosynthesis which balances out the trunk breathing costs (Foote, Schaedle, 1978).

The aspen is noted for its extensive root system. A tap root develops only on a young aspen and later disappears among strong lateral roots. A part of roots reaches 4-5 meters deep into the ground and the other part spreads superficially up to 35-40 meters from the tree. After felling or fire damage, the root system of one stem can reproduce several thousand root sprouts from accessory buds and during the next vegetation period they will reach 50-90 cm in height (Chizhov et al., 2013).

After falling, aspen leaves do not roll unlike birch leaves and stay flat forming a thick litter layer. Apparently for that reason, an evil role is assigned to the aspen: “On the spots where it falls it seems like all grassland vegetation is destroyed” (Nesterov, 1894). Aspen leaves are nearly round; the leaves’ petioleleaf lamina is thin and long, often longer than the lamina itself, it is flattened on the sides and the middle is the thinnest part.

Fig. 187. Judas Iscariot.
(http://static.biblioclub.ru/art_portal/pictures/404/404073/asgb156a.jpg).

The Russian forester of the 19th century, Nesterov left the following comment on this aspen’s feature in his book “The value of aspen in Russian forestry” (1894. P. 6): “Due to this petiole structure, the aspen leaf starts trembling in the slight breeze and that’s why the aspen is always restless and always awake! Whether in a hot afternoon when all nature is full of bliss as if it snoozes in delicious languor, or in a silent summer night when everything falls asleep, keeps silent, the aspen alone rustles, it alone doesn’t hot have any rest! Is there any wonder that people’s fantasy attributed the aspen with various mysterious characteristics, came up with a belief connecting the aspen tremble with the Saviour’s Passions and his betrayer’s death”(**Fig. 187**). And then he clarifies the belief: “When Judas Iscariot betrayed the Divine Master, he was horrified, started rushing around and wooing death, looking for a tree to hang himself, then the poor aspen was used as a gallows-tree for the self-murderer and betrayer; but having experienced the dead body of the awful sinner, it grasped out of the fear and since then it will be shaking till the world ends. In virtue of this legend up until now good Christians consider the aspen as a dirty and pagan tree” (P. 7). It is not an accident that in old times people used to say

“O Aspen, you Aspen —
Wood that is cursed.
Neither heat, nor smoke,
Nor coals to the samovar”.

The last two lines of this folk saying reflect some relatively low application properties of the outcast wood species related to its porosity; therefrom is a relatively low caloric content of a volume unit and the brittleness of the coal made out of the aspen wood. On top of that, for some reason historically the aspen was considered as a pest species. After felling, one aspen tree on a logging site is enough to cover all the space with a continuous root sprouting carpet, which while getting older, becomes infected with a stem rot (a parasitic fungus *Fomes igniarius* destroying the wood). As a result, in the dry conditions, aspen forests decay barely reaching 30-40 years of age. For a long time the aspen was ignored when founding forestry. According to Nesterov, German foresters were especially unfriendly towards the aspen, and only since 1930-1940s, Russia, Germany and some other countries have started selecting it.

Yet everything has its own intended purpose in the nature and every biological species is incorporated into the complex nature interconnection system providing a universal balance. Low density and timber brashness properties of aspen wood in the wet condition during the drying process are replaced to some other physical and mechanical characteristics such as elasticity, resistance and hardness that rank it together with the oak, larch and elm. The dry aspen wood especially dried-out before felling through girdling lasts in buildings for a long time; that can be proven with one of the oldest Russian wooden architectural monuments Kizhi, where the church domes are covered with aspen shingles. Long since in Russia, the aspen has been in use all around: in house construction, river shipbuilding, well chamber building, in woodwork, woodenware production and river tools construction. The aspen wood splits well and that's why it is also used in coopery, matches production, shingling and etc. Aspen firewood doesn't only rank below spruce firewood in calorific capacity, but also unlike the latter, they sweep the chimney coating it with a glossy vitreous layer.

Already in the 19^{th} century on the basis of a careful mechanical conversion, the special wood fibers characteristics of the aspen allowed production of cotton threads and fabric no different from regular cotton and linen ones. In 1847 in Silesia the "paper paste" production from the aspen wood was invented and that was the beginning of the aspen wood's use in the paper and paperboard production. This direction combined with the possibilities of the aspen use in the particleboard and HDF production open an exclusively great prospect to replace constantly reducing conifer wood sources to the aspen.

Both a wide distribution and an exceptionally fast growth due to which the aspen is called a "eucalyptus of the North" encourage a large-scale use of aspen (Vekhov, 1932). However the aspen is highly distinguished by the growth rate and some other characteristics due to distanced polymorphism and polyploidy. Aspen is very changeable and within one species there are tree forms differentiating by the bark color, leaf shape, wood anatomy, decay resistance and so on. The first knowledge of the aspen polymorphism in Russian forests was revealed back in the 19^{th} century (Gebner, 1859; Kunitskiy, 1888). By now a number of literature is dedicated to the aspen form diversity by the bark color, and one of the most complete overlook is presented by Smigla (1986) who showed that the four forms of aspen: green-, light-, grey- and dark-barked aspen are mostly common on the former USSR lands. A general conclusion is that green-barked form is distanced from others for its thin transparent periderm that is characterized by the most capacity and the best heart rot resistance.

Nesterov (1894) draws some examples of extremely high growth capacity of aspen: In England (Yorkshire) a tree with a more than a 3 meter trunk in diameter and a stem volume of 21 m^3 was once felled, in Finland aspen grew up to 190 years without any signs of heart rot. Usually this kind of phenomenon is related to such aspen characteristic as a polyploidy –a genome mutation during the evolution process with a fold multiplication of chromosome complements in nucleuses. A triploid aspen forms as natural clones are mostly found among the subgenus *Leuce*, which aspen belongs to as well. Tetraploid forms of *Populus* have not been found in the natural environment (Bakulin, 1990).

The vegetative reproduction capacity allows the triploid forms to survive with an inadequate reproductive process and aborted seeds (Matskevich, 1965). A nuclear cell division to 38 chromosomes (2n=38) is typical for a regular diploid aspen, but in 1935 in Sweden the first spontaneous triploid was found, when its nuclear cell divided to 57 chromosomes (3n=57) (Műntzing, 1936; Nilsson-Ehle, 1936). Two years later a triploid, 134 year old aspen, was described by Yablokov (1941) in the Kostroma region and he called it gigantic (*P. tremula,* f. *gigas*). Unlike a regular form, this one was marked for significantly larger leaves, branches, buds, pollen grains, fiber size, wood density, a very intensive growth and absolutely sound timer. Triploid *P. tremula* growing stock in the south subzone of western Siberia taiga has reached 564 m^3/ha by the age of 91, which is almost twice the volume of a regular diploid form of *P. tremula* of the same age that was heart rot damaged early on in the same site (Bakulin, 1966). Taking into account that the *Populus* *tremula* f. *gigas* found in Sweden had 50 chromosomes instead of 57, Yablokov (1941) makes a conclusion that the aspen “gigantism” can’t only be explained by means of the chromosome number fold to the regular aspen; and “it is not so much about the chromosome number, as *the size and biological characteristics of cells* of these aspen forms” (p. 19). Noteworthy is that the growth intensity of the tetraploid *Populus* is slower than regular diploids due to the slowing down of the cell division rate (Bakulin, 1990).

If the aspen is distributed in the depressed relief regions, on uplands and mountains under various site conditions, then the rest of the *Populus* species are usually considered as the flood-lands plants (Ivannikov, 1980). **Fig. 188** shows the areas of the main species.

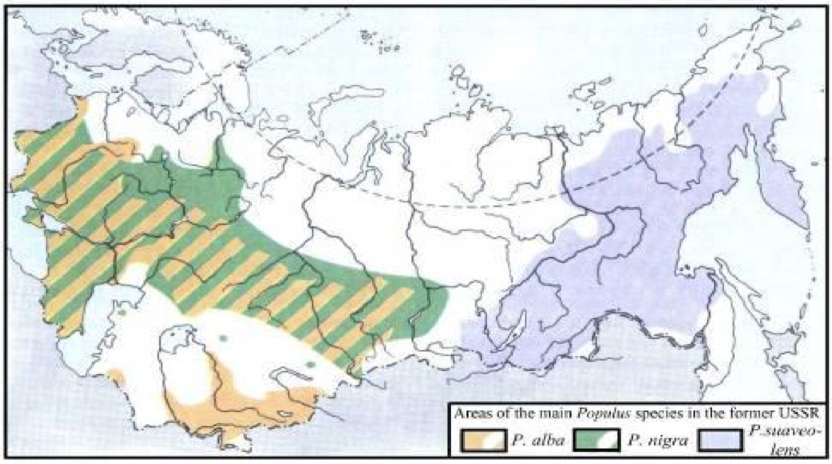

Fig. 188. The main areas of poplar in the former USSR (Forest encyclopedia, 1986).

The black poplar (*P. nigra* L.) (**Fig. 189**) belongs to the subgenus *Eupopulus* Dode of the section *Aegirus*. The tree is up to 30 meters high, lives up to 200 years and has a wide spreading crown. Young leaves are sticky, scented coat with thin layer of fuzz. The leaf petioles are thinner in the middle which makes the leaves tremble like the aspen leaves. The root system consists of one reaching deep into the ground major root and a number of up to 20 meters long lateral roots. Black poplar stands spread like ribbons along the rivers, from the Dnieper River to the Irtysh River.

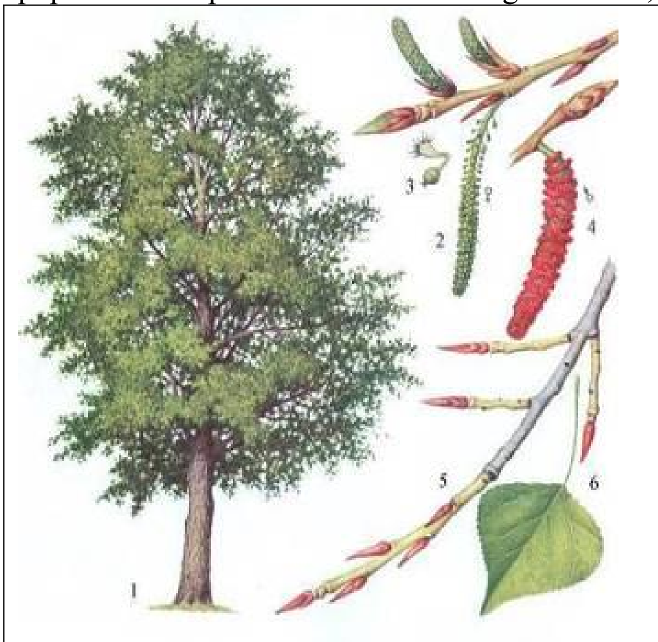

Fig. 189a. The black poplar: 1 –a general view; 2 –a shoot with female catkins; 3 –a fruit; 4 –a shoot with a male catkin; 5 –a coppice shoot; 6 –a leaf (Forest encyclopedia, 1986).

Fig. 189b. The black poplar in Desna River floodplain, near the city of Oster, Chernigov Region. The end of 1950s. Photo by Tarko.

The fragrant poplar (*P. suaveolens* Fisch.) belongs to the subgenus *Eupopulus* of the section *Tacamahacae*. The tree with an egg-shaped crown and sideways rising branches, the leaves are oval. The yellow fragrant resin gives the stickiness to the buds and spots the first leaves. The tree reaches the north vegetation distribution line spreading to the tundra along the rivers floodplains. The height regrowth stops by 25-30 years, the shoots die down early and due to that the crown develops an unaesthetic view. In the north the tree lives until 230 years and in the south –till 160 years. When mature, it often putrefies forming a cave big enough for a few people (Kachalov, 1970; Sokolov et al., 1977). It is distributed from Mongolia up to the Arctic Circle.

The Japanese poplar (*P. maximowiczii* A. Henry) also belongs to the subgenus *Eupopulus* of the section *Tacamahacae*. It grows in the Primorye region, the Korean Peninsula and Japan. The tree has a wide egg-shaped crown and the grey deep lateral furrowed bark. The leaves are large, sleek on the upper side and whitish on the lower side. The Japanese poplar is marked for its large size. On the south of the area trees reach 45 meter in height and 2.5 meters in trunk diameter. They live up to 180-200 years (Vstovskiy, Starikov, 1963; Sokolov et al., 1977).

The laurel-leaf Poplar (*P. laurifolia* Ledeb.) belongs to the subgenus *Eupopulus* of the section *Tacamahacae*. The tree with an A-tent-like subramose wide crown. It reaches 25 meter at 120 years and a volume of 300 m^3/ha however its maximum volume (370 m^3/ha) accounts for the age of 80-90 years (Bogdanov, 1936; Nemich, 1991). The typical sites are the mountain river valleys in the transition areas from mountains to steppes. 80% of the total space occupied with the laurel-leaf poplar within its area accounts for Tuva – the area center (Maskaev, 1987).

The black cottonwood (*P. trichocarpa* Torr. Et Grau) belongs to the subgenus *Eupopulus* of the section *Tacamahacae,* the line *Balsamiferae* and originates in the Northern America. The tree is up to 60 meters tall with 0.5 –2.5 meter trunk diameter and a wide A-tent-like crown and crooked trunk. It ranges along the river sides, brooks and lakes; it reaches 1800 meter elevations and survives -40^{0}C cold. It is widely cultivated around Europe and the European part of Russia (Usmanov, 1971).

The white, or silver poplar (*P. alba* L.) is a part of the subgenus *Leuce* the line *Albidae*. The tree grows to heights of up to 30 m, with a trunk up to 2 m in diameter. The bark is covered with dark marks–lenticels (**Fig. 190**). Bogdanov (1952) described the 130 year old white poplar which was 35 m tall and 4 m trunk in diameter on the Black Sea coast of the Caucasus. It grows wild in forests and plain floods of Middle Europe, Siberia, Central Asia and the Caucasus. The opinions regarding its longevity vary: it can live from 80 years (Sokolov et al., 1977) up to several hundreds of years reaching a huge trunk diameter with a hollow or heart rot in the last case (Ovsyannikov, 1934). Due to the large variety of the forest sites, the white poplar forests presented in forms of disunited forest outliers interspersed with meadows or black poplar forests.

Fig. 190. The white poplar bark with typical lenticels (Jenik, 1987).

In the zone of the *P. alba* and *P. tremula* areas overlapping, the grey poplar (*P. canescens* (Ait.) Smith) – a hybrid genetic species (*P. alba x P. tremula*) – occurs sporadically. It is a fast growing tree up to 30 m tall and ratoons abundantly; it does not form single species forests (Sokolov et al., 1977). By a mature age the volume of its triploids in the Middle Don River reaches 1200 m^3/ha (Kovalev, Petrukhnov, 1982).

The Bolle's poplar, or Turkestan poplar (*P. bolleana* Lauche) is included in the subgenus *Leuce* the line *Albidae* (**Fig. 191**). The pyramid-shaped poplars historically have developed under the culture conditions and are not found in wildlife: they were propagated by graftings more than two thousand years ago (Yablokov, 1956). *P. bolleana* is one the largest poplars in Central Asia. It is a low tapered, up to 35 m tall and with 2 m trunk diameter tree with a smooth light grey or greenish bark and narrow pyramid-shaped crown. Branches grow at an acute angle.

Fig. 191. The Bolle's, or Turkestan poplar (http://www.udec.ru/derevo/topol-piramida.php).

The black, or Lombardy poplar (*P. nigra* L. var. *pyramidalis* Spach., or *P. pyramidalis* Rosier) belongs to the section of the black poplars *Aegirus* (**Fig. 192**). It is distributed in Afghanistan. The tree is up to 40 m tall with straight branches and branch almost from the base of the trunk; the branches pointed up and form a narrow pyramidal crown.

Fig. 192. The Lombardy, or black poplar.

The Asiatic poplars are the representatives of the subgenus *Turanga* Bge., grow in the tugai river valleys of Central Asia. During the hot periods in the dry sites, the Asiatic poplars shed a part of leaves which helps the conservative water use. According to Krishtofovich (1934), the Asiatic poplar's ancestor (*P. mutabilis* Heer.) ranged "in the region of Kyrgyz steppe from the Aral Sea to the Irtysh River" during the Oligocene (p. 355). The bloomy poplar (*P. pruinosa* Schrenk) and the downy poplar (*P. diversifolia* Schrenk) originated from that species, and *Populus ariana* Dobe was isolated in the floodplain of the Amu-Darya, Murghab and Kushka Rivers, and *Populus litwinowiana* Dode was isolated in the valley of Ili river.

With the purpose of the heterosis effect, i.e. the increased function of any biological characteristics, the directed hybridization in the genus *Populus* came into widespread acceptance that can also have a spontaneous and random nature. The Berlin poplar (*P.× berolinensis* Dippel = *P. laurifolia* Ledeb.× *P. nigra* L. var. *pyramidalis* Spach) is an example of a very successful hybrid that inherited from the parent trees and included such useful characteristics as the fast growth, pyramid shaped crown, cold resistance and a good rooting ability from grafts. It appeared spontaneously in Berlin Botanical Garden. The mother tree was the laurel-leaf poplar and the father tree was the black poplar. The crown is wide pyramidal shaped. In Belarus it reaches the height of 25 meters, in the forest steppe of the European part of Russia in culture by the age of 30 and is on average 27 m tall with the growing stock of 1350 m^3/ha. It demands soil moisture, grows well in the floodplains, is valuable for the decorative matter, however it is sensitive to pests and diseases (Bogdanov, 1936; Redko, 1975).

Euro-American hybrids (*P. euroamericana* (Dode.) Guinier). Several subgenuses of the Canadian poplar (*P. deltoids* Marsch.) brought to Europe as the result of the natural crossing with the European black poplar (*P. nigra* L.) formed the variety of hybrids and consequently had numerous names. In 1950 the International Botanical Congress in Stockholm adopted one general name *P.* × *euroamericana* (Dode) Guinier for all the Euro-American poplar hybrids. Also the decision was taken to keep the names of the oldest and the most common hybrids cultivated in Europe for more than 150 years as specific designations, or cultivars, for instance *P.* × *euramericana* (Dode.) Guinier cv. 'marilandica' (the May poplar) or *P.* × *euramericana* (Dode) Guinier cv. 'robusta' (the robusta poplar) (Red'ko, 1975).

From the robusta poplar clone, the English professor Henry selected a cultivar *P. euroamericana* cv. 'vernirunebs' (spring red poplar) that was marked for the heterotic growth and its orange-red leaves in early spring. From the same robusta poplar clone the French professor Bachelie selected a cultivar *P.*× *euramericana* cv. 'bachelieri' (*populus Bachelieri*) characterize with the heterotic growth and well districted pyramidal shaped crown. Both cultivars (*P. 'vernirubens'* and *P. 'bachelieri'*) are marked for a twice faster growth in the young age than the local black poplar (*P. nigra*) (Skupchenko, Romanovskaya, 1970).

In the Ukraine the most distributed out of the Euro-American group was the May poplar; it is very productive on rich floodplain, light clay-loam moist soil; it grows also on sandy soils with the near underground water occurrence, yet it does not tolerate the acid boggy and turf soils. In comparison to the other hybrids, the May poplar is relatively salt-resistant; however it is easily infected with leaf rust and bark canker. The may poplar cultures in the floodplain of the Desna River (near Chernigov) at the age of 21 years were 23 m tall on average (I*b* productivity class) and had a stand volume of 335 m^3/ha, and in the upland degradation in the same region at the age of 29 years they were 19 m tall and made the stand volume of 330 m^3/ha (Red'ko, 1975). *Populus Bachelieri* in Bulgaria (Svishtov) on the meadow-boggy reclaimed mid clay-loam soil has even higher productivity: at the same age of 21 years it reached 29 m in height (I*e* productivity class) (Broshtilova, 1986).

In Bulgaria the age trends of the medium height hybrids overtop the upper limits of a general site class scale for poplars and willows by 40% (Kozlovskiy, Pavlov, 1967; Krustanov et al., 1987). Evidently it requires the development of a special site class scale for hybrids which is restrained due to the insufficient number of their mature stands.

Lost opportunities and hybridization perspectives can be demonstrated on the example of our undeservingly compromised aspen. The aspen hybridization is carried out in three directions where they hybridize 1) valuable forms and the clones together; 2) different geographical forms and clones; 3) aspen with geographically closed and geographically distant poplars. For example, a valuable hybrid progeny, characterized with a heterotic growth exceeding the reference copies was received in the Czech Republic as the result of the hybridization of aspens with different ploidy, in particular with the use of a tetraploid species as a pollinizer of a diploid one (Smilga, 1986).

In the southern Kazakhstan conditions, the hybrids resulted in the hybridization between species belonging to the populations of different geographical zones show the fastest growth. When hybridizing, the aspen with Bolle's poplar (*P. bolleana* Lauche), the heterosis developed more in the progeny of the Tian Shan aspen race than the Tselinograd one (Besschetnov, Iskakov, 1971). In the Baltic States, the hybridization of the local *P. tremula* with the American aspen (*P. tremuloides* Michx) gave the best heterosis effect (Smilga, 1986).

A North American "newcomer" of the subgenus *Eupopulus* of the section *Tacamahacae* – the balsam boplar (*P. balsamifera* L.) has gained widespread in greening and landscape building. It is considered that due to the sticky discharge of buds and leaves it cleans the air from dust well. However in the view of its biology it doesn't adjust well to the urban environment. For instance, in

Krasnoyarsk more than 70% of the poplar tree has drying off symptoms mainly because of the canker group diseases (Pushkarev, Tatarintsev, 2003).

In Yekaterinburg due to the progressive *Lithocolletis populifoliella* content, the balsam poplar trees look very “sad” already in the middle of summer because of the leaves turning yellow and untimely falling foliage. In the absence of the appropriate control over the planted trees, female parents of this species filled the streets of the cities gave a lot of trouble to street cleaners and allergy-predisposed people because of the poplar wool during the blooming time in spring and summer. Every year the Municipal services spend large amounts of money on decapitation, i.e. trunk topping in order to lower the damage of extraordinary fertility of female parents and “rejuvenate” male ones since growing older they become dangerous for residences because of the fragile branches and trunks. These injured, basically crippled trees make a painful impression, especially in the leafless winter (**Fig. 193**).

Fig. 193. Manmade tree snags - the result of the balsam poplar “rejuvenation”in Yekaterinburg. Photo by V. Usoltsev.

Clearly that it is necessary to cultivate trees and shrubs with a more aesthetically beautiful look and adjusted to the urban environment for the greening. One of the cultivars meeting the purposes is the Sverdlovsk silver pyramidal poplar-hybrid; it was hybridized by one of the members of the Botanical Garden and later a professor of the Ural State Forestry Engineering Institute, Mr. Konovalov (1959b, 1960, 1964), who obtained more than 10 *Populus* hybrids with good potential in Yekaterinburg. The Sverdlovsk silver pyramidal poplar is the result of the hybridization of the white poplar (see **Fig. 190**) and Bolle's poplar from Central Asia (see **Fig. 191**) and for a half of a century has shown good results in urban greening in Yekaterinburg (Atkina et al., 2009). It is found on the alleys of Vostochnaya, Shevchenko and other streets and locations (**Fig. 194-197**).

This hybrid, unlike its southern pyramidal "fellows", does not freeze in the harsh Ural winter conditions and at the same time is marked for an appealing external appearance, the absence of "wool", late defoliation and pest resistance. According to the professor of the Ural State Forestry Engineering Institute, Mr. Srodnykh (2001), it is also vulnerable to pests (poplar aphid and rust fungi) due to the air pollution, dust content and soil consolidation, moreover the amount of affected foliage goes up during the summer and by the end of the season can reach 60-90%. However the effect of this poplar hybrid, unlike the balsam poplar, does not go to a catastrophic proportion and does not affect its external appearance. Srodnykh recommends this species for the urban greening preferably on sunny sides of the streets since the species favors direct sunlight.

As all the pyramidal poplars, the Sverdlovsk silver poplar is cultivated by grafting but not always successfully. To provide a higher graft establishment the professor of the Botanical Garden of the URAS Mr. Kozhevnikov takes the grafts not from the bottom crown part of a mature tree, but from the most viable and bioactive young shoots. These shoots are hard-to-get technically since they are located in the crown top; that's why a tree is "put on a stump", i.e. it is cut and from the numerous coppice shoots growing on a stump, he picked young grafts and planted them in a greenhouse.

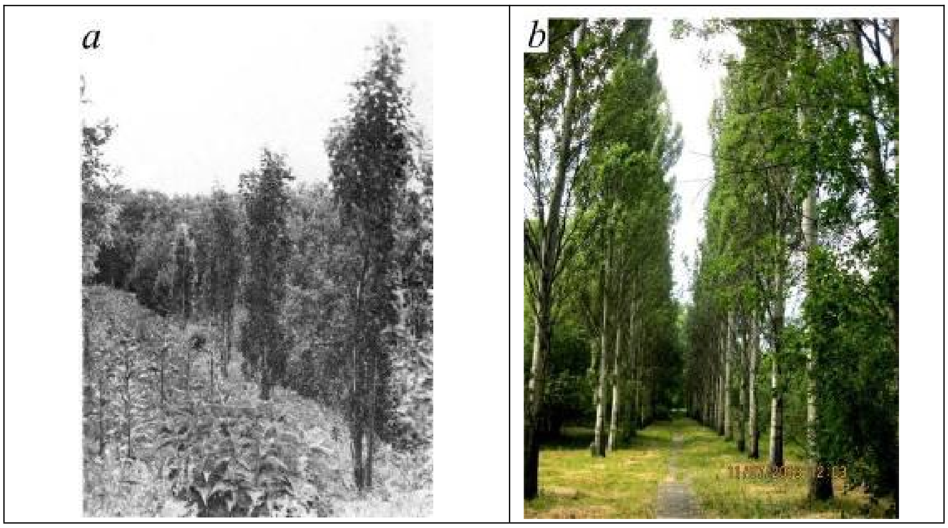

Fig. 194. Alley plantation of the Sverdlovsk silver pyramidal poplar (Populus alba L. ×P. bolleana Lauche) in the Botanical Garden of the URAS. ***a*** *–in the year 1957 (Konovalov, 1959b). Photo by Shaburov.* ***b*** *–the same alley in 2013. Photo by Noritsina.*

Fig. 195. The middle of October in 2014. The alley plantation of the Sverdlovsk silver pyramidal poplar on the USFEU campus still keeps the green foliage on. It is seen that all the deciduous trees are already resting for the winter. Photo by V. Usoltsev.

*Fig. 196. The Sverdlovsk silver pyramidal poplar bark inherited from the white poplar its typical lenticels (see **Fig. 190**). Photo by V. Usoltsev.*

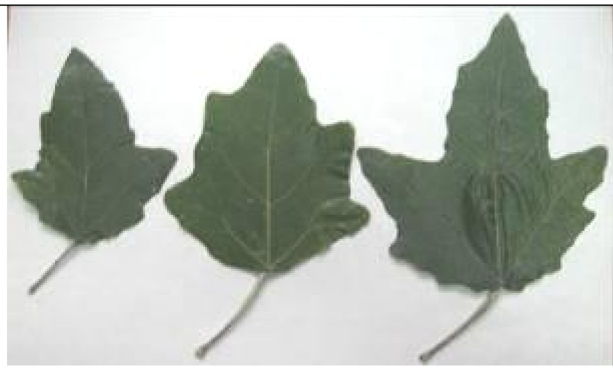

*Fig. 197. The Sverdlovsk silver pyramidal poplar leaves inherited the leaf shape of Bolle's poplar (see **Fig. 190b**). They stay vital active up to the first snowfalls and fall before they turn yellow. Photo by V. Usoltsev.*

In terms of the calendar deadline, the vegetative propagation technology of pyramidal poplar-hybrids in the Ural conditions was developed by Kozhevnikov and described by Noritsina and co-authors (2014): April 17-18, 2013, poplar ligneous shoots stocked up and stored in the open air wrapped. May 5th–grafting is complete; the grafts are put in a container with water inside (**Fig. 198a**); after leafing (**Fig. 198b**) the planting in a greenhouse on May 13th was done. In the end of the vegetative period on August 19th (**Fig. 198c**) the sapling establishment and their seasonal height regrowth in accordance to the graft stock variety (from different crown parts of the tree at a different age and from root suckers). The graft sampling from root suckers of the poplar alley plantation on the USFEU campus (see **Fig. 195**) obtained the best results in the establishment (64%) and height regrowth (up to 1 m). The conclusion was drawn that ligneous shoots taken from root sucker can be used for the reproduction of the silver pyramidal poplar of Konovalov's selection if impossible to get the grafts from a bioactive crown part of a parent tree.

Fig. 198a. Shoot grafting (length is 20-30 cm).

Fig. 198b. Leafing.

Fig. 198c. Grafted saplings at the end of the vegetation season.

One more hybrid (hybrid No 121) the Bashkir pyramidal poplar bred on the Bashkirian Forest Experiment Station by Berezin (1938, 1939), as the result of the black poplar (see **Fig. 189b**) pollination with the Lombardy poplar (see **Fig. 192**) good results were showed in greening the cities of Bashkiria in the Ural region conditions. It's a large tree (at 17 years old it reaches 22 m in height and 25-33 cm trunk diameter). The crown is a narrow pyramidal shape (**Fig. 199**), the trunk is straight; the bark is green grey with numerous lenticels, dark at the bottom with clearly defined cracks. The shoots are thin, smooth, grey yellow with whitish round lenticels, cylindrical, slightly angular to the top. The buds are pointed, red; side buds are significantly smaller then crown buds, thin. The mature tree leaves remind the black poplar leaves –triangle or rhombic, grandular and crenate, usually with a long pointed top, sometimes slightly bent, glabrous, the edges are wavy. On the coppice shoots, the leaves are a wide triangular shape (10 cm long and 12 cm wide) with a short pointed top. In autumn leaves stay on for a long time. The leaf petioles are 5-7 cm long, flatten, bright red, shiny. The hybrid No 121 has a high growth potential: the yearly height growth on the Bashkirian Forest Experiment Station reaches 2.2 m with 1.7 cm diameter. In all the zones it is characterized with a relatively early growth end thus it's winter hardy. It survives $-56^{0}C$ in Bashkiria. It is drought resistant and soil demanding. It reproduces well with grafting; gives root suckers. It is rather decorative due to its narrow pyramidal crown shape (http://reftrend.ru/558907.html).

Fig. 199. The Bashkir pyramidal poplar.

Summarizing, the genus *Populus* is generally characterized by a wide range of biological and economic features. On one hand, the aspen is a weed plant, but on the other hand it is a great quality timber; on one hand it is a grey barked form dying from the heart rot at the age of 30-40 years, on the other hand, it is gigantic (triploid) form maintaining high growth rates and sound timber up to 130 years or older. For historical reasons, when evaluating some of the weaker aspen properties were prioritized. However, the contemporary selection and breeding levels of the genus *Populus* and also the technology levels of the timber modification and processing open the door to a “justification” of this uncommon wood plant and a total review of its place and role in the bio-ecological and economic matters.

8. Oak (the genus *Quercus* L.) is the symbol "a mighty beauty" and longevity

In the temperate and tropical zone of the northern hemisphere, the genus *Quercus* includes about 600 species. A distinguishing dependence of oak forests on climate is their affiliation with the humid regions with reduced continentality. In the temperate climate of Western Europe, they range from the Mediterranean Sea and deep into the north whereas in more continental conditions in the East European Plain geographically they are localized in a relatively narrow band. In Russia the oak forests are less than 1% of the forested area (The Forest Fund of Russia, 2003).

"The mighty beauty" of the oak was praised by people due to its sublime, wide and splendid crown and an extensive root system. In Slavic countries the popular assembly (*veche*) gathered under age-old oaks. For the Midsummer Night celebration, all Ivans received oak branches as a symbol of stability and courage. The oak was dedicated to mighty Perun, the god of thunder and lightning. Many Slavic tribes lived in oak forests. In the Kirovograd region, archeologists discovered acorns and acorn flour that was used for baking more than 5,000 years ago. Oaks were singed for; people wrote poetry and fairy-tails and painted oaks. Many nations awarded and still award the winners with oak chaplets; oak leaves were also stitched on warriors' collars (Atrokhin, Solodukhin, 1988).

The most typical representative of the genus *Quercus* in the European part of Russia is the common oak (*Q. robur* L.) of the section *Eulepidobalanus* Oerst, which is more adapted to the continental climate. It is the main forest-forming species of deciduous and coniferous-deciduous forests in the European part of Russia (**Fig. 200, 201**). Naturally it grows from the Baltic Sea to Lake Onega in the North; to the Black Sea in the south and from the western country border to the Urals in the East (**Fig. 202**). With such a pronounced ecological flexibility the oak is capable to occupy large areas developing various climate and edaphic ecotypes, forms and species.

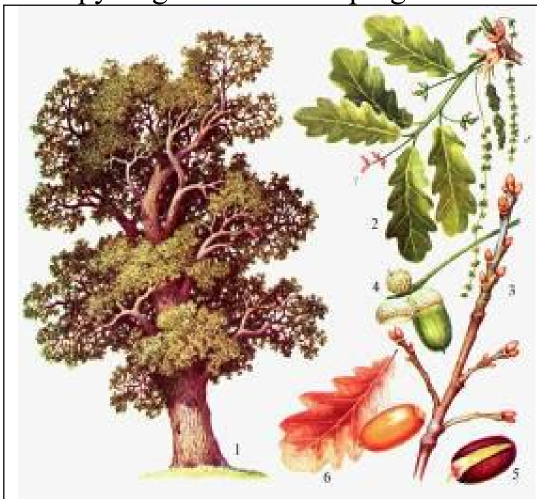

Fig. 200. The common Oak (Quercus robur L.): 1 – a general view; 2 – a blooming branch (left - pistillate flowers, right - staminate flowers); 3 – a spring shoot; 4 – acorns with stalks; 5 – a sprouted acorn; 6 – a leaf (autumn colors) (Forest encyclopedia, 1985).

Fig. 201. A 700 year old oak in Verkhnyaya Khortitsa village, near Zaporozhye. Within its lifetime Crusades and Battle on the Ice took place. The tree is 36 m tall, with 6.3 m trunk diameter and 43 m crown diameter (http://faktzafaktom.ru/samyj-staryj-dub/).

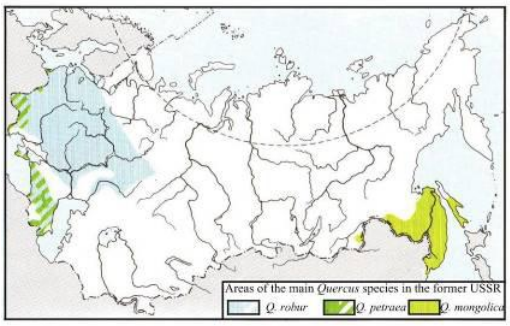

Fig. 202. The area of the main oak species in the former USSR (Forest encyclopedia, 1985).

In the Paleo Holocene there was no common oak in the north of the European part of Russia. The postglacial common oak migration to the North went alongside the floodplains and the floodplain oak associations in the north of the East European Plain became the earliest formations of the oak forests (Neishtadt, 1957; Denisov, 1980). The common oak has one ecological optimum in Western Europe under the conditions of the oceanic climate and brown forest soils, and another one on the East European Plain, and moreover, according to Shelyag-Sosonko (1971) – in the forest steppe and steppe zones and according to Lositskiy (1949) in the zone of coniferous and coniferous-deciduous and deciduous forests.

The common oak is a large tree, up to 50 m tall and usually up to a 1.5 m trunk diameter; it has a full-boled trunk and a small crown in a close forest. It lives up to 1000-2000 years and reaches 4 m in diameter. Leaves have a very short stalk, wrong lobed shape, leather-like, they are shiny on top and light green on the bottom. The common oak forms a strong major root already when sprouting from an acorn and later develops an extensive taproot system 5 meters deep into sandy, sandy loam and clay-loam soils; on the waterlogged land it develops a lateral root system, on stony soils – an anchor root system enveloping stones. The tree is very wind-resistant. It starts bearing fruit at the age of 10-15 years in the open land and at the age of 60 years in forest; it bears fruit and retains the rejuvenation capacity up until the a great age (Kachalov, 1970; Sokolov et al., 1977).

The common oak obtains a special status, mentioned above, also due to extraordinary longevity and a large number of remaining trees "the old timers" (see **Fig. 201**). The oak is often named as the patriarch of the Russian forest (Atrokhin, Solodukhin, 1988). The oldest oak in Europe was found near the Stelmužė village in Lithuania and was called "Stelmužė old fellow" by the locals. It appeared before the Common Era and now it is more than 2,000 years old and has a 3 m trunk diameter. An 1100 year old oak grows near Buda Khutor in the Chernigov Region. It is 30 m tall, the trunk circumference is about 9 m and the trunk diameter is 3 m.

In the Kaliningrad region there is an 800 year old Grunwald oak – the witness of the Teutonic Knights batter. The Zaporozhye giant oak is more than 800 years old on Khortitsa Island. It is 36 m tall, the trunk circumference is over 6 m and the crown diameter is 43 m. From a far, this green "tent" resembles a whole groove (Atrokhin, Solodukhin, 1988). A 500 year old oak with a 1.5 m trunk diameter sustained in the southwest of Udmurtia near the Kizner village. Its bottom branches spread so wide that they arched beneath its own burden, balked into the ground and rooted. Surrounded with scrubs, this oak family under one crown roof is the monument to rustling here one day large and rich oak forests (Bogoyavlenskiy et al., 1999). The only 300 year old long-boled mountain oak forest is the "Forest on Vorskla" in Europe and is preserved in the Borisov district in the Belgorod region due to the fact it has been a private protected area for 200 years (Grin'kova, 2014). There was a time when the oak wild forest in Germany struck awe into the Romans. Pliny wrote that "In northern Germany there is the large Hercynian forest, untouched for centuries and is the same age as the Universe; due to its everlasting destiny it leaves behind miracles".

The common oak demands the soil richness and moisture; however it also grows on forest podzolic clay-loam, stony and rather dry soils, on chalk slopes and in steppe on degraded vlack earth, alkali and even chestnut soils; in floodplains it survives longtime dumping on alluvial soil and develops adventitious roots after silting up. In the western part of the South Urals on 800-900 m tall mountains, the common oak reaches the upper forest line tolerating the sub goltsy altitudinal belt climate better than other broad-leafed species. Growing there as a medium size tree (up to 9 meters) with a crooked trunk, here and there it forms small areas of specific oak elfin woodlands (Gorchakovskiy, 1975).

It is a comparatively winter and drought resistant species of medium warm-endurance yet very sensitive to suppression from above. Whereas the side shading is beneficial: it brings along the height growth and die-off of bottom shoots. During the first years it grows slowly and by the age of 10 years it reaches 0.5-1 m in height, and in case of auxiliary species (side shading) – 2-4 meters. It grows strongly in height (up to 1.5 per year) up to the age of 60-80 years, then till 200 years of age the growth tempo slows down. When mature, the accretion mainly concentrates on the trunk enlargement and crown extension. By the age of 150 years and older, it sheds yearly part of its branches with shoots and therefore it controls the crown size stability (Kachalov, 1970; Sokolov et al., 1977).

Oak wood is good looking and heavy, has great strength and hardness; it is very resistant to decay. Seasoned oak wood discolors to dark red and assumes extra hardness and under it is used for valuable articles and furniture production under the ‘bog oak’ title. The oak is especially popular in the coopering; it is used for the production of the most valuable barrels. The decoction of oak bark is used in medicine.

Acorns serve as a food source for many animals (wild boars, deer, bears, squirrels and rodents), birds (jays, pigeons, pheasants) and domestic animals. Kholodnyi (1941) developed a hypothesis that the jay was the main, if not the only, natural oak distributor in wild nature. It consumes almost only acorns hiding from feathered predators in a thick-set. While carrying acorns in a nib and opening them the jay loses the best part of acorns, which can explain oak distribution as an individual tree and not “from a pile” as it took place in regards to the Siberian stone pine. Acorn’s oval shape and the smooth surface is an adaptive behavior of oak, i.e. a characteristic of its adaptive nature that developed during the process of natural selection and ensued the slipping out of acorns from jay’s nib and talons.

The common oak foliage releases 10-14 tons per ha of oxygen, i.e. more than any other species, and filter off up to 56 tons per ha of dust per year. In comparison to its companions – linden and maple, the oak is more air pollution resistant, especially to sulphuric, fluorine and nitrogen ones, and it is less resistant to the chlorhydric acid suspensions (Konashova, 2000 a, b). An unknown author of the article “Incredible vitality of the pedunculate oak (*Quercus pedunculata*)” published in 1874 in “Forest Journal (Lesnoi Zhurnal)”, vol. 2, writes that “A 60 foot tall and 380 year old oak was cut down in Croatia in 1845. A long top of it was left on a felling area until the spring of 1846. At that time a forester found this tree top and was not only covered with new leaves but also was blooming. Although people say this occurrence is not uncommon, only a few actually saw it; especially the second aspect, i.e. the blossom of a cut part of a plant demonstrates the incredible vitality of the pedunculate oak. The forester was indeed surprised when the same year in June he saw *fresh acorns* as big as a grape-shot on the cut tree top! However, in July the log completely dried out” (P. 184).

Despite the longevity of some individual common oak trees, currently on the southern border of the area, in forest steppe and steppe, (Sumy region in the Ukraine, Kursk and Voronezh regions, Nizhnee Povolzhye and Trans-Volga regions), the pre-steppe oak forests experience mortality (Napalkov, 1951; Kraynev, 1951; Tantsyura, 1983). The last listed author explains this phenomenon by the fact of the summer soil over drying and general land aridization. An intensive oak forest dry-out also occurs in the floodplain of the Ural River in the steppe zone (The Ural region of Kazakhstan). The average age of the predominant coppice oak there (57 year) is critical under the harsh condition of the extreme continental climate, and at the age of 85-95, the share of drying-out trees goes over 70% (Startsev, 1994).

Though the intensive dry-out takes place not on the southern area limit of oak but in the rather favorable climate conditions, in the mixed coniferous-broad leafed and broad-leafed forest zones – in Bryansk, Orel, Tula and other regions. In particular, especially in the last decade, a drastic decline of the oak population occurs in the south of the Bryansk region, and the loss of growth in the middle-aged and mature forest stands has reached 50-65% (Erokhin, 2006). The reason is the consequences of the cold weather in the 1940s and 1970s, dry winters and droughts in the 1960s and periodical outbreak of leaf-eating insects in 1940-1990s (Lositskiy, 1949; Tikhonov, 2006).

Similar processes take place in the foothills of the Carpathians (the upstream of the Dniester River). As result of the loss of growing forest, the forest density there declines from 0.8 in the II age class to 0.6 in the VI age class, respectively the phytomass productivity goes down. The drying of oak in the Transcarpathia lowland forests is explained by a number of reasons including the insufficient hydrological regime (Tribun et al., 1977) and turf formation (Afendikov, 1954). The three oak species - Hartwiss oak (*Quercus Hartwissiana* Stev.), *Quercus pedunculiflora* C. Koch) and the sessile oak (*Quercus petraea* Liebl.), that range in the foothill and upland oak forests of the North Caucasus dry out individually and massively in the mixed forest composition supposedly due to the cancerous vascular disease which is not observed in regards to other broad-leafed and small-leafed species and shrubs (Shcherbin-Parfenenko, 1954).

The very cold-resistant Ural race was distinguished wishing the common oak area (Forest Encyclopedia, 1985). In the Sothern Urals, the oak survives the frost up to -40°C, however 50% of the stems have frost clefts. In some particular situations the oak survived the frost of -50°C but later within the next cerebral decades, the majority of trees dried-out. In the 19th century the oak forests occupied a larger land there than now and had seed origin. Nowadays they mostly have a sprouting origin, reach only up to 60-80 years and age slowly since there is now a natural substitute with their parent species. As the result of the dry-out from frost and insect pest damage, grazing of livestock and recreation, unappropriated management, the area of the oak forests in Bashkiria was reduced by half in the 1960s (Mamaev, 1999, Konashova, 2000 a, b), and by 40% in general in the European part of Russia (Erusalimskiy, 1995). By man-made way the oak forests are regenerated on limited land areas. If the forest steppe and steppe of the East European Plain is the oak optimum, then in south of the Urals, the oak takes root and grows particularly slow under the steppe zone conditions. For example, in the Chelyabinsk region, steppe the root-taking of 2-3 year old oak plantations is 2-62% whereas in the forest steppe in the same region it goes up to 34-91% and in the mountain forest zone is reaches 95-99% (Petrov, 1961).

The dry-out of the oak not only on the south area limit but also in the optimum zone testifies that the common oak steps out of its ecological zone at the present time stage, but that might be a temporary occurrence related to the solar period (Sidorov, 2004). At least the lowest levels of the ground waters within the Volga-Don basin are evident, simultaneously with the changes of the Caspian Sea with a 10-12 year cycle (Tyurin, 1949; Lositskiy, 1981). Moreover, the even and odd 11 year cycles (according to Zürich counting) influence the radial growth of the oak in the Voronezh forest steppe differently: an increased growth prevails during the even cycles and a reduced growth – during the odd cycles (Kostin, 1971). However in general, the dry-out reasons are not fully studied (Lindeman, 1975; Novoseltsev, Bugaev, 1985; Odinak, 1992).

In the middle part of Europe and North Caucasus, to a great extent the common oak yields the position to another oak species, to the durmast oak (*Q. petraea* Liebl.), the section *Eulepidobalanus* Oerst. (**Fig. 203**). In its biological properties, habitus and bark color of the durmast oak is similar to the common oak but it is demands more warmth and air humidity and at the same time it is capable of managing drier, poor and well aerated soils (Sokolov et al., 1977).

Fig. 203. The durmast oak is the main composition member of the oak forests in North Caucasus (Petrov, Dorozhkin, 2002).

Fig. 204. The pubescent oak (http://благос.рф/wp-content/uploads/2013/03/Dub-pushisty-j-2.png).

Fig. 205. The red oak, or the champion oak (http://eva.ru/jsf/forum/print-all.jsp?topicId=2787817).

Fig. 206. The holm oak (http://commons.wikimedia.org/wiki/File:Mendaza,_Navarra_Spanien-Steineiche).

The pubescent oak (*Q. pubescens* Willd.) of the section *Eulepidobalanus* (**Fig. 204**) is close to the durmast oak. The area ranges from France to Asia Minor. In the Elbe River basin the pubescent oak in the north reaches almost the south border of Germany, and along the Rhine it occurs even northward. It also spreads in the western Mediterranean and the Balkans, in the north-west Caucasus, on the southern coast of Crimea and in Dagestan. The tree is 10-20 m tall with a crooked trunk and sometimes with an umbrella-shaped crown. There is a 100-year old and 15 m tall pubescent oak in the Nikitsky Botanical Garden. The leaves are deep and shallow lobed with a heavy pubescence. Their distinct characteristic is the rough maintenance even after the decay. It is very light demanding and drought resistant (Sochava, Semenova-Tyan-Shanskaya, 1956; Kachalov, 1970).

Since the 18th century, a native to North America, the red or champion oak (*Quercus rubra* L.), (**Fig. 205**) was cultivated in the Old World with decorative purposes. This tree is up to 25 m tall, grows well in the south of Russia, up to Moscow and Lipetsk regions however, its branches frost up in the Middle Urals. It has high decorative properties: before the autumn leaves fall the tree is "dressed" into a wonderful purple-red gown. Due to the fast growth and an easy acclimate capacity, the red oak has become one of the main species in the man-made forest cultivation (Kachalov, 1970; Komaskella, 2002).

The holm oak (*Q. ilex* L.) is typical for the Mediterranean region; it is an evergreen tree up to 25 m tall with the smooth dark grey bark (**Fig. 206**). It grows in the lower coastal belt up to 1200 m A.S.L. and is drought resistant. It is an evergreen exotic species in the south of Russia.

There is another evergreen species, the corn oak (*Quercus suber* L.), in the western part of the Mediterranean Sea basin. When growing in a forest the crown is cylindrical, and it is spreading and has an irregular shape on the open land. The trunk is up to 20 m tall, up to 2 m in diameter. The leaves are egg-shaped with toothed edges (**Fig. 207**). The bark is light grey, very thick and is the only source of cork used in the industry and known to the early Greeks and Romans by its insulation and floating properties. The outer cork layer is split off as solid fragments uncovering the inner brown-red layer. It is possible to harvest up to 1 kg of cork from one tree. The cork harvest starts when a tree is 11-12 years old however the cork is a better quality at an older age (30-150 years). In south Crimea and the Caucasus, there are plantations cultivated just for the cork harvest and the cork oak is also cultivated for ornament in parks (Kachalov, 1970; Komaskella, 2002).

The Adriatic oak (*Quercus cerris* L.) with an open spread crown is a typical sub-Mediterranean species (**Fig. 208**). It ranges from Europe to Asia Minor in the altitudinal belt from

0 to 800 m A.S.L., also grows well in the Ukraine and the Caucasus and the south of Russia. The tree is up to 30-35 m tall and is cultivated in parks and for the urban greening.

In Transcaucasia, the durmast oak is substituted for the Georgian oak (*Q. iberica* Stev., or *Q. petraea* ssp. *iberica*) of the section *Eulepidobalanus* (**Fig. 209**). This is a 20-40 m tall tree with short-lobed leaves up to 20 cm long. In the north it almost reaches Novorossiysk and dominates in forests of the lower and partially middle belt; it is the main edification of the mesophile oak forests in Transcaucasia that occupy drier slopes in comparison to beech forests (Sochava, Semenova-Tyan-Shanskaya, 1956; Kachalov, 1970).

Fig. 207. The Cork oak is the only cork source that was known already to the early Greeks and Romans by its isolating and floating properties (Komaskella, 2002).

Fig. 208. The Adriatic oak that is used for the urban greening in the south of Russia, in Caucasus and the Ukraine (Komaskella, 2002).

Fig. 209. The Georgian oak, Abkhazia. (http://www.plantarium.ru/page/image/id/151503.html; http://благос.рф/wp-content/uploads/2013/03/dub-gruzinskij.png).


Fig. 210. The Hartwiss oak (http://www.dom-bez-kluchey.ru/russian-flora)

The Hartwiss oak (*Q. hartwissiana* Stev.) is typical for the strictly mesophile forest communities of Caucasus and the south of the Black Sea coast; the tree is 34-36 m tall with numerous (9-12 pairs) small lobes, not drought resistant enough (**Fig. 210**). The Imeretian oak (*Q. imeretina* Stev.) and *Q. pedunculiflora* C. Koch close to the common oak are included in this community. The first one forms the forests along the Kodori River and the second one, that is noted for pubescent blue-grey leaves and grows on the mountain slopes up to 1000 m A.S.L. All the tree species are from the section *Eulepidobalanus* (Sochava, Semenova-Tyan-Shanskaya, 1956; Kachalov, 1970; Sokolov et al., 1977).

The chestnut-leafed oak (*Q. castaneifolia* C. A. Mey), the section *Cerris* (Spach) Oerst belongs to the same ecological type (**Fig. 211**). The tree is 40-45 m tall and up to 1.2 – 1.5 m in trunk diameter. It grows very slow up until 20 years old reaching 5-6 m in height, from 20 to 60 years of age it grows fast (up to 25 m tall and 45-50 cm in trunk diameter), and the following growth slows down. It starts bearing fruit at 20 years old, provides coppice shoots up to 60 years of age and lives up to 300 years. On deep soils it develops a taproot system, on the lowlands – lateral root system. It is one of significant forest forming species in Lankaran where it ranges on the south mountain slopes from the sea level up to 1800 m elevations (Sochava, Semenova-Tyan-Shanskaya, 1956; Kachalov, 1970; Sokolov et al., 1977).

East Mediterranean oaks are represented in south Transcaucasia by the gall oak (*Q. araxina* (Trautv.) Grossh.) of the section *Eulepidobalanus* (**Fig. 212**) and close to it *Quercus dschorochensis* C. Koch of the same section. The gall oak is a 16 m tall tree with a 70 cm trunk diameter, grows in the lower mountain belt and up to 1000-1300 m elevations forming dry open forests and forests in the regions of poor rainfall (350 mm per year), hot summers (26-27°C) and warm winters. The stands are usually coppice by origin, 2-10 m tall, growing in a shrub form (Sokolov et al., 1977).

The Caucasian oak (*Q. macranthera* Fisch. *et. Mey*. *ex* Hohen) of the section *Cerridopsis* Maleev belongs to the same group and grows in Transcaucasia, north-east of Turkey and the north of Iran (**Fig. 213**). The tree is up to 20 m tall yet usually shorter, with a 80 cm trunk diameter, with a thick short trunk, almost black bark and typical pubescent all crown parts including acorns. It grows in the middle and upper mountain belt, up to the upper forest line at 2300 m A.S.L. and is not just a drought but also a cold resistant tree (Kachalov, 1970; Sokolov et al., 1977).

Fig. 211. The chestnut-leafed oak (http://upload.wikimedia.org/wikipedia/commons/7/76/Quercus_castaneifolia2_kew.jpg).

Fig. 212. The gall oak (http://agbina.com/site.xp/053051053124049048049051.html).

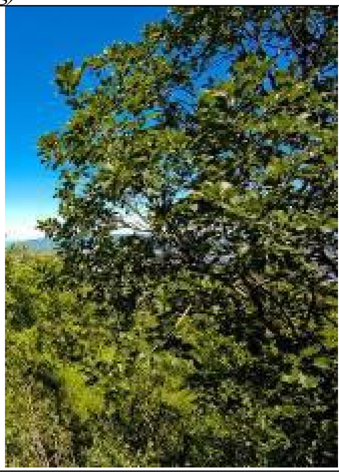

Fig. 213. The Caucasian oak, Georgia (http://upload.wikimedia.org/wikipedia/commons/1/1b/Quercus_macranthera_Tbilisi.jpg?uselang=ru).

Fig. 214. The Pontine oak (http://upload.wikimedia.org/wikipedia/commons/8/8d/Quercus_pontica).

The middle and lower mountain belts in Transcaucasia are usually occupied with *Q. pedunculiflora* and the durmast oak that range up to 1600 m A.S. L. The Caucasian oak's unusual cold resistance and a corresponding affiliation with the upper forest line are explained with the fact that in comparison to *Q. pedunculiflora* and the durmast oak, it does not develop a lammas-shoot (Johannistrieb). The latter develops in the mid of summer, does not have enough time to lignify by autumn and is frosted by the first cold spell (Gulisashvili, 1940). With this being said, the absence of a lammas-shoot and unusual cold resistance are the important ecological characteristics of the Caucasian oak that lets us suggest its origin from the northern oaks. At the same time, *Q. pedunculiflora* and the durmast oak provides seasonal growth twice the size in height by means of a lammas-shoot (a physiological atavist frosted in autumn) and shedding leaves for 1-2 winter months, draw near to the evergreen species and apparently originated from the tropical ancestors (Gulisashvili, 1940).

The Pontine oak (*Q. pontice* C. Koch.) of the section *Eulepidobalanus* is distributed in the Caucasus and Turkey mountains and grows at 1200-2100 m elevations as a prostrate tree or a shrub forming a subalpine crooked forest (**Fig. 214**). Due to snow piles, lying stems take root and die by the base and slide down the slopes. They live long but it is hard to identify their age. Stems are 10-12 m long, 30-40 cm in diameter and the tree tops are lifted up to 6-7 m above the ground (Sokolov et al., 1977).

In the Far East, the oak is represented with the three different species: the Mongolian oak (*Q. mongolica* Fisch.) (**Fig. 215**), *Q. crispula* Blume. of the section *Eulepidobalanus* and the Daymyo oak (*Q. dentata* Thunb.) of the section *Dentatae* C. K. Schneid. The Mongolian oak is a relatively drought and cold resistant deciduous tree 24-25 m tall, 1-1.2 m trunk in diameter, lives up to 300 years. It occurs on low-productive stony soils on dry southern slopes. In the midstream of Argun and on the Amur, near Albazino it has the form of a crooked shrub 0.6-1 m tall (Shperk, 1882). In the North-East near the Arpa River, discharged into Nikolai Gulf, on the 150-180 m elevations it grows as individual trees in the cloud spruce forests or forms open stands with undergrowth. In the south Primorye it reaches 21 m in height. On the Zeya-Bureya', Mid-Amur' and Prikhankay lowlands the Mongolian oak dominates in the IV-V productivity class stands on temporary dry gravel soils on the southern slopes and mountain ridges. In the Middle Sikhote Alin the mountain oak forest go up to 500-700 m A.S.L. Shrubby oak forests (1-2 m tall) with a flag-shaped crown composed of the Mongolian oak that occurs on the seaward sea cliffs of the Primorye.

Fig. 215. The Mongolian oak in the Kedrovaya Pad Nature Reserve on the western Amur Bay coast (Forest encyclopedia, 1985).

The *Q. crispula* is a deciduous tree 12-14 m tall and 40-60 m trunk in diameter, distributed in south Sakhalin, on the Kuril Islands (Kunashir and Iturup), in Japan, Korea and China (**Fig. 216**). It forms open oak forests on low-hill terrains in Sakhalin, going up to the mountains to the rocky birch forests. It often grows as shrubs with a deformed crown shape (Sokolov et al., 1977). The Daymyo oak (*Q. dentata*) is a deciduous, relatively heat-loving tree drawn to the oceanic climate regions, up to 15-20 m tall with a thick cracking bark (**Fig. 217**). The leaves are up to 20 cm long and turn bright orange-red colour in autumn. Mostly in China the leaves are used to rear the oak silkworm (Kachalov, 1970; Sokolov et al., 1977).

Fig. 216. The Quercus crispula (http://flower.onego.ru/kustar/ena_9910.jpg).

Fig. 217. The Daymyo oak. (http://flower.onego.ru/kustar/ena_3483.jpg).

Summarizing, the genus *Quercus* is divided into the western and eastern parts of the Eurasian continent, developed in the Tertiary period and during the genealogy process formed 600 species deeply varied by biological and especially ecological characteristics. There deciduous and evergreen trees, slow and fast growing at the young age, large trees and sub-shrubs, drought resistant and long-term water logging tolerated species. However there is one common feature for all these species, which is the affiliation with the humid region with the reduced continentality.

9. Linden (the genus *Tilia* L.) – the nectar-bearing tree in the Russian forests

Linden (lime) - the genus *Tilia* L. counts up to 50 species. The western Slavs considered linden as a national tree and associated the Slavic kindness of heart and geniality with it. The Slavs worshiped linden as the "mother of trees", the source of life and the sweetest, healthiest for everyone honey; and as a tree the parent providing clothes, shoes and roots. It made it the symbol of femininity and tenderness (Pokhlebkin, 1989). Linden found its place in the folklore literature:

The perpetual lime tree
Rustles over the river
A daring song
Sounds from a far

The meadow is covered by fog
Just like the altar-cloth
One can hear from the burial mound
The sound of the guard[*]

**Translation cited from http://masterrussian.net/f14/%D0%BB%D0%B8%D0%BF%D0%B0-%D0%B2%D0%B5%D0%BA%D0%BE%D0%B2%D0%B0%D1%8F-another-great-poem-6419/*

In Russia, linden is one of the forest forming species but shares 0.4% of the forest land. The tree is up to 40 m tall and with up to 2, rarely 5 m trunk diameter. The leaves are simple, dentate. The fructification is annual. It reproduces well with coppice shoots, layers and root suckers; it is very shade-resistant, ornamental and is the best nectar bearer.

The age limit for the most part of the trees is 500-800 years old, however 1100 year old linden trees are also known to exist (Kachalov, 1970). One of the oldest Linden grows near Württemberg and Neustadt town (Gernamy). According to Stuttgart records, already in 1932 this was a large tree with a very spread crown and along with that, 60 stone pillars were set up to support its branches. In 1665 this tree was 8 m in a stem girth; in 1849 the stem girth was 10.3 m, in 1938 – 13.0 m and heave branches were supported with 98 stone pillars, as a result the tree was like a whole grove. This tree is 700 years old. Another, Troas Linden in Graubunden canton in Switzerland was known already in 1424; in 1778 its stem girth was 14.5 m and it was 883 years old by that time (http://alanles.ru/dolgovechnost-derevev.html).

There are several species that are presented in Russia, the main among them are the small-leaved linden (*T. cordata* Mill.), the Siberian linden (*T. sibirica* Bayer), Amur linden (*T. amurensis* Rupr.); Take's linden (*T. taquetii* C. K. Schneid.); Korean linden (*T. koreana* Nakai) (**Fig. 218**). The small-leaved linden is the only species which area ranges throughout all of Europe and partially in Asia (**Fig. 219, 220**). The tree is up to 30 m tall; in Tatarstan, by the age of 50, it reaches the average height of 16 m and the growing stock of 250 m^3 per ha, by the age of 100 years is 23 m in height and 470 m^3 per ha of volume respectively (I site index). It occurs more often in mixed forests but also forms single species forests in Bashkiria and Tatarstan. Linden is very demanding of the soil quality; it does not grow on poor dry and boggy soils. In dense stands it forms a full-boled trunk and prunes naturally. It propagates by seeds as well as by means of coppice growth, lives up to 200 and even 600 years. Up to 50-60 years of age, even coppice linden has a sound wood, but later it starts decaying and at the age of 100 years there is a cave in the trunk. It is the most typical the genus *Tilia* element of the broad-leaved forests is distantly occurring also in the taiga zone (Tkachenko et al., 1939; Kachalov, 1970). All the modern linden forests were established after the clear felling of the oak and spruce-fir stands. It is stated that in the Mid-Povolzhye the most part of linden trees at the age of 80 have a seed origin and sprout trees only make 20% of the total amount (Bukhovets, 1965; Zhuravleva, 2004).

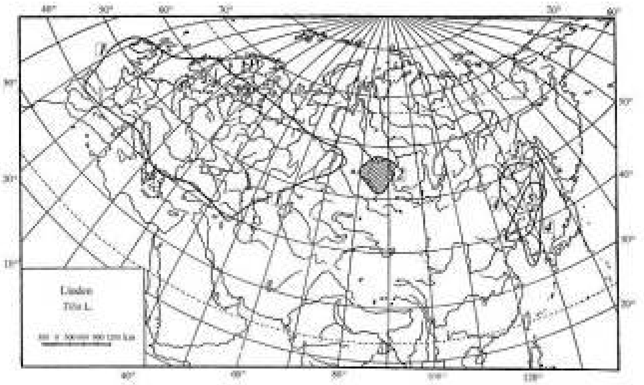

Fig. 218. Main linden species areas: 1- small-leaved linden (T. cordata Mill.*); 2 - Siberian linden (T. sibirica* Bayer*); 3 - Amur linden (T. amurensis* Rupr.*); 4 - Take's linden (T. taquetii* C. K. Schneid.*); 5 - Korean linden (T. koreana* Nakai*). (Trees and shrubs of the USSR, 1958).*

*Fig. 219. The avenue of limes "Unter den Linden" in winter (**a**) and summer (**b**), Nizhnie Sergi in the Middle Urals. Photo by V. Usoltsev.*

The linden leaves are roundish with a slightly pulled top and heart-shaped at the base, dark green above and lighter beneath. The flowers are yellowish-white, very fragrant, arranged in cymose clusters with a pale green wing-like bract. Due to it, linden received its Latin name "Tilia" which means a wing or winged (Atrokhin, Solodukhin, 1988). However, according to Shtremberg (cited by "Trees and Shrubs of the USSR", 1958) in Greek "tilia" means "a tree attracting bee swarms".

These fragrant flowers appear in the mid of summer and are the nectar source for bees that during 10-12 days of blooming manage to collect the most amount of stored honey. It is assumed that the forests within a radius of 3 km from a stationary bee garden are used for bee keeping. For a thousand of years people have been using this linden nectar and beebread bearing properties. The linden ability to release the nectar and pollen is 7 times higher than oak's. In the year of plenty, one large linden tree provides as much nectar as one hectare of buckwheat, and one hectare of a good linden forests releases up to 700 kg of nectar. The linden nectar contains up to 40% of saccharose and 12% of fructose and glucose. Linden honey is one the most valuable; when fresh it is light amber in color. It is an extremely high-calorie product: 1 kg of linden honey contains more than 3150 calories. The honey has some bactericidal properties and that is why it is very effective when treating infected wounds. In ancient Greece, honey was considered as one of the most valuable gifts of nature, and eternal gods supposedly ate ambrosia that contained honey. In Ancient Russia for many centuries honey was the only source of sweet and was almost as valuable as fur (Mamaev, 1999; Sultanova, 2006).

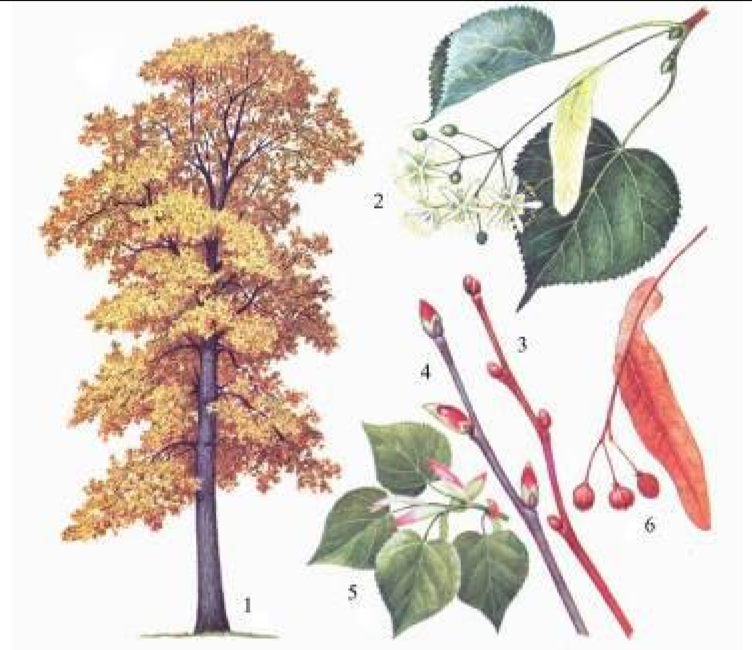

Fig. 220. The small-leaved linden (Tilia cordata Mill.*): 1- a general view of the tree in autumn; 2 – a blooming branch; 3 – a winter shoot; 4 – a spring shoot; 5 – a leafed spring shoot; 6 – a collective fruit of linden (Forest Encyclopedia, 1986).*

Fig. 221. The Siberian linden (Tilia sibirica Bayer.*): a lower part of a mature multistem tree. Mountain Shoriya, Kuzedeevo Lime Island (http://www.plantarium.ru/page/image/id/40819.html).*

More than a third of all linden forests in Russia (about 1 million ha) are located in Bashkiria, where they make up 16% of the total forest area. The first knowledge of the apiculture– the initial form of bee-keeping based on maintenance of bees in tree trunk hollows – havs been known since the 17th century. The golden age of it accounts for the 18-19th centuries and in 1770, Rychkov wrote that hardly any other nation could excel the Bashkirs at beekeeping. At the moment, there are more than 250 thousand honey-bee colonies on different kinds of farms. Bashkir linden honey contains 37% of glucose and about 40% of levulose (Sultanova, 2006).

Another of the most valuable properties of linden is its wood. It is soft, white, with even structure, easily processed, fairly firm and what's most important is that it does not cramp or rupture and that's why it can be used for wood carving. Based on Rastrelli's design, the linden wood carving elements were made for the Catherine Palace interior; Russian serf craftsmen left great decorative art pieces craved out of linden wood in the Ostankino Palace in Moscow, the Winter and other Palaces in St. Petersburg. Nowadays this folk craft is revived in Suzdal in the "Vladimir Patterns" manufacturing company. However according to the company manager Mr. Vladimir Kehter "energetically writes" linden wood is required for the souvenir decorative design. Another valuable product of linden is its bark (bast wood). About 99% of Russians used to wear bast shoes made out of young tree living bark; bast fibre was used for sacks and bast mats, and woodcuts are for house shingling and other products (Mamaev, 1999).

Lime has good aesthetic properties, discharges lots of phytoncides and is well-adjusted to the urban environment. That's why it is one of the main park-forming species and widely used for urban greening. By means of topiary work, it is possible to make any crown shape. Great linden alleys are preserved in many old country estates.

A close species to the small-leaved linden is the Siberian lime; the tree is up to 30 m tall and with a 1 m trunk diameter, distributed only in the Altai forests (**Fig. 218 and 221**). The oldest stands are 170 years old and some individual trees live up to 300 years. The Siberian lime in Kuznetsk Alatau (Mountain Shoriya) is a unique nature monument of the former broad-leaved forests in mid-mountain taiga in the moderately cold and humid belt of aspens and firs. The relict Siberian lime area consists of isolated areas associated with the coal deposits. Lime stands in that region are preserved despite the unfavorable climate indices for lime regular distribution site. Lime holds occupied lands due to the good vegetative regeneration, an ability to adjust its life form under unfavorable conditions, a shot growth period and frost resistance of the upper tree part.

The linden root system is sensitive to the low temperatures which impair its ability to compete. However the proximity of underground gas-bearing formations plays a crucial role in lime-tree forest survival in the harsh mountain conditions of Altai. They create particularly favorable thermal and hydrological regimes and support the positive temperature control in the root range. These formations also are the source of the ground layer and soil saturation with the CO_2 by means of which the Siberian lime does not yield in height and diameter growth to the small-leaved linden in more favorable climate conditions of the Eastern European Plain (where the air temperature is 1.2-1.4°C higher during the growth period). Nevertheless the effective temperature sum is not enough for the regular seed ripening and fungal diseases limit the abilities of the seed regeneration of the Siberian lime there (Khlonov, 1996).

The Amur lime (*T. amurensis* Rupr.) is distributed in the mixed coniferous-broad leaved and broad-leafed forests in the Far East (**Fig. 218 and 222**) and replaces the small-leafed linden. The tree is up to 25-30 m tall, marked for largely dentate leaves and distinguished edges on nuts. Take's lime (*T. taquetii*) is distributed in the same place, southward on the Kola Peninsula. The tree is up to 25 m tall with the grey bark and 3.5-7.0 cm long leaves (see **Fig. 218**). The Korean lime (T. koreana) occurs within the same area limits but on the significantly smaller space; the tree is up to 15 m tall with the grey bark and pear-shaped fruits (Sochava, Semenova-Tian-Shanskaya, 1956; Kachalov, 1970).

The Balkan species - silver linden (*T. tomentosa* Moench.) (**Fig. 223**) has a relatively small area. The tree is up to 25 m tall, very oriental; the leaves are white-tomentose on the bottom. It is tolerant and oriental due to its silver foliage and is one of the most beautiful linden trees in the country south. The trunk is covered with a dark grey bark that remains smooth until old age. The branches and buds are slightly pubescent. It blooms a few days later than the small-leaved linden and its flowers release an even stronger scent. The fruits are tomentous ball-like nuts. Unlike all the other European linden species, the silver linden retains green foliage up to autumn. In autumn the leaves turn yellow. The tree looks very decorative in parks and alleys.

		
Fig. 222. The Amur lime (T. amurensis Rupr.*) (http://upload.wikimedia.org/wikipedia/commons/8/85/Tilia_amurensis_2777.jpg).*	*Fig. 223. The silver linden (T. tomentosa* Moench.*) (http://mpg.susu.ru/_otkritki_derevya/index.php?page).*	*Fig. 224. The European lime (T. europaea* L.*) (http://vin-ru.1gb.ru/enc/ena_0736.jpg).*

The European lime (*T. europaea* L.) ranges within Western and Central Europe including the south of the Northland (**Fig. 224**). The tree is up to 40 m tall and lives up to 1250 years. The large-leaved linden (*T. platyphyllos* Scop.) has almost the same area size as the European lime but it significantly shifts to the south (**Fig. 225**). The tree is up to 30 m tall with the grey bark and reddish-brown fresh shoots; the leaves are 7-12 cm long, larger than that of the small-leaved linden leaves (Kachalov, 1970).

The Caucasian lime (*T. caucasica* Rupr.) is distributed in the Caucasus and the Black Sea region. The tree is up to 35 m tall with greenish-brown fresh shoots, drought resistant; the leaves margin is sharp and serrated. Ledebour's lime (*T. ledebourii* Borb.) has a significantly smaller area limited to the Black Sea coast. The tree is up to 30 m tall with dark bark and bears fruit poorly. The leaves are asymmetrical; 8-12 cm long. And the insignificant range area belongs to the Crimean endemic - Crimean linden (*T. dasystyla* Stev.). It is an alpine tree up to 20 m tall with dark bark and is very ornamental (Kachalov, 1970).

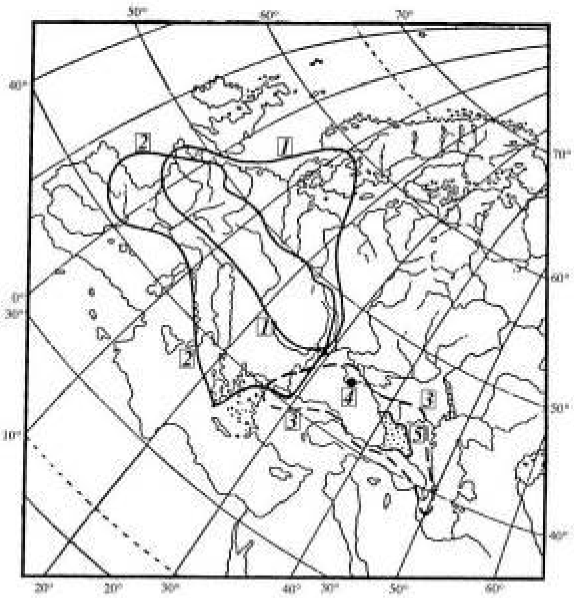

Fig. 225. Areas of Tilia europaea L. *(**1**), T. platyphyllos* Scop. *(**2**), T. caucasica* Rupr. *(**3**), T. dasystyla* Stev. *(**4**), T. ledebourii* Borb. *(**5**). (Trees and shrubs of the USSR, 1958).*

In summary, the diversity, uniqueness and value were unveiled through the example of one more tree species of the Russian forests – linden.

10. Alder (the genus *Alnus* Gaertn.) – a global pioneer tree.

The genus *Alnus* Gaertn as well as the birch belongs to the family *Betulaceae* C. A. Agardh and includes 30 species ranging mostly in the northern hemisphere. After the Ice Age, alder was one of the first species distributed in the coastal area of the Pacific Ocean - it is the first wood species that appeared on the Planet (http://qftarchitects.net/mebel-iz-olxi/). The genus *Alnus* includes about 50 species growing in the northern hemisphere. The genus representatives are widely spread in Europe, Asia, Northern and Southern America, in the Algeria' mountains. There are 9 species in Russia. Alder is one of those trees that does not stand out in a forest. An extended, thin and often crooked trunk of the alder reaches up to 25-30 m in height and is black-brown in color. Young and mature tree trunks are smooth; the old ones are slightly fractured. The alder's leaves are oval or almost round, with a typical cut on top, 5 to 10 cm long and sticky in spring. Alder leaves keep their mat green color below and grey-green color beneath up to late autumn and fall green and not yellow or red unlike other species leaves. Alder has an affinity for moist soil and usually grows on rivers, ponds and lake shores or in spring flooded forests.

Yuriy Linnik quotes Vladimir Lugovskoy:

"Up to the Lake Onega pines
The river streams so calm.
So gently and so tender
The Alder blooms down low".

And his poetic tree description follows: "indeed it blooms above the snow banks! What can be more beautiful than its long, string sensitive catkins? You shake the tree and a golden pollen cloud rises up into the blue sky: maybe it will mix with cosmic dust" (Linnik, 2015, P. 211).

The Latin genus name "*Alnus*" was mentioned by the Roman authors as Vitruvius and Pliny and some other of that time period. The Russian genus name "ольха" (olkha) comes from the common Slavic word «olьха», «elьха» and is the derivative of the root el-, ol-, related to the term for light, red and brown color. There are a variety of folk names of the genus. Alder in Russia is included in the number of the forest forming species, although out of 719 million hectare of the total forest area, only 1.7 million hectare, i.e. 0.2% falls on alder share. There are three of the most distributed alder species: grey alder (*A. incana* (L.) Moench.), common alder (*A. glutinosa* (L.) Gaertn.) and dwarf alder*(A. fruticosa* Rupr.).

Grey alder is the tree up to 15-20 m tall and with a 30, rarely 50 cm trunk diameter. The bark is grey, smooth, the shoots and buds are with grey pubescence. The leaves are up to 10 cm long and 4 cm wide, ovoid or egg-shaped with pointed top; pale green above and grey beneath. In the natural environment it grows in the European part of Russia, Western Siberia, the Caucasus, Western Europe and North America. In Finland under the better conditions (I site index), it reaches average height of 14 m and the timber volume of 250 m^3 per ha at the age of 40. The leaves are grey-green and piliferous on the bottom; young leaves are not sticky (**Fig. 226**).

Grey alder is one of the fastest growing species (annual height growth may be more than 1m) especially at a young age, has a shallow root system that is located in the upper 10-20 cm thick layer, it produces lots of root suckers and stump suckers. It is winter resistant, more shade tolerant than birch and aspen trees however, it has an affinity for lighten sites. It tolerates the excess of water, rather demanding soils, at the same time it aerates the soil itself. It lives up to 50-60 years, rarely till 100. It propagates by seeds and suckers, stakes and cutting.



Fig. 226. Grey alder (http://ru.wikipedia.org/wiki/%CE%EB%FC%F5%E0_%F1%E5%F0%E0%FF); (http://cveti.clan.su/forum/2-538-1)

Grey alder ranging (**Fig. 227**) occupy mostly the forest zone, and only its single outliers reach the forest-tundra and forest-steppe. In the Caucasus it reaches elevations of 2400 m A.S.L. It does not form a primary forest; the primary and secondary of its associations on hollows, ravines and moor edge is still an outstanding matter. However due to the rich seed production, easy ways of seed distribution and good sprouting, grey alder intensively occupies spare lands forming temporary secondary associations that often are replaced with spruce within 50-60 years (Tkachenko et al., 1939; Kachalov, 1970; Sokolov et al., 1977).

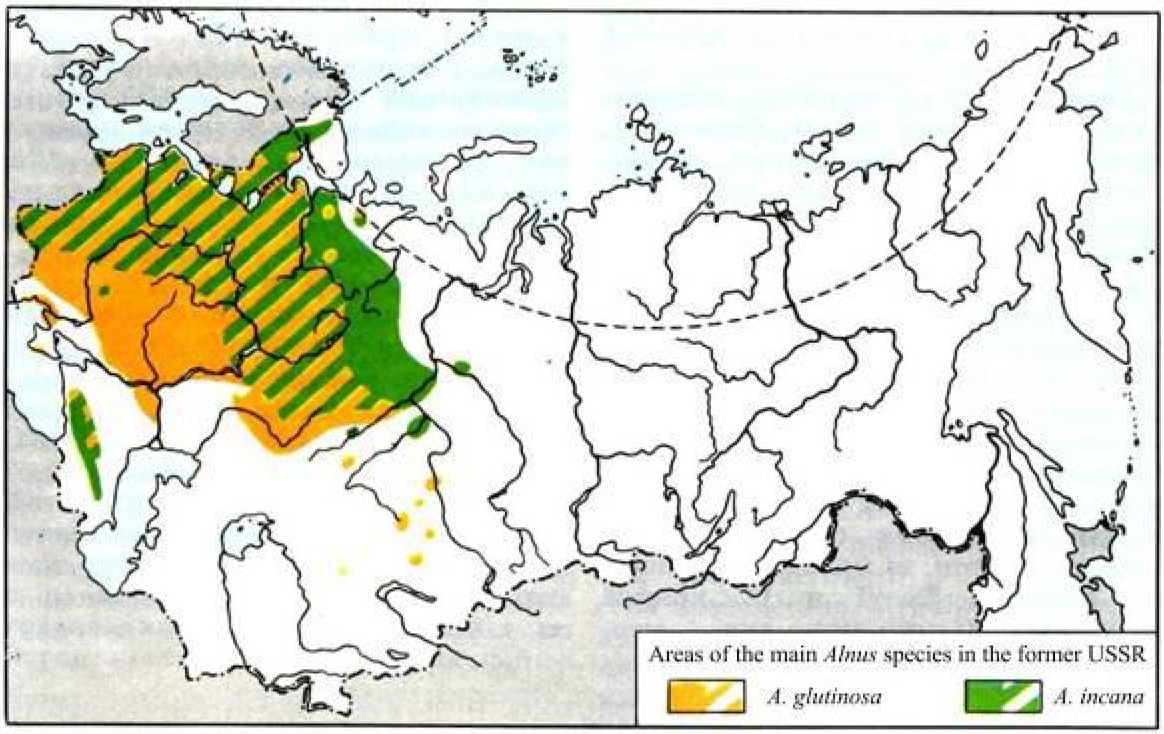

Fig. 227. The areas of the main alder species in the former USSR (Atrokhin, Solodukhin, 1988).

Common alder (*A. glutinosa*) is the tree up to 35 m tall, with up to a 50 cm trunk diameter. The bark of young trees is brown, old tree bark is almost black, with light fractures. Young shoots are three-edged, reddish-brown and sticky. The leaves are 4-6 cm long on a long stalk, rounded and wedge-shaped base (**Fig. 228**). Young trees have an egg-shaped crown and with age the crown becomes cylindrical. Common alder grows fast, especially at the early age, at 60 years old its growth slows down drastically. Common alder is a light-demanding, well self-priming wood, humid soil demanding but does not grow on acid bogs and poor dry soils. It forms high productivity forests on rich humus, over wetting soils with flowing ground waters. In better conditions in the Ukraine, by the age of 40 years it reaches 21 m in height and the volume of 329 m^3 per ha (I site index), at 80 years of age - 27 m tall and 505 m^3 per ha of volume respectively. Common alder is a longer living tree than grey alder, lives up to 100 year and even up to 300 years old. Common alder ranging area is significantly shifted southward relative to the grey alder area (see **Fig. 227**). It is mostly distributed in Belarus and the Ukraine Polesye (Tkachenko et al., 1939; Kachalov, 1970; Sokolov et al., 1977).

Fig. 228. Common alder: 1 – general view; 2 – a branch with male and female blossom cluster; 3 – female blossom cluster; 4 – female flower; 5 – male flowers; 6 – a branch with cones; 7 – an open cone; 8 – seeds (Atrokhin, Solodukhin, 1988).

Fig. 229. Dwarf alder.

Dwarf alder (*A. fruticosa*) is a 4 m tall shrub of prostrate, “creeping” form in tundra and the sub-goltsy altitudinal belt. It grows as a single shrub, in groups or makes tangled vegetation in floodplains, on ruby slopes, moss bogs of tundra, forest-tundra and forest zones (**Fig. 229**). The ranging area is affiliated to the continental climate regions; however within the area, dwarf alder chooses rather moist sites. On northeast of Siberia, the dwarf alder communities often intersperse with *Pinus pumila* communities; moreover these two species form a 1.5-2 m tall heavy vegetation on the northern slopes in coombs of the sub-goltsy altitudinal belt.

In the Polar and Northern Urals, dwarf alder forms the thicket above the crooked birch forest belt, on the Central Siberian Plateau – above the larch sparse forest belt, in the Stanovoi Range it goes to the sub- goltsy altitudinal belt up to 1700 m A.S.L. This species forms primary stands under the floodplain conditions, often mixed with willow woods. In the taiga forests it plays a significant role in bushwood formation (Sokolov et al., 1977).

11. Willow (the family *Salicaceae*) – our rivers guardian

Willow (white willow, goat willow, osier, sharp-leaved willow, purple willow, chosenia) belongs to the genus *Salix L.* – one of the largest wood species of the middle latitudes and it counts more than 370 species (**Fig. 230**) ranging mostly in the moderately cold regions of the northern hemisphere, where willow goes beyond the Polar Circle. Several taxons are distributed in the tropics. There are more than 65 species in North America, but only 25 of them reach the tree size. Usually the trees are 15 m tall or shrubs, however individual trees among some willow species can reach up to 40 m in height and more than 50 cm in trunk diameter, and willows of only several cm tall can be found in the tundra.

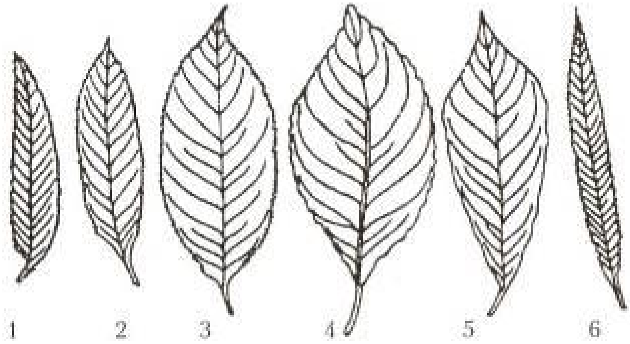

Fig. 230. Willow species leaves: 1 – white willow (S. alba L.); 2 - Almond willow (S. triandra L.); 3 – bay willow (S. pentandra L.); 4 –goat willow (S. caprea L.); 5 –grey willow (S. cinerea L.); 6 - sharp-leaved willow (S. acutifolia Willd.) (Forest Management Encyclopedia, 2006).

Dwarf willows grow along our rivers, close the water itself, sometimes hanging over it and willow trees are found further from the shore. Widely spread roots bind soil and protect shores from cutting even when they are under the water during floods. Regarding the river flow, they sustain settling out of the mechanical impurities on a river bed and due to the river surface shading they reduce the evaporation. Dwarf willows (sharp-leaved willow) are used for sad fixation: they suppress the sand and protect pine plantations from sand accumulation (Atrokhin, Solodukhin, 1988).

There are six species mostly common in Russia: white willow (*S. alba* L.), Almond willow (*S. triandra* L.), bay willow (*S. pentandra* L.), goat willow (*S. caprea* L.), grey willow (*S. cinerea* L.) and sharp-leaved willow (*S. acutifolia* Willd.).

Fig. 231. White willow: 1 –a general view; 2 –female flower; 3 –male flower; 4 –male catkin; 5 - female catkin; 6 –a leaf. (Forest management encyclopedia, 2006).

Fig. 232. Weeping type of white willow (Salix alba f. pendula). "Little green willow bent over the river" (Vasiliy Alferov). http://www.stihi.ru/2014/03/21/7573

The white willow is a large tree, up to 30 m tall and with up to 1.5 m thick trunk (**Fig. 231, 232**). It lives up to 100 years or more. The crown is round, wide; the roots reach deep into the ground. Almond willow (*Salix triandra*) is a 5-6 m tall shrub or a 14 m tree. The trunk bark is grey, its top layer exfoliates. Bay willow is a tree up to 18 m in height; in lots of cases it has a shrub form. Goat willow is up to 15 m tall tree, and cold resistant. The bark is grey and fractured by the base. Grey willow is up to 5 m tall shrub with grey and greenish-grey bark. Shoot are brown or brown-yellow. Sharp-leaved willow is a shrub or up to 12 m tall tree. Branches have a gray wax coat and are brown-red. An extensively developed root system spreads up to 20 m distance from the trunk (Forest Management Encyclopedia, 2006). Globe-shaped willow (*Salix fragilis* L.) (**Fig. 233**) that have variety of sorts and hybrids are widely used in the landscape design.

Fig. 233. Globe-shaped willow (http://susbint.ucoz.ru/news/iva/2013-07-26-127).

A "marvelous northern" chosenia (*Chosenia arbutifolia* (Pall.) A. K. Skvortsov) is only known to the people in Eastern Siberia and Far East. The area ranges to Anadyr in the north and up to Lake Baikal in the west. This is the main pioneer species of the floodplains of the Far East North from the family *Salicaceae*. The trees are up to 37 m tall and 80 cm in trunk diameter (**Fig. 234-236**). It lives up to 100-130 years. The crown is pyramidal or egg-shaped and becomes umbrella-shaped. It resembles willow a lot but differs by the absence of nectar in flowers (Atrokhin, Solodukhin, 1988; Moskalyuk, Mazurenko, 1992).

Fig. 234. Chosenia forest in the river valley (http://molbiol.ru/pictures/419585.html).

Fig. 235. Chosenia shoot (http://commons.wikimedia.org/wiki/File:Chosenia_arbutifolia_leaves_and_catkins.jpg?uselang=ru).

Fig. 236. Spring thicket of young chosenia on gravel in Kolyma region (Mazurenko, Moskalyuk, 2009).

Chosenia fulfils an ameliorative function in floodplains. Upon that, chosenias' life cycle divides into two periods. During the first period it resists to the extreme environmental conditions on bare gravels: extreme temperature differences, occasional substrate drying and devastating summer floods. Due to chosenia, river deposit retention the floodplain level rises, the river falls back and the flood intensity declines. Thick forests on high quality soils are formed only for 10-15 years. Then the second period of the chosenia life cycle starts when it annually produces about 30 tons of leaves per hectare which is 5 times more than in larch forests on the same sites (no more than 6 tons per ha) (Moskalyuk, Mazurenko, 1992).

Conclusion

From the presented brief review of out forest trees it is clear that every species has its own distinctive biological and ecological characteristics. Some of them are common for several tree species, for example, the regeneration and growth affiliation of spruce, pine tree, stone birch and sometime fir with decaying stump wood, fallen logs and branches. They are united by the alpine origin and the development on the poor stone soils. However the biology of their affinity to decay wood remains unknown and the researchers' attempts of explaining the phenomenon by means of the ecological site properties are contradictory. In case of these contradictions the reason should be found in the biology and biophysics of the symbiosis. Although the role of the detritus logs as a spruce establishment site is very limited in time as well as space, they nevertheless play a crucial role in the boreal and temperate spruce forests dynamic.

Physical scientists, biophysicists and medical community are expected to determine the role of the "mitogenetic" radiation in the cooperation of plants between each other and radiation effect on people and to explain the physical nature of that cooperation. By its particular characteristics and complexity, biological systems are so far away from the "primary" substance level that nothing can be explained by means of only a "primary" physical representation in the biological processes (Kaznacheev, Mikhailova, 1985). "There is nothing mysterious in this world, – the doctor Myuge (1989) says. - There is only the unstudied"(p. 48).

The further development and specialization of the biothermodynamics concept allow adjustments in the methodology of the energy to be made and materials flow quantification in the forest ecosystems and in the ecophysiological methods of bioproductional process modeling with due regards to the solar cycles. It is especially important for the perception of the global carbon cycle biology. Only the very first steps were taken in this direction. For the Russian forests, the rates are also controversial and range by the carbon supply in forests from 28 to 50 Gt (Kurbanov, 2000) and by its annual deposits in forest cover from 58 to 429 Mt (Zalikhanov et al., 2006).

Every tree species has a specific complex of properties useful for people health, takes its own ecological niche and contributes to the biological forest variety. The biological variety study is one of the most crucial directions in the modern ecology.

In the wild nature every tree species grows not only as a pure tree society but also as a mix with others, and mixed forests dominate in the total forest area in the Russia. The described here tree species characteristics in the mixed forests are accompanied with the number of new, "emergent" properties appeared due to the cooperation of composing the species. In the long run all these characteristics are aimed to the optimum employment of food and energy resources of each wood element. A biological variety is a systemic index: the more components are united in a forest ecosystem, the more complicated their cooperation between each other is, and the more effective the employment of the resources and energy received from the outside is (Panyukov et al., 2005). The more biological species there are, the more complicated the interactive system between them is; the more connections and interactions there are in the system, the more sustainable its status is and the more sustainable the system operation is (Novohenov, 2005). The loss of one link in the ecosystem cooperation chain can lead to a chain reaction of the other links loss. For instance, if we assume a nutcracker population death, then probably cedar pine population won't survive either.

The mentioned interactions of the wood species can be isotropic, i.e. to be in dialectically controversial relationships, as is the case in the conjoined growth of birth and spruce: there is a birch suppressive effect on the spruce crown development on one hand and the spruce humus "improvement" by birch on the other hand. Then, a successful growth of larch in the mix with birch in the Ukraine, and yet birch suppression of larch in northern Kazakhstan; a successful growth of larch together with spruce in the Moscow region, and the failure attempts of mixed larch and spruce cultivation in the Western Ukraine; the age role change in the interactions between Scots pine and larch in artificially regenerated stands in the European part of Russia and northern Kazakhstan; and lastly the larch contradiction between its productivity and reproducibility and many other.

The reviewing of these emergent properties deserves a special study and analysis that is mostly timely in regards to the need of biosphere stability maintaining and it also requires a more detailed modelling and prediction of the forest bioproductional potential as the Earth climate system stabilizer in the context of a growing anthropogenic impact on forest ecosystems.

The biosphere can remain in stable state and does not become degraded until the decline of its biodiversity which carries more slowly than a biosphere biomass decrease (Svirezhev, 1989). Before our eyes, the number of Red Data Books multiplies (biodiversity is decreasing) and forest harvesting takes place on large areas (planet biomass is declining), however both of these trends are not the subjects of rather specific quantitative determination and we can't define the biosphere stability bounds (**Fig. 237**). Today all of Europe is covered with forest plantations that by biodiversity significantly lose to the natural forest ecosystems. 70% of all pristine forests on the Northern Hemisphere accounts to Russia; and it is believed (Kondratiev et al., 2002) that namely Russian pristine forests are of value that exceeds the value of all mineral and raw material resources in Russia.

Fig. 237. A victory or a defeat? (Kuliešis, Petrauskas, 2000).

During the International Conference "The world's pristine forests and their role in the global processes" that took place in Khabarovsk in 1999, it was stated that the pristine forests that now account for only 10% of world's forests let promising trends of forest development be defined; they are the global biosphere stabilizing factors and peoples' ability to keep the value for the next generations will be tested on forests'destiny. The pristine forests are marked not only for their high biodiversity, but also for their "unforgettable beauty"and according to the professor Novozhenov (2005), the beauty is adaptive for nature as well as for a human being, it helps nature to survive and people to adjust. In Novozhenov's opinion, the perception of beauty serves as an emotional signal of the approaching the truth. Our way to the truth – through the beauty - to kindness and humanity. However today people continue to destroy the remaining pristine forest outliers, and while natural forests disappear, we lose an irreplaceable part of our history.

The destiny of our forest worries not only foresters. The culture expert, Tsvetkov's position (2007) is hard to argue: "Do we realize today what forests are and what we do to them in a technical progress delirium? What for and how does it live (rather – survive) griped between highways, suffocative with manufactories, amelioration dehydrated, not to speak of forest harvesting? The forest that was considered by druids and wise men not just as the living base but also as the base of knowledge. We don't even know what sacred information we erase from the planet's memory, destroying it by the hundreds of square kilometers. Indeed we cut our own throat. We cut as religiously as we are afraid to run out of time to destroy both ourselves and the Planet" (p. 167).

To a great extent, the Russian people mentality has a connection to the specific cooperation traditions with the forest that ascends to antiquity: "There is a traditional order of the cooperation with the forest in Russia in the wood lands throughout, and not only on the territories of the traditional natural resource use. This order is usually conditioned with the traditional perception of the forests as of a special space that does not belong to people. …This order conditions a negative attitude towards forest reorganizations focused on privatization and utilization escalation. A forced break with the order and interference with it lead to serious conflicts and further possible loss of cultural traditions" (Zakharova, 2005. P. 87).

Today the reality is that for many years since the implementation of the absurd Forestry Law in 2006, our forests have been put on a "death carrousel" (Usoltsev, 2014). After implementation of the Law and the liquidation of the forest guard, a total extermination are threatening to the Russian forests due to their illegal harvesting (**Fig. 238-241**).

Fig. 238. No comments. Picture caption: "There is only one step left to complete the forest management reorganization" (Konstantinov, 2006).

Fig. 239. The most important thing for a thief is to disappear in time! (http://www.rb.ru/article/srub-dostalsya-podeshevke/5195907.html).

Fig. 240. Dog's solidarity… (file:///C:/Users/м/Desktop/Приколы/IMG_0167.JPG)

Fig. 241. A dying poplar as a requiem to all Russian forestry and science? (Photo by V. Usoltsev).

Consequently the poetry dedicated to a forest theme shifts from a grand mode to a hopeless tragic one:

…Above the birch tree strengthens
the axe's whistle of victory
So far, all-powerful.
The people grumble…

Softwoods of the taiga they skin,
They raft the forest to China along the Amur River.
The execution of chestnuts, the mayhem of willows…
Such doom
You cannot describe even with the stylus of Leskov,
Not even with a fiery feather from the legendary Firebird!

You flourished - in forests and to the skies…
Are you really going to turn treeless
The motherland of forests?
Not one of the birch trees stands at gunpoint;
They are falling—of titans by an entire army
The ash, cedar, oaks from one end to the other.
That which arson did not take, logging takes.
The entire country is for sale!

N. Matveeva, 2014.

However people's nature as well as the nature of all living residents is in optimism (**Fig. 242**). That's why we finish our review on a positive note. This tone of optimism has been set by the Russian scientist Mikhail Lovonosov in the 18th century who claimed that the power of Russia would grow along with Siberia. Let's hope that born in the nearest future, forests of Siberian and all Russia will contribute to that growth.

Fig. 242. A final arabesque: Two optimists (Kuliešis, Petrauskas, 2000).

According to the geneticist Chadov's theoric suggestion (2015), the evolution of lifeless and living matters has finished. They keep existing as a base for a continuing evolution of mind and that's why they demand care and protection. They already can't defend themselves. The care and protection of the matter taking precedence of the mind is one of the most important noosphere aspects according to Vladimir Vernadskiy.

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	**Vladimir Usoltsev** (Doctor of Agricultural Science) was born in 1940; graduated from Ural State Forest Engineering Institute in 1963; professor of Ural State Forest Engineering University, Senior Research Associate of the Botanical Garden of URAS, honored forester of Russia. He wrote about 650 research papers, including 35 monographs on the issue of forest biological productivity evaluation and modeling and cultural issues.

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