Betula L. A wonder plant: Taxonomy, Reproductive Biology and Medicinal uses

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Growth habit and occurrence: The genus Betula, commonly known as birch, belongs to the family Betulaceae. It is represented by 40 to 50 species of deciduous trees and shrubs occurring in the cooler parts of the Northern Hemisphere (Weaver 1978). It attains a height of 15-20 meters from the ground. Their bark is smooth, shining, reddish white or white, with white horizontal lenticels. The outer bark consists of numerous thin papery layers, exfoliating in broad horizontal rolls. The inner cortex is red and moist. They are fast growing and many are short lived. White barked species are weak-woody and their twiggy crowns collect and hold ice and snow. Therefore they are subject to damage from winter storms. Because of these characteristics few birches are recommended as street trees. For home gardening they are most useful when grown in association with other trees, although a few are most effective when planted as specimens. Care should be taken to prevent the outer bark of the white-barked species from being stripped or marred since the injured area will always remain green (Hylander, N 1957). Their leaves are ovate-acuminate, elliptic and irregularly serrate.

Taxonomy: The taxonomy of Betula is controversial, and various classifications have been proposed. The first monographer who provided an extensive review of the genus was Regel (1865), who divided the genus into subgenera Betulaster and Eubetula. Subgenus Betulaster contains only one section, the Acuminatae. Subgenus Eubetula comprises six sections, namely Costatae, Lentae, Nanae, Albae, Fruticosae, and Dahuricae. Winkler (1904) proposed a slightly different division, lowering the status of the sections to that of subsections, merging the Fruticosae and the Dahuricae with the subsection Albae and merging the Lentae with the Costatae. More recently, De Jong (1993) proposed a division into five subgenera, namely Betuletana, Betulaster, Neurobetula, Betula and Chamaebetula. Subgenus Betuletana is considered the most primitive subgenus, followed by Betulaster and Neurobetula. Neurobetula is considered a very heterogeneous and partly artificial group (De Jong 1993).

The subgenera Chamaebetula and Betula are considered to be more derived. Hybridization and introgression are common in Birches where the natural distributions of birch species overlap, for example among the European birch species B. pendula, B. pubescens, and B. nana (Palme et al. 2004). Betula utilis D.Don the only critically endangered species has been reported from North-West Himalaya and Kashmir but Steward (1982) has collected number of accession mostly described them either as sub-species/variants due to which the taxonomy of the species is doubtful and need further scientific investigation for their correct taxonomic structure. Moreover, several of the recognized Betula species have a hybrid origin (Nagamitsu et al. 2006). Hybrids generally show morphology intermediate between the parental species but are not always morphologically distinct as a group (Thorsson et al. 2001). This overlap in morphological features complicates species and hybrid identification. Introgression appears to be bidirectional (Williams and Arnold 2001) but asymmetrical (Palme et al. 2004). Hybridization and introgression are further facilitated by the introduction and distribution of artificially propagated cultivars outside the natural distribution range. The simultaneous occurrence of polyploidization, extensive hybridization, and introgression complicates taxonomical studies in the genus Betula.

Flowering and fruiting: Mature birch trees carry large amounts of female and male catkins and the flowers are monoeocious bloom in May June (Koski and Tallqvist, 1978). Staminate catkins are formed in late summer or autumn, remain naked during winter, and open after considerable elongation in the spring. The pistillate catkins, which are cone-like with closely overlapping scales are born terminally on short, spur-like lateral branches and appear with the leaves. When the female catkins (strobilus) ripen in late summer or autumn, they become brown and woody and are either erect or pendulous. Each scale may bear a single small, winged nut (seed) that is oval, with two persistent stigmas at the apex. The seeds turn from greenish tan to light brown or tan when mature (Brinkman 1974). Seeds disperse from late fall until the following spring.
After establishment in a less, Betula utilis (Ford et al. 1983) trapped about 5% of the total seed-fall from round-leafed birch at nearly 100 m from the parent tree. An abundance of seeds can be found in the forest soil, but these seeds are found to be short-lived. Most seeds are nonviable after the second or third year (Granstrom 1987; Granstrom and Fries 1985; Johnson 1975; Moore and Weir 1977; Peral and Alm 1989; Steijlen and Zackrison 1986). The abundance of seeds in the forest soil is, therefore, likely supported by regular replenishment from new crops (Komarova 1986). A rare case of excessive seed production has been observed to lead to crown deterioration and reduced growth of the parent trees (Gross 1972). Seeds of yellow birch shed in August were found non-viable. Viable seeds were not released in meaningful amounts until September, with the maximum of good seeds being released in October (Houle and Payette 1990). After seed fall, the strobilus slowly disintegrates on the trees, with the axes persisting on the branch lets.

**Seed production, collection and extraction:** Lepisto (1973) reported Birches tends to flower at the relatively young age of 10 to 15 years. Some individuals are precocious in flowering and this appears to be under genetic control (Huhtinen and Yahyaoglu 1974). In greenhouse conditions with irrigation, fertilizers and CO₂-enriched air, European white birch seedlings have produced male catkins as early as 9 months and commercial quantities of seed from 5-year-old trees (Lepisto 1973). Bjorkbom and others (1965) reported that paper birch produced a higher proportion of viable seeds in good seed years than it did during poor seed years. The percentage of viable birch seeds can be estimated by examining the seeds on a light table (Patterson and Bruce 1931). The number of seeds per square meter in a birch stand can be hundreds of thousands (Koski and Tallqvist, 1978). When birch seedlings are raised in continuous light together with high nutrient level and elevated CO₂ concentration in a greenhouse, the generation time from seed to seed can be reduced to less than 1 year (Kärki, 1976). Commercial seed production starts 2 years after establishment in a less intensive polythene seed orchard. Birch flowering starts early in the spring after a certain threshold temperature is reached. Due to the elevated temperature in the poly house, the flowering time is some weeks earlier than outside, which totally eliminates the risk of pollen contamination. The ability of birch to ‘accelerate breeding’, making it is possible to get any seedling or graft to flower and set seed, is a crucial advantage relative to conifers.

Birch seeds are collected by picking or stripping the strobilus from standing trees or shrubs or from trees. This is done best when the strobilus are still green enough to hold together. Because ripe strobilus shatters readily, they are put directly into bags rather than allowed to fall onto the ground or tarps, which can result in loss of seed. Freshly collected strobilus can be subject to heating as they are usually green. They should be spread out to dry for several weeks until they begin to disintegrate. Low relative humidity is the most important way in drying the strobiles. Once the strobilus begin to fall apart, they can be shattered by rubbing or shaking or can be put in the blander, and the seeds can be separated from most of the scales and debris by screening and fanning. Round-hole screens of the following sizes have proved satisfactory for the following species: glandulose birch, 2.38 mm; yellow birch, 3.2 mm; river birch, 4 mm; paper birch, 3.2 mm; European white and downy birches, 2.6 mm. The remaining scales can be removed by fanning (Brinkman 1974). Birch seeds are very small and light and show considerable variation with the number per weight and yield per volume among species.

**Seed Germination:** European white birch (Black and Wareing 1955; Vaartaja 1956) and paper birch (Bevinton and Hoyle 1981) can germinate in the dark, whereas monarch and Japanese white birches and Erman birch require light (Nagata and Black 1977; Nagata and Tsuda 1975; Odani and Anma 1986). Gibberelic acid (GA3) in concentrations of 50 to 100 ppm could substitute for the light with Erman birch (Odani and Anma 1986). The basic chromosome number of Betula lenta is n = 14, and the species form a series of polyploids with chromosome numbers of 2n=28, 56, 70, 84, 112, and 140 (Furlow 1990). Some robust and fast-growing silver birch individuals have been found to be triploid (2n = 42) (Sarvas, 1958). Polyploidy is a common feature among Betula species, and its presence within at least four of the five recognized subgenera suggests several independent polyploidization events.

**Medicinal Use:** Betulin, lupeol, oleanolic acid, acetyl-D-geoside, betulinic acid, lupenone, sitosterol, methyl betulonate, and methyl betulate have been extracted from its bark. A new triterpenoid, called karachic rustics which is aromatic and has antiseptic properties (Barnes et al. 1974; Bevinton et al. 1981) have also been extracted. The compound Betulin shows anticancer activity by suppressing growth of malignant melanoma and cancer of liver and lungs (Kikuzaki, H and Nakatani, 1993). According to literature Betulin is a pentacyclic triterpene with the lupane skeleton whose existences in nature have been reported since 1788, isolated from bark bark as pure chemical substance by sublimation and elemental analysis of this natural constitutes was done in 1876 (Hayak et al., 1899). Traditionally birch bark has been used as rheumatism, gout, malaria (Hager 1967) by human being. Betulin can be isolated (Ender et. al 2003) from the outer layer of the bark of Betula alba with maximum yield. It can also be isolated from the Himalayan birch tree, Betula utilis that contains betulin up to 12% of its weight. Betulin is an ideal starting material for the synthesis of biologically active betulinic acid via jone’s oxidation method. Betulin and its derivatives possess biological effects, e.g. Anti-inflammatory, antiviral, anti-HIV, hepato protective. (Dzubak et. al. 2006). Some of derivatives of betulinic acid also show high anti-HIV and antiviral activities (Dzubak et. al. 2006). Betulinic acid has been studied more extensively then betulin, having selective antitumor activity against human melanoma cell culture and anti-HIV activity.
Several species produces valuable lumber. In Northern Europe, pollen of birch is a major cause of hay fever complaints, as is pollen of the Fagales species hazel and alder (Breiteneder et al. 1989, 1992; Lüttkopf et al. 2002). The major allergen involved is Betv 1 of which several variants exist that may differ in their allergenicity (Ferreira et al. 1996, 1997; Schenkel et al. 2006).

The bronze birch borer, Agrilus anxius Gory, is the major lethal pest of white-barked birches. The larvae of this native buprestid beetle form extensive mines in the cambial-phloem region beneath the bark, leading to the death of large branches and entire trees. Fisher (1928) listed B. papyrifera, B. alba L. (which includes both B. pendula and B. pubescens), B. populifolia, B. lenta, and B. lutea (= B. alleghaniensis) as hosts of bronze birch borer. Weaver (1978) based his observations on trees growing at the Arnold Arboretum in Massachusetts and rated B. pendula, B. populifolia, and B. albosinensis as susceptible, with B. papyrifera being slightly less susceptible. Weaver listed B. davurica, B. ermanii, and B. maximowicziana (monarch birch) as probably resistant species.

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Betula platyphylla

Betula occidentalis

Betula nigra

Betula papyrifera

Betula ermanii

Betula pubescens


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