Eurasian J. For. Res. 13-1: 25-40 , 2010

White Birch Trees as Resource Species of Russia: Their Distribution, Ecophysiological Features, Multiple Utilizations

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Abstract

Four birch tree species (*Betula costata, B. pendula, B. platyphylla, B. pubescens*) are traditionally important resource species in Russia. In the article, we discuss their spatial and ecophysiological features, biochemical constituents of the living tissues of the birches such as the wood, outer and inner bark, twigs, leaves, buds, roots. The exudation, tapping periods and sap productivity, exudated birch sap and derived birch tar are also reviewed. We show numerous useful wooden, medicinal, tanning, coloring as well as feeding and decorative properties. Chaga – (*Inonotus obliquus*), a fungi-parasite developed on the stems of the birch trees, is mentioned to be famous due to its antitumor and/or especially anti-cancer activity. It is reported that the former birch sap production being closed completely at the transition to a market-economy has restarted in the Russian Far East. Extensive bibliographic list is represented to acquaint foreign readers with unknown literature on white birches published in Russian.

Key words: birch species (*Betula costata, B. pendula, B. platyphylla, B. pubescens*), birch tar and Chaga, living tissues, distribution, sap exudation and tapping

Introduction: a brief survey of traditional uses

White birch species (*Betula* spp.) are traditionally important trees for Russian peoples. They are grown all over vast Russian territory and used for a wide variety of purposes. None of the trees have such wide usage in everyday life and folk medicine as a birch tree. The Russians are fond of lightness, elegance, grace and fragrance of birches particularly after rain as well as they like to visit birch forests gathering wild strawberry and mushrooms in them. Being soft and cheap, wood and outer bark of birch are used for making different goods: decorations, bark dishes, boxes, furniture, etc. The bundles of young birch twigs are also usually used in Russian sauna bath, like in the Finnish ones, as aroma source and skin activator while birch fire-woods are burnt to make the temperature in the sauna very high. In country districts babies' cradles were once made from birch wood to protect their innocent charges. Various parts of the tree have been traditionally applied to medicinal uses (Evseeva, 2005).

Since ancient times Russian peoples recognized a symbol of Russia in white birch tree considering it as a core element of the poems, proverbs and fairy-tales. During heathenism our ancestry believed a birch tree was a God's Gift which could ward off the evil eye (Evseeva, 2005). They considered a birch as their tutelary goddess, thinking the peoples' souls transmigrated into birch trees at death (Nozdrin *et al.* 2005). A traditional folk women's dress "saraphan" (popular wear especially in the country regions till 1940-s) has been cordially associated with white birch outer bark. The beauty of Russian young ladies was usually compared with the beauty of birch trees. Complimenting a lady on her appearance the peoples say that she is slim like a young birch tree. In one of the famous Russian wonder-stories the apples that could bring the youth and the beauty back were growing on the birch tree. Finally, for Russian peoples white birch tree is closely associated with the sense of the Motherland. Being far away abroad the peoples usually remember white birch forests, not the other ones.

Why do the peoples unconsciously provide white birch tree with such magic properties while world famous Russian poet Sergey Esenin devoted his poems to it? This is likely to happen due to some features of the birch, which differ it from the other tree species. One of such unique features seems to be a birch sap exudation at the early spring, so called "birch weeping".

Of 15 *Betula* species distributed over the territory of Russia 8 species are tree species (Vegetative resources.., 1984). Although total number of *Betula* species is still unclear because of uncertainty in *Betula* genus taxonomy (Koropachinsky, Milyutin, 2006), we follow the nomenclature of Latin names of birch species established by Czerepanov (1985). Four species (*Betula costata*, *B. pendula*, *B. platyphylla*, *B. pubescens*) are traditionally used for numerous needs of the peoples, including birch sap harvesting.

In this article, we reviewed distribution,

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ecophysiological traits, utilities of white birches for providing the basic idea of natural resources conservation.

Betula costata Trautv**.**

Distribution, ecophysiological features

Betula costata is distributed limitedly in the south of Russian Far East occupying Primorskiy and Khabarovskiy krai as well as Amurskaya district (Fig. 1A). This birch tree reaches its height of 27-32 m and diameter of 80-120 cm, living by ca.300 years (Fig. 2A) (Izmodenov 2001, Taghiltsev 2001). The bark of the young trees shows light yellow, peeling off by big pieces. The bark of the lower old stems is brown-yellowish or grey, and finally is desquamating. This species belongs to the group of tall forest trees, which are the main co-dominants of the mixed broadleaf trees-Korean pine forests and rarely form pure tree stands (Krestov 2003). As the composer of the mixed forests, birch tree performs best on lower and middle north-facing slopes from sea level up to 800-900 m.

Biochemical constituents of living tissues of birch

Branch bark contains phenolic glycosides and rhododendrin (Santamour, Vettel, 1978). Its leaves has triterpenoids: i.e. 3α17α20-trihydroxydammara-24-ene (Uvarova *et al*. 1976), betulafolientriol 0.007-0.035% and its oxide (Gorovoi *et al*. 1975, Polonik *et al*. 1977, Uvarova *et al*. 1976), betulafolientetraol 0.016-0.66% and its oxide (Malinovskaya *et al*. 1975, Polonik *et al*. 1977, Uvarova *et al*. 1976), betulin (Hegnauer 1964). And content of steroids is 0.004-0.011% (Polonik *et al*. 1977).

Exudation and tapping periods, birch sap productivity

In the forests near Khabarovsk city, this birch sap exudation lasts for maximum 32 days in early spring. It usually starts on April 10-18th (average on April 14th) and finishes on May 11-18th (average on May 15th) (Izmodenov 2001). The period of the most intensive sap exudation covers about two weeks from April 19th till April 30th (Taghiltsev and Kolesnikova 2000, Taghiltsev 2001). The commercial tapping lasts 24 days from April 14th till May 7th (Izmodenov 2001).

Betula costata is established to be of the highest sap productivity as compared with the other birch species (Sukhomirov 1986, Izmodenov 1997). One birch tree can exude 1600 liters of the sap per one tapping season while the maximum amount is recorded to be equal to 2500 liters (Izmodenov 2001).

Biochemical constituents of exudated sap

The sap of *B. costata* is a colorless transparent liquid, which density is a highest in the beginning and the middle of the exudation (1.0040 and 1.0043 g cm^{-3}, accordingly), decreasing gradually by 1.0028 g cm^{-3} at the end (Taghiltsev and Kolesnikova 2000). Such sugars as glucose and fructose were detected to be the main components of the sap, which total amount was 0.9% in the beginning and at the end of the exudation, increasing up to 1.3% in its middle (Taghiltsev and Kolesnikova 2000). The dynamics of coumarin seemed to be similar to that of the sugars while sap acidity (pH) decreased gradually from 6.0 to 5.6 towards the end of the exudation (Taghiltsev and Kolesnikova 2000).

Useful properties

The wood is used in aviation (Usenko 1969, Tsymek 1956) and in various branches of wood industry (Vorob'ev 1968). The alcoholic tincture of the bark cures malaria (Kurentsova 1941) while that of the buds releases stomach and intestine spasms as well as rheumatic pains and treats the wounds (Brekhman and Kurentsova 1961, Kurentsova 1941). Leaf decoction has antiphlogistic and diuretic activities and is used at the skin diseases (Brekhman and Kurentsova 1961, Kurentsova 1941). The twigs are important for the feeding of livestock and wild animals (Larin 1957). The sap of this birch cures both kidney and urine cyst troubles (Kurentsova 1941) and is traditionally used as healthy beverage as well as against scurvy (Kurentsova 1941, Izmodenov 2001, Taghiltsev and Kolesnikova 2000, Taghiltsev 2001). This tree is also known as a decorative species (Vorob'ev 1968).

Betula pendula Roth**.**

Distribution, ecophysiological features

Betula pendula (white birch) broadly distributes over the territory of Russia (Fig. 1B). In boreal zone it occupies different forest sites, forming both pure secondary stands on the burned and logged areas as well as mixed stands with the conifers at the late-successional stages of forest regeneration after such disturbances. At the southern limit of the range in forest-steppe zone white birch performs best on the north-facing slopes, avoiding over moisten conditions, while it prefers the warmest flats and riversides at the northern limit, where permafrost occurs. In the mountainous regions, *B. pendula* occupies various sites from foothills up to ca. 2500 m a.s.l.

This birch tree reaches the height of 18-20 (30) m and the diameter of 70 cm, living by 200 years (Fig. 2B). The bark of the mature trees is white or grey in the lower stem. Due to fast vegetative reproduction white birch easily invades logged and burned areas.

Biochemical constituents of living tissues of birch

Wood has steroids and their derivatives are sterols' and fatty acids' ethers (Lindgren 1965, Selleby 1960), fatty acids 0.08% (palmic, oleic, linoleic and linolenic) (Ekman and Pensar 1973), betulaprenol (Lindgren 1965, Wellburn and Hemming 1966).

Inner bark. Essential oils 0.052%: methylsalicylic, palmic, phenic and behenic acids, sesquiterpenes (Goryaev 1952, Pavlov 1947). Triterpenoids: betulin 1.8-14% (Ban'kovsky *et al* 1947, Jordanov *et al*. 1970, Pavlov 1947, Rimpler *et al*. 1966), betulonic 0.012% and betulinic 0.032% aldehydes, lupeol 0.2%, acetyloleanolic 0.01%, betulinic 0.021%, oleanolic and ursolic 0.4% acids (Rimpler *et al*. 1966). Steroids 0.028% (Rimpler *et al*. 1966). Alkaloids (Massagetov 1946). Phenolic glycosides: gaulterin (Jordanov *et al*.

1970, Pavlov 1947), rhododendrin (Santamour and Vettel 1978). Carboxylic acids: gallic (Vereshchagin *et al*. 1959). Catechins: 3.3 % (Dolgodvorova and Chernyaeva 1977). Tan substances: 4-15% (Alexeev 1977, Aliev and Damirov 1948, Jordanov *et al*. 1970, Klobukova-Alisova 1958, 1960, Tkabladze 1961). Fatty acids: palmic (Ban'kovsky *et al* 1947, Goryaev 1952) and behenic acids (Pavlov 1947).

Outer bark. Triterpenoids: betulin (Pasich 1965). Catechins: 1.3% (Dolgodvorova and Chernyaeva 1977). Lipids: 38.7-43.4% (Holloway 1972). Tan substances. Flavonoids: 0.05% (Dolgodvorova and Chernyaeva 1977).

Buds. Essential oils: 0.2-6.25% (Alexeev *et al*. 1958, Balvochyute *et al*. 1980, Tomchuk *et al*. 1973, Shreter 1970, 1975), sesquiterpenes (Barbarich *et al*. 1961, Tomchuk *et al*. 1973), palmic acid (Tompson 1933). Alkaloids: 0.1% (Ban'kovsky *et al* 1947). Vitamin C (Geideman *et al*. 1962, Shreter 1970, 1975). Flavonoids: apigenin, apigenin-4'methyl ether, kaempheride, kaempherol-3,4'-dimethyl ether, kaempherol-7,4'-dimethyl ether, isorhamnetin (Kononenko *et al*. 1975, Wollenweber 1975), kaempherol, quercetin, skutellarein-6,4'-dimethyl ether, kaempherol-3-methyl ether, kaempherol-7-methyl ether (Wollenweber 1975), 6-oxykaempherol-6,4'-dimethyl ether, 6-oxykaempherol-3,6,4'-trimethyl ether (Wollenweber 1975), sakuranetine, 5-hydroxy-7,4' -dimethoxyflavon (Kononenko *et al*. 1975, Popravko *et al*. 1974, Wollenweber 1975). Fatty acids: palmic (Tomchuk *et al*. 1973), linoleic and linolenic acids (Konina 1976).

Leaves contain essential oils of 0.04-0.81% (Goncharova 1975, Goncharova *et al*. 1968, Jordanov *et al*. 1970, Komendar 1961, Tomchuk *et al*. 1973). Triterpenoids: 3α17α20-trihydroxydammara-24-ene, betulafolientriol 0.8% and its oxide, betulafolientetraol (Uvarova *et al*. 1976), betulinic acid (Ban'kovsky *et al* 1947). Vitamin C (Geideman *et al*. 1962, Deruma *et al*. 1975), E (Ionushaite and Dagis 1970), PP (Komendar 1961), carotene (Berzinya 1969, Goncharova 1975, Deruma *et al*. 1975). Carboxylic acids (Bate-Smith 1962). Tan substances: 1.07-9% (Alexeev 1977, Goncharova 1975, Goncharova *et al*. 1968, Tkabladze 1961, Khalmatov 1979). Coumarins: 0.09% (Khalmatov 1979). Flavonoids 1.96-5.56% (Goncharova 1975, Khalmatov 1979): hyperoside (Goncharova 1975, Jordanov *et al*. 1970, Elbanowska and Kaczmarek 1966), 0.36% (Geissman 1962), aviculyarin, rutin (Goncharova 1975), myricetin-3-digalactoside (Elbanowska and Kaczmarek 1966, Hegnauer 1973), kaempherol, quercetin, myricetin (Bate-Smith 1962). Anthocyanins: cyanidin, delphinidin (Goncharova 1975, Bate-Smith 1962).

Inflorescences (catkins). Vitamin E (Ionushaite and Dagis 1970), PP (Dagis and Sadyatskene 1966).

Seeds contain fatty oil of about 28% (Aliev *et al*. 1961).

Exudation and tapping periods, birch sap productivity

In Ukraine total period of the sap exudation covers 32-35 days in early spring. It usually starts on March 17-18th and finishes on April 18-20th reaching maximum 5-7 liters in the period from March 28th till April 3rd (Ryabchuk 1974). The beginning of the exudation is established to correlate closely with positive mean daily wood and soil temperature regardless air temperature. Sap exudation starts at +7~ +8°C of wood while air temperature ranges from –3 to +16°C (Kryuchkov 1960).

Diurnal sap exudation per one birch tree ranges from 2.5 up to 13.5 liters, in average 4-5 liters (Koldaev 1971, Kostron' 1977, Sokolovskii 1951) while that of for the whole season reaches maximum 425 liters, in average 25-129 liters (Vershnyak 1977, Kadochnikov 1977, Koz'yakov 1977, Osipenko and Ryabchuk 1970). One hectare of white birch stand was reported to exude 3-32.8 tons of the sap over the season (Vink and Panov 1973, Gavrilyuk *et al*. 1977).

Biochemical constituents of exudated sap

Glucose and fructose were reported to be the main components of exudated birch sap (Ryabchuk and Osipenko 1981, Klobukova-Alisova 1958, 1960, Pavlov 1947). The elements such as Ca, Na, Mg, K and Fe prevail while Mn, Zn, Cu, Al, Ni, etc. present in trace amount (Ryabchuk and Osipenko 1981, Drozdova *et al*. 1995, 2000). The amino acids (Ryabchuk and Osipenko 1981) and the vitamins (PP) (Dagis and Sadyatskene 1966) were also detected.

Useful properties. Wood. *B. pendula* is an official plant of "The state pharmaceutical indices" (1989). Birch wood is traditionally used for building construction, for furniture and different goods production because it can be easily polished (Geideman *et al*. 1962, Grossgeim 1942, Klobukova-Alisova 1958, 1960, Pavlov 1947). The wood of *B. pendula* Roth var. *carelica* (Merckl.) Hämet-Ahti (Czerepanov 1985) is recognized to be of the highest value as a furniture wood due to its wavy-fibered and curly properties (Fig. 3). This variation of white birch occurs in Karelian Republic only (north-western part of Russia) and is characterized by very slow growth and burr wood whose texture resembles marble. The pellets of birch charcoal, named "Carbolen", are used at stomach and intestine troubles, food intoxications (Krylov and Stepanov 1979, Turova 1974) as well as for spirit and vodka purification and for painting (Grossgeim 1952, Klobukova-Alisova 1960). Birch essential oil has diuretic and worm powder properties (Besser 1950, Sklyarevsky and Gubanov 1968).

Twigs. The bundles of young twigs are traditionally utilized for sauna bath as skin activator and source of aroma (Klobukova-Alisova 1960) as well as for livestock feeding (Larin 1957).

Inner bark. The constituents of this part cure malaria (Dragendorf 1898, Hoppe 1958), gout and lung troubles as well as are used as wound healing and disinfective substances (Deryabina 1969) at skin diseases such as various sores (Alexeev and Yakimova 1975) and causal fungus invasions (Dragendorf 1898). It is also used as yellow coloring agent for wool

(Kasumov 1973) and tan liquor.

Outer bark. The upper thin layer can cure the skin boils (Balitsky and Vorontsova 1980), while traditionally different goods are produced from the outer bark (Fig. 4A-G). The products being put in such birch bark boxes (Russian name "birch tues") preserve their freshness for a long period of time, and water does not freeze even under very low air temperatures (Evseeva 2005).

Buds. In the official medicine bud tincture is widely used as diuretic, sweating (Mashkovsky 1979), antiphlogistic and antiseptic (Alexeev *et al*. 1958) substance while in the folk medicine bud decoctions and tinctures are well known to cure such diseases as liver and urine cyst troubles (Deryabina 1969, Nosal' and Nosal' 1958, Vollosovich 1965), rheumatism, gout, sclerosis (Bereznegovskaya *et al*. 1972, Grom 1965, Nosal' and Nosal' 1958, Yakubova 1961), tuberculosis, bronchitis (Khalmatov 1964, Minaeva 1970) as well as various skin troubles (Nikolaeva 1979, Nosal' and Nosal' 1958, Vollosovich 1965). In veterinary medicine such decoction is used as diuretic, sweating and antispasmoic substance as well as for skin inflammations treatment (Tsarev 1964). Alcoholic extract of the buds stimulates hair growth (Komendar 1961) while its essential oil is added as aroma into liquors (Dragendorf 1898, Klobukova-Alisova 1960).

Leaves. Birch leaves are used similar to those of birch buds (Alexeev and Yakimova 1975, Bereznegovskaya *et al*. 1972, Grom 1965, Deryabina 1969, Nikolaeva 1979). Additionally, their extracts and tinctures cure anaemia, neurosis (Krylov and Stepanov 1979), the sores and burns (Turova 1974). Leaf decoction strengthens the hair (Alexeev and Yakimova 1975) and is used as yellow, golden-yellow, brown-blackish, green coloring agents for wool, silk and cotton cloths (Blagoveshchensky 1953, Kasumov 1973).

Inflorescences (catkins). Staminate tincture cures heart and stomach diseases, tuberculosis, anaemia and sores (Alexeev and Yakimova 1975, Minaeva 1970).

Birch sap. The sap is traditionally used as a healthy beverage (Khalmatov 1964, Yakubova 1961) and can affect such troubles as anaemia (Khalmatov 1964, Krylov and Stepanov 1979), cancer (Balitsky and Vorontsova 1980, Deryabina 1969), tuberculosis (Deryabina 1969, Parahonyak 1970), kidney and liver stones (Deryabina 1969, Kucherov *et al*. 1973, Nosal' and Nosal' 1958), gout, arthritis, rheumatism (Nosal' and Nosal' 1958), cold (Khalmatov 1964, Turova 1974) and skin (Dobrokhotova and Tchudinov 1961, Nosal' and Nosal' 1958, Turova 1974) diseases. It also has diuretic and worm powder (Kucherov *et al*. 1973, Nosal' and Nosal' 1958) and prevent tooth troubles (Baranova and Prokazina 1977). "Biomos" medicine, based on birch sap, cures unhealing wounds and burns and affect as antiphlogistic and antisclerotic substance (Beskrovny et al. 1977). In veterinary medicine birch sap cures cow diseases and increases milk amount (Orlov 1974).

Peoples usually use the sap as fresh drink as well as for vine (Nikitinsky 1921), vinegar, syrup, kvass and confectionary (Koldaev 1971, Nikitinsky 1921) domestic production. In perfumery and cosmetics industry birch sap is added in the lotions and shampoos (Krylov and Stepanov 1979, Orlov 1974) while in bee farming it is used as extra feed for the bees (Dobrokhotova and Tchudinov 1961, Orlov 1974). In research studies the pollen is treated by birch sap to accelerate its germination (Orlov 1974). This tree is also known as a decorative species (Koropachinsky 1983, Skvortsova 1961).

Betula platyphylla Sukacz.

Distribution, ecophysiological features: *Betula platyphylla* is the most distributed tree birch species of Russian Far East (Fig. 1C), which occupies here about 9 million hectares of the territory (Krestov 2003). This species is one of the composers of mixed forests and seral species in reforestation after clear cuttings and wildfires due to fast vegetative reproduction. It can also form pure tree stands. This birch tree is less warmth and soil moisture demanding than *Betula costata*.

On the fertile soils this white birch reaches 27 m in height and 50 cm in diameter and lives to 120 years (Fig. 2C). It is a fast-growing tree species with white or grey bark, which reaches harvesting age by 50-60 years.

Not all Russian botanists recognize the existence of *B. platyphylla* as a separate species. Particularly, leading by the Russian dendrologist academician, I. Yu. Koropachinsky (1983, 2006) considers the territory of Asian Russia is occupied by the only white birch species – *Betula pendula* whose western individuals (westward from Enisei river) have the leaves cuneate at base while the eastern trees (eastward from Enisei river) have the leaves truncate at base.

Biochemical constituents of living tissues of birch

Stem bark contains triterpenoids: i.e. betulin. Phenolic glycosides is rhododendrin (Vegetative resources 1984).

Buds. Essential oils are vitamin C (Petryaev 1952) and flavonoids, i.e. apigenin, kaempherol, apigenin -7-methyl ether, apigenin-4'-methyl ether, apigenin -7,4'-dimethyl ether, skutellarein-6,4'-dimethyl ether, kaempherol-7-methyl ether, kaempherol-4'-methyl ether, kaempherol-7,4'-dimethyl ether, 6 -oxykaempherol -6,4'-dimethyl ether, 6-oxykaempherol -3,6,4'-trimethyl ether, quercetin-7-methyl ether, quercetin-3'-methyl ether, quercetin-7,3'-dimethyl ether (Wollenweber 1975).

Leaves have essential oils. Triterpenoids, i.e. betulafolientriol 0.123-0.64% (Pokhilo *et al*. 1975, Polonik *et al*. 1977). Steroids 0.059% (Pokhilo *et al*. 1975). Vitamin C (Egorov 1954, Petryaev 1952), carotene (Egorov 1954, Tomchuk and Tomchuk 1973).

Exudation and tapping periods, birch sap productivity

In the forests near Khabarovsk city, sap exudation of *B. platyphylla* lasts about 25 days. It usually starts on April 10-12th (average on April 11th) and finishes on May 4-6th (average on May 5th). The commercial

tapping lasts 19 days from April 12th till 30th. One birch tree can exude 400 liters of the sap per one tapping season (Izmodenov 2001).

For the tapping season in Yakutia, - the sap exudation per one birch tree ranges from 19 up to 78 liters, and its maximum value of 150 liters. One hectare of white birch stand was reported to exude 5 tons of the sap over the season (Vershnyak 1977, Petryaev 1952).

Biochemical constituents of exudated sap

The sap of *B. platyphylla* seems to have similar parameters of contents and dynamics as that of *B. costata*, being insignificantly more dense and acid. It is a colorless transparent liquid, which density is a highest in the beginning and the middle of the exudation (1.0050 and 1.0070 g cm^{-3}, accordingly), decreasing gradually by 1.0036 g cm^{-3} at the end (Taghiltsev and Kolesnikova 2000). Such sugars as glucose and fructose were detected to be the main components of the sap, which total amount was 0.9% in the beginning and 1.0% at the end of the exudation, increasing up to 1.2% in its middle (Taghiltsev and Kolesnikova 2000). The dynamics of coumarin seemed to be similar to that of the sugars while sap acidity (pH) decreased gradually from 5.8 to 5.4 towards the end of the exudation (Taghiltsev and Kolesnikova 2000).

Useful properties. The use of the living tissues and the exudated sap (Larin 1957, Makarov 1962, Mashkovsky 1977, Pakhomov 1961, Petryaev 1952, Usenko 1969, Vostrikova and Vostrikov 1971) of *Betula platyphylla* are similar to those of *Betula costata* and *B. pendula*.

Betula pubescens Ehrh.

Distribution, ecophysiological features

The distribution range of *Betula pubescens* is almost coincident with the range of *B. pendula* (Fig. 1D), but, on the contrary, this species performs best under over moisten and even bogged soil conditions. This birch species usually follow in its distribution "dark-coniferous forests", forming both mixed stands and pure dense stands on over moisten sites, so called "sogry", with the average tree height of 3 m and diameter of 5-8 cm (Koropachinsky 1983). On the fertile and well-drained soils, *B. pubescens* reaches 18-20 m in height and 50 cm in diameter and lives to ca. 120 years (Fig. 2D), relatively short-lived species.

Biochemical constituents of living tissues of birch

Inner bark has essential oils of about 0.052% (Rutovsky 1931). Triterpenoids, i.e. betulin 0.36-44%, betulinic aldehyde 0.024%, lupeol, betulinic 0.019%, acetyloleanolic 0.011%, oleanolic and ursolic 0.054% acids (Rimpler et al. 1966). Steroids (Rimpler *et al*. 1966). Alkaloids (Ban'kovsky *et al* 1947). Phenolic glycosides: rhododendrin (Karrer 1958, Santamour and Vettel 1978). Tan substances: 4.1-15% (Klobukova-Alisova 1960, Pavlov 1947). Fatty acids: behenic acid (Karrer 1958).

Outer bark. Carboxylic acids: rhododendrol (Karrer 1958). Tan substances: 2.3% (Hegnauer 1964).

Buds contain essential oils: 1.2-8.5% (Alexeev and Yakimova 1975, Balvochyute *et al*. 1980, Rutovsky 1931). Vitamin C (Alexeev and Yakimova 1975), carotene. Tan substances (Alexeev and Yakimova 1975). Flavonoids: apigenin, kaempherol, apigenin-7-methyl ether, apigenin-4'-methyl ether, skutellarein-6,4' -dimethyl ether, kaempherol-3-methyl ether, kaempherol-7-methyl ether, kaempherol-4'-methyl ether, kaempherol-3,4'-dimethyl ether, kaempherol -7,4'-dimethyl ether, 6-oxykaempherol-6,4'-dimethyl ether, 6-oxykaempherol-3,6,4'-trimethyl ether, quercetin-3'-methyl ether, naringenin-7-methyl ether, naringenin-4'-methyl ether, naringenin-7,4'-dimethyl ether, 5-hydroxy-7,4'-dimethoxyflavon (Karrer 1958, Wollenweber 1975). Fatty acids: 55.42% (Konina 1978).

Leaves have essential oils, i.e. 0.04-0.31 (Goncharova *et al*. 1968, Rutovsky 1931), Glycosides (Tschesche *et al*. 1977), Steroids, i.e. phytosterol 0.059% (Goncharova *et al*. 1968). Vitamin C, carotene (Goncharova *et al*. 1968). Carboxylic acids. Tan substances: 5-9% (Goncharova *et al*. 1968). Coumarins (Goncharova *et al*. 1968). Flavonoids 0.85% (Alyukina 1977, Goncharova *et al*. 1968): hyperoside 0.36% (Karrer 1958), apigenin, kaempherol (Murav'eva 1978), kaempherol-3-rhamnoside, kaempherol-3-glucoside, quercetin-3-rhamnoside, quercetin-3-glucoside, myricetin-3-digalactoside (Hegnauer 1964). Anthocyanins (Goncharova *et al*. 1968).

Pollen contains flavonoids of about 1.56% (Alyukina 1977).

Exudation and tapping periods, birch sap productivity

In Arkhangel'skaya district (north-west of Russia), diurnal sap exudation per one birch tree makes up 4.4 liters and usually increases with tree diameter and crown length increase. The content of the sugars increases simultaneously. The exudation period lasts here 10-20 days (Korolyak 1970, Sukhanov 1977).

Biochemical constituents of exudated sap

Such sugars as glucose and fructose were reported to be the main components of the sap of *Betula pubescens* (Ryabchuk and Osipenko 1981). Malic acid was also isolated (Alexeev and Yakimova 1975).

Useful properties. The use of the living tissues and the exudated sap (Balitsky and Vorontsova 1980, Grom 1965, Efremova 1967, Larin 1957, Shreter 1970, 1975) of *B. pubescens* are similar to those of, mainly, *Betula pendula*.

Thus, four birch species (*Betula costata*, *B. pendula*, *B. platyphylla*, *B. pubescens*) in Russia are characterized by a wide range of spatial and ecophysiological features as well as the exudation and tapping periods and sap productivity. They show numerous useful properties of the living tissues and the exudated birch sap, which were investigated intensively in the former Soviet Union in the period from 1960's till 1980's, especially.

Birch tar

Birch tar (Fig. 5A), a substance obtained by the

destructive distillation of the white birch bark has been traditionally used by Russian peoples (Evseeva 2005). In the villages the wooden houses, the fences, the boats, the cart's wheel axes were usually covered with birch tar to prevent the decays. The peasants treated the cowhouses, sheepfolds and pigsties with the tar to protect their livestock against various diseases. The horse's hooves were covered with the tar because of the same reasons. The peoples also dropped birch tar on the red-hot carbons for air disinfection inside the houses. They used the repellent properties of the tar for their own and the livestock protection against mosquitoes and other bloodsucking insects.

To prevent pest's increase in the gardens the peoples sprayed fruit trees, vegetable plants, and ground surface with the soap-tar water solution. The wine-makers kept fresh wine in the tar impregnated wineskins to provide a peculiar "smoked" taste of the beverage. Nowadays this technology is completely lost.

Birch tar was widely used in the process of leather dressing (Evseeva 2005). This imparts peculiar well-known odour and durability to the leather. Owing to the presence of the tar the books bound in Russian leather are not liable to become mouldy as compared with the treatment of the tar produced in Holland or Germany (http://www.controverscial.com/Birch.htm).

Since ancient times the birch tar has been recognized as "a remedy against 100 diseases" (Kutuzov 2006). In the folk medicine birch tar was valued owing to its analgesic, antiseptic, disinfectant, depurative, diuretic, and febrifuge properties. This remedy was widely used for external application at dermatological diseases, at rheumatism, liver and gynecologic troubles (Dragendorf 1898) while in veterinary medicine it was used for the wounds and causal fungus invasion's treatment as well as a worm powder (Hoppe 1958).

At present birch tar as a constituent of Vil'kinson, Kon'kov and Vishnevsky ointments (Fig. 5B) cures nonhealing wounds and skin diseases (Mashkovsky 1977). In perfumery birch tar is added into special medicinal soap (Fig. 5C) and tar-water (Kos 1963). Recently the researchers of the Pharmaceutical Scientific Company "Retinoids" Ltd. (Moscow) have patented a new method of short-term external birch tar application to cure eczema, psoriasis, neurodermatitis, pyodermatosis, seborrhea, skin itch (Arhapchev *et al*. 2004), based on the properties to increase tissues blood supply and to stimulate regeneration of epidermis. The studies of the birch tar (purified substance) useful pharmacological properties are continuing intensively in Russia now.

Chaga (*Inonotus obliquus* (Pers.) Pilat.

Chaga is a fungi-parasite, which can develop on the stems of all birch trees (Fig. 6). Chaga is well known due to its medicinal properties (Kahlos *et al*. 1983, 1984, 1986, 1987, 1988, 1990, Mizuno *et al*. 1996, Saar 1991). In its biochemical composition such constituents as chaga acids 60%, steroids (ergosterol, inotodiol, lanosterol), organic acids (acetic, oxalic, formic, oleic), triterpenoids, lignin, alkaloids, microelements (Cu, Mn, Ba, Zn, Fe, K, Al, Mg, Na) were detected (Shin *et al*. 2000, 2001, Taghiltsev *et al*. 2004).

In Russia water extracts of chaga are widely used as antiphlogistic, antitumor and especially anti-cancer medicines (Sokolov and Zamotaev 1993, Taghiltsev *et al*. 2004). Based on chaga, "Befungin" medicine cures stomach and intestine troubles as well as cancer of different organs.

Chaga seems to be pure investigated in Russia, although the results of the researchers published (Shin *et al*., 2000, 2001) have witnessed chaga would be a fascinating object to be studied in future.

Conclusion and future remarks

White birch species (*Betula* spp.) are traditionally important tree species for both the daily-life and the minds of the Russian peoples.

Of 15 *Betula* species distributed over the territory of Russia, eight species are tree species. Four species (*Betula costata*, *B. pendula*, *B. platyphylla*, *B. pubescens*) are usually used for birch sap harvesting. *Betula pendula*, *B. platyphylla* and *B. pubescens* broadly occur in boreal forests, while *B. costata* is the main composers of cool-temperate forests in Russian Far East. The boreal birches form both pure secondary stands on the burned and logged areas as well as seral species may accompany different conifers. *B. costata* is one of the co-dominants of the mixed broadleaf trees-Korean pine forests and rarely form pure tree stands.

All birch species have rapid growth rate, preferences of light-demanding, reaching 20-25 m in mean height and maximum age of 200 years. Only *B. costata* differs in larger size (by 27-32 m) and lives longer by 300 years. It is also the most warmth-demanding species among the other birches. Due to high plasticity and high tolerance capacity against disturbances, birch species occupy a wide range of mesic forest sites without substrate preferences, with the exception of *B. pubescens*. At both the northern and southern limits of the boreal forests, the trees are exposed to both severe and highly fluctuating environmental conditions.

All parts of birch trees such as the wood, inner and outer bark, twigs, leaves, buds, roots and birch sap are usually used in aviation, for furniture production, in both official and folk medicine as well as in veterinary medicine, in the feeding of livestock and wild animals, etc. due to the unique wood structure and the composition of the biochemical compounds. *B. pendula* seems to have the widest spectrum of the use.

Daily birch sap exudation ranges from 0.9 up to 10 liters and equates in average 4-5 liters per one tree of *B. pendula*, *B. platyphylla* and *B. pubescens*. The amount of sap exudated is established to depend on tree diameter and crown length. *Betula costata* appears to be of the highest sap productivity as compared with the other birch species.

At present, whilst Russia is in transition to a market-economy, it faces also a major economic crisis. The former birch sap production is completely closed by imbalance between trade and consumer's performance (Tolstykh *et al*. 2004). But recently, local authorities in different regions of the Russian

Federation have undertaken some efforts to promote the possibilities of conservation of natural resources and their sustainable use. For example, the government of Khabarovsky krai (Russian Far East) has elaborated a new Program on natural vegetative resources use, which included the creation of the regional Center for harvesting, processing and selling of wild products (Khlynov 2004). The restart of birch sap production is one of the main goals of this Program. The harvesting stock of birch sap was planned to be as follows (Table).

Table. Annual harvesting stock proposed by the Program, tons.

Product \ Years	2004	2005	2006	2013-2020
Birch sap	50.0	60.0	70.0	800.0

In 2004 actual harvesting stock of birch sap made up 77.3 tons (Tolstykh *et al*. 2004). This exceeded parameter proposed and thrice more than in 2001. The technology of sap tapping and production specification for "Natural birch sap" and "The Far East birch sap with sugar" have been also elaborated (Ivanov and Shamorov 2004, Taghiltsev and Kolesnikova 1999, 2000, Tolstykh *et al*. 2004). The number of products containing birch sap has gradually increased in the region recent years, a trend that is continuing (Taghiltsev and Kolesnikova 2000).

Thus, the birch tapping and sap production in Khabarovsky krai has begun to restart. It is hoped on the other forested districts would follow this positive experience. Moreover, birch forests cover about 40% of the forested area in Russia and the resources of birch sap are abnormal high. We hope to save birch stands stock as promising natural resources for keeping our health as well as our precious treasure of amenity.

Acknowledgements

We thank the staff of Hokkaido University Forests (Japan) and of Far East State Agricultural University (Russia) for an opportunity of review on birch species. Financial support in parts by Joint Grant of Siberian and Far East Branches of the Russian Academy of Sciences n. 76 as well as by Grants of Russian Foundation for Basic Research n. 09-04-00179a and n. 10-04-10052k is greatly acknowledged.

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Fig. 1 A

Fig. 1 B

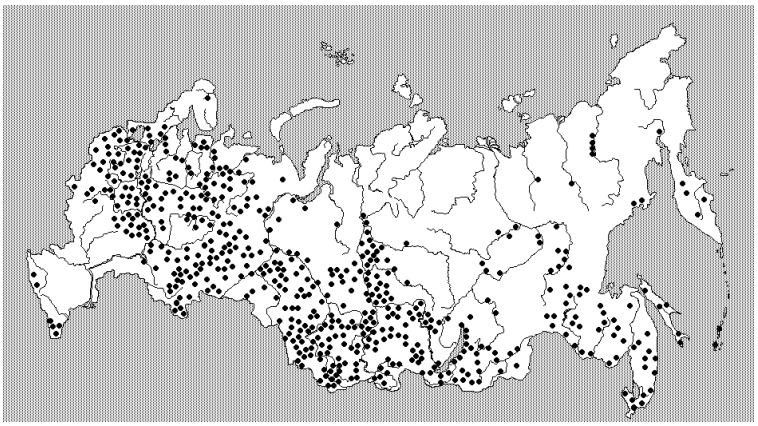

Fig. 1 C

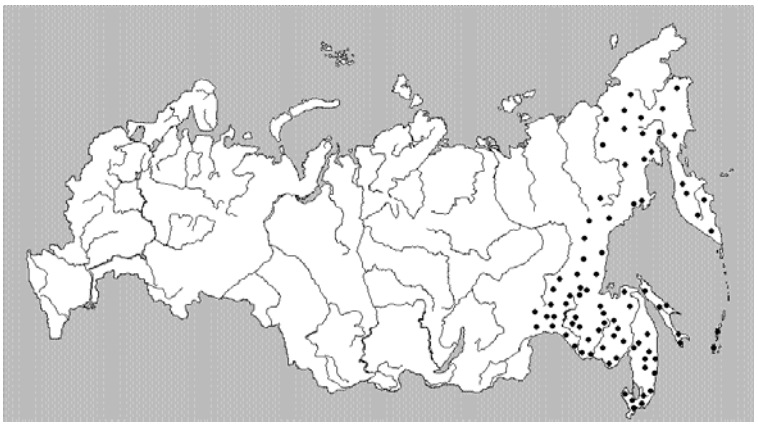

Fig. 1 D

Fig. 1. Distribution of white birch trees in Russia (Zyryanova 2004):
A - *Betula costata* Trautv., B - *Betula pendula* Roth.,
C - *Betula platyphylla* Sukacz., D - *Betula pubescens* Ehrh.

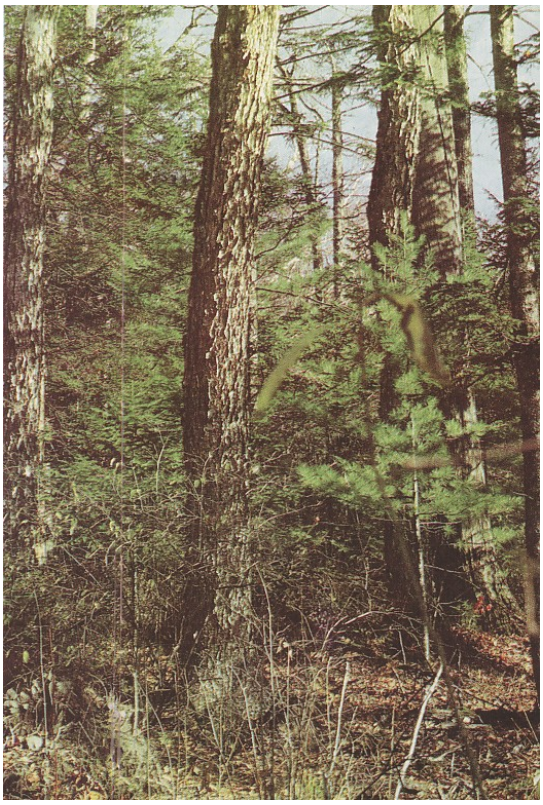

Fig. 2 A

Fig. 2 B

Fig. 2 C

Fig. 2 D

Fig.2. Birches in Russia producing sap:
A - *Betula costata*, B - *Betula pendula*,
C - *Betula platyphylla*, D - *Betula pubescens*
(Photos by A.G. Izmodenov – a, c, and V.I. Zyryanov).

Fig. 3 A

Fig. 3 B

Fig. 3 C

Fig. 3. Furniture of Karelian birch wood (Photos from: www.sciteclibrary.ru/karbel).

Fig. 4 A

Fig. 4 B

Fig. 4 C

Fig. 4 D

Fig. 4 E

Fig. 4 F

Fig. 4 G

Fig.4. Outer birches' bark goods
(Photos by Zyryanov V.I.):
A - bread keeper, B - salt and pepper cellar,
C - birch bark cup, D - candy box,
E - flour box (tues), F - women's decorations,
G - kid's toy

Fig. 5 A

Fig. 5 B

Fig. 5. Birch tar and pharmaceutical preparations with its addition (Photos by Zyryanov V.I.):
A - pharmaceutical birch tar,
B - Vishnevsky ointment,
C - medicinal soap.

Fig. 5 C

Fig. 6

Fig. 6. Chaga (*Inonotus obliquus*) on birch stem (Photo by Zyryanova O.A.).