

# *Pinus peuce* Griseb., Macedonian or Balkan pine

**Peter Savill** and **Bill Mason** outline the characteristics and highlight the potential of this little used species in the UK.

Much thought is being given by foresters to possible tree species that might be used in Britain if climate change proceeds as predicted, and in the light of the threats posed by tree pests and diseases that have become so numerous since the turn of the century. Recently the Wessex Silvicultural Group has considered the matter (Bladon and Evans, 2015), as has Wilson (2011, 2014) among others. There is also an on-line network that promotes novel species known to have potential to grow well in the UK (SilviFuture, 2015). It includes nine high priority species, and 20 medium priority species. In addition, Read et al. in their 2009 publication *Combating climate change* also suggested possible species, including 15 broadleaves and 10 conifers.

Pines represent a potentially valuable group of alternative species for productive forestry in drier areas of Britain and/or on less fertile soils. However, the preferred species at present, Corsican pine, lodgepole pine and Scots pine, are susceptible to varying degrees to *Dothistroma* needle blight (DNB). There are about 114 species of pines in temperate, sub-tropical and tropical regions of the world, including 11 in Europe. Seventy of the world's species are in the subgenus *Pinus* (the 'yellow' or 'hard' pines). These are mostly two- or three-needled pines, and 44 species are in the subgenus *Strobus* (the 'white' or 'soft' pines), which have four or five needles. The best known North American example is Eastern white pine (*Pinus strobus*) periodically cultivated in Britain as Weymouth pine and regarded as a valuable timber tree during the period 1700-1900. *Pinus peuce* is one of only two European species in the latter group, the other being *Pinus cembra* L. (Swiss stone pine), a tree confined to the subalpine zone at elevations mainly between 1,500-2,200m. Interest in *P. peuce* arises because it appears to be immune to blister rust (see later), unlike the North American five-

needled pines (Forest Research, 2015). The name 'peuce' is not a reference to a reddish or purple colour (e.g. of the developing cones), but is derived from the Greek *peuke* meaning 'pine tree'. Indeed, some older texts refer to the species as *Pinus peuke*.



Figure 1. Natural pure stand of *Pinus peuce* in the Mount Pelister National Park in Macedonia. The trees show the same high stocking density that is found in Britain and therefore presumably also have a high basal area.

(Photo: Dr Bojan Simovski, University of Skopje)

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Figure 2. *Pinus peuce* growing alongside Scots pine in the Voras Mountains of northern Greece at the southern edge of the natural range. (Photo: N. Mentis, courtesy of Dr. Nikolaos Grigoriadis, Forest Research Institute, Thessaloniki, Greece)

## Origin and introduction

Macedonian pine (*Pinus peuce*) is probably a Tertiary relict that has survived severe contractions of its range due to glacial restrictions during the Pleistocene. Its current range consists of two disjunct populations between 41° and 43° North, separated by the valley of the Vardar River; one in the west is centered in Albania and one in the east in W. Bulgaria. It is a five-needled pine that is closely allied to the Himalayan *Pinus wallichiana*. It is native to the highest parts of the Balkan peninsula – Montenegro, Macedonia (Fig. 2), western Bulgaria, Albania and northern Greece – where it occupies a total area of no more than 30,000ha near the timberline, ranging from between 600m and 2,200m above sea level. The best forests occur between 1700 and 1900m (Holzer, 1972). In its native range it is listed by Farjon (2013) and IUCN (2015) as ‘below the threshold for Vulnerable’ or ‘Near Threatened’ and is no longer significantly exploited for timber production in the native range. The species was introduced

to Britain in 1863 but has never been planted on any scale. About 30-40 small trial plots have been established with this species in Britain since the 1920s, over half of which date from the late 1950s or early 1960s (see Figs. 3 and 5-8).

## Climatic and site requirements

Limited experience exists with the tree in Britain, but such as it is, together with an account of the tree’s performance in its natural habitat, has been given by Lines (1985a). It appears likely to grow well on a wide range of soils, including peats, in such inhospitable places as the central and northern Highlands of Scotland (Fig. 4). In its native range, it grows on soils derived from acid parent materials, but also on serpentine. The soils are usually poor in nutrients. The tree does best where the climate is humid, especially in summer, and it can withstand much snow in winter. It is adapted to cold mountain climates with long winters and short summers. In its native range, the most extensive and best stands are found on north and northwest-facing slopes (Holzer, 1972) as with Caledonian pine in Scotland. It withstands exposure and atmospheric pollution well, and the cold mountain climate and high air humidity provide very suitable conditions according to EUFORGEN (2015), who also say that: “the exceptional adaptation of Macedonian pine to the severe mountain climate conditions makes it a valuable species for afforestation on high terrain for protection against erosion”. Farjon (2015) states that it is usually found on north-facing slopes on siliceous soils and rarely on carbonate soils. Holzer (1972) considered that: “For best growth both *P. cembra* and *P. peuce* prefer light and humus soils; heavy



Figure 3. A *Pinus peuce* stand at the Forestry Commission’s Bedgebury pinetum in Kent. (Photo: Dr Richard Jinks)





Figure 4. An exceptionally large *Pinus peuce* 31.8m tall and 64cm dbh, at Corrour in the Highlands. (Photo: Tom Christian, Royal Botanic Gardens, Edinburgh)

grassy soils very often make growth impossible". In Britain it will grow on a wider range of soils, from flushed peats to podzols and sand dunes i.e. poor to medium nutrient regimes. It is hardy to between  $-23.3^{\circ}\text{C}$  and  $-28.8^{\circ}\text{C}$  and not known to be particularly drought sensitive.

## Other silvicultural characteristics

*Pinus peuce* is potentially a big tree (see Fig. 4), growing up to 35 to 40m tall, although it is very much shorter near tree lines (Alexandrov and Andonovski, 2011). In the Balkan Mountains it reaches 26m at the age of 160 years. The tallest specimen in Britain was recorded by Johnson (2003) as being at Chatsworth House, Derbyshire, at 41m tall and 92cm diameter. It grows very slowly when young, and has intermediate shade tolerance, but is capable of sustained growth over many years (Forestry Commission, 2015). Keenleyside (1985) found that the tree grew initially at 10-12cm a year at Corrour in the Highlands, though later it produced leader extensions of 20-30cm, possibly as a result of the heather having been suppressed. It eventually grew at



Figure 5. *Pinus peuce* in a trial at Culbokie, Black Isle, Ross and Cromarty. Self-pruning is said by some to be good, but experience in Britain suggests that this is not the case. (Photo: Dr Scott Wilson)

30-50cm per year. Holzer (1972) stated that although the species has the reputation for being a useful plantation tree in central Europe, it has extremely slow juvenile growth (for the first 20-30 years). This slow growth occurs when seedlings are grown both in high mountains and in warmer conditions at lower elevations. Growth therefore appears to be under genetic control since it cannot be accelerated by planting into warmer climates (Holzer, 1972). Terminal shoots can reach 10-20cm from about age 15 (which is much slower, only about 40%, than that of blister rust-devastated *Pinus strobus*). It reaches the height of 20-year-old *P. strobus* not earlier than 50 years of age. Difficulties with it arise in the nursery and establishment phases, which is probably why it has received so little attention up to now. Early growth is very slow. Until the fifth or sixth year the trees have a dense, bushy ('grass phase') form before making strong vertical growth. The bark remains thin for up to 30 years and so is potentially susceptible to being stripped by deer. In Macedonia it forms pure stands on gentle mountain slopes, interspersed with grassy glades and meadows. In most areas where it occurs, it grows both in pure stands and in mixture. The mixed stands are mainly with *Picea abies* but also with *Abies alba*, *Abies borisii-regis*, *Pinus sylvestris*, *Pinus mugo*, *Pinus nigra* and *Fagus sylvatica* with which it can compete due to relatively high shade tolerance (IUCN, 2015). According to Holzer (1972), *Pinus peuce* and *Picea abies*, and *Pinus peuce* and *Abies alba* have been combined very successfully in mixed, two-storeyed stands.

When very young, a *Pinus peuce* tree develops a well-formed, spindle-like, central root but its lateral root system gradually develops, and penetrates deeply into the soil,



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providing the basis for its reputation for high stability (Alexandrov and Andonovski, 2011).

The American *Pinus palustris* (longleaf pine), like *P. peuce* goes through a similar period of slow initial growth called the 'grass stage', which is believed to be under strong genetic control. Although the length of time that individual seedlings remain in this stage is influenced by the environment, it can last for as long as 25 years and often for 15 years. Reasonable stands will reach breast height at about eight years. Generally seedlings of *P. palustris* remain in the grass stage until they reach 2.5cm at the root collar, and they invariably begin more rapid height growth upon reaching that size. The control of vegetation competition is a major factor in stimulating fast diameter growth; if it is good, height growth can begin at the end of the second year (Walker and Wiant, 1973). It is possible that a similar mechanism may operate in *P. peuce*. It does not exist in *Pinus strobus*.



Figure 6. *Pinus peuce* at 55-years old in the Kilmun arboretum, Cowal, Argyll. (Photo: Dr Bill Mason)

## Diseases and pests

Macedonian pine is notable for its resistance to the diseases and pests that affect so many other pines. A possible reason is the high resin content of its wood, buds and cones, which is said to have toxic properties.

Unlike Weymouth pine (*Pinus strobus*), another five-needled pine, Macedonian pine is resistant to attacks from the blister rust, *Cronartium ribicola*. This was noted by Stirling-Maxwell in 1929 at Corrae and also by Wilson (personal communication) at Crarae, where *P. wallichiana* was also affected. It is also resistant to attacks from the pine beauty moth caterpillar, *Panolis flammea*; is less susceptible, though not immune, to red band needle blight, *Dothistroma septosporum*, that is affecting all other pines grown in Britain; and little affected by the pine wood nematode, *Bursaphelenchus xylophilus*, another potential threat to many pines, including *Pinus pinaster* (Savill, 2015). In fact, it seems likely to be a remarkably hardy and healthy tree in Britain. Various bark beetles in the genera *Ips*, *Pityogenes*,



Figure 7. *Pinus peuce* in the Brechfa Forest Plots at age about 50 years. (Photo: Dr Bill Mason)



*Myelophilus*, and *Pissodes* are known to attack the species as does *Hylobius abietis*, a common pest of conifers that attacks mainly seedlings by gnawing their bark but also feeds on needles.

Among fungi, Macedonian pine is attacked by *Heterobasidium annosum* (especially on drier sites with mineral soils), *Phaeolus schweinitzii*, *Cenangium ferruginosum*, *Armillaria mellea*, *Trametes pini*, *Polyporus* sp., and *Stereum* sp. As stated above, considerable resistance to *Cronartium ribicola* has been reported (EUFORGEN, 2015).

## Seed production, nursery conditions and establishment

The cones take two years to develop. Seeds are fully ripe in September but in Britain are often completely stripped in August, at least in small plots, by squirrels. In natural conditions the seeds are distributed by jays and squirrels (Oswald, 1956). Gosling (2007) states that the seeds are 'orthodox' in that they can be dried without harm, and once dried can be frozen, and stored for years at <4°C and 6-8% moisture content with little deterioration and can be relatively easily revived.

Lines (1985b) commented that one of the major disadvantages of Macedonian pine is the tendency to poor or delayed germination, which is partly due to incomplete embryo development. He reported that in bare-root nurseries in the Balkans, while some seeds germinate in the first spring, many do not germinate until the second. The seeds are described by Gosling (2007) as 'deeply dormant' and an average of 30 weeks of cold (c.4°C) stratification is recommended. More detailed studies (Mason et al., 1995) suggested that alternating warm (20°C) and cold stratification can give improved germination compared to cold stratification on its own. To achieve the required duration, pretreatment has to start at the beginning of August for the seeds to be ready to sow by the start of March. Such pretreatment is "only partially effective even with the longest pretreatment durations and/or several pretreatment cycles".

Preliminary investigations of nursery production techniques indicated that better germination and growth was obtained when growing seedlings in containers in a polyhouse compared to bare-root nursery production (Mason et al., 1995). However, even under the best regimes, it takes two years to produce seedlings that are over 10cm tall and such plants are still marginal for forest use.

This slow initial growth is carried over into the early years of the establishment phase as shown by results from a 1995 experiment near Llandovery in mid-Wales. This investigated the effect of fertilizer or herbicide inputs on survival and growth of Macedonian pine planted on either a cultivated (scarified) site or uncultivated ground. Scots pine was also planted for comparison. After six years, the main result observed was an increase in survival of Macedonian pine in the presence of cultivation (Table 1), but height growth was slow and less than half that found with Scots pine.



Figure 8. *Pinus peuce* at Shin, Sutherland at age about 40 years. Note the coarse branching and apparently high basal area in comparison with natural stands shown in Figs. 1 and 2. (Photo: Dr Scott Wilson)

**Table 1. Height growth and survival of Macedonian and Scots pines 6 years after planting in an experiment in mid-Wales.**

Species	With cultivation		No cultivation	
	Height (m)	Survival (%)	Height (m)	Survival (%)
Macedonian pine	0.8	75	0.7	62
Scots pine	2.2	98	1.6	78

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## Provenance

There has been little formal provenance testing reported for this species and only one replicated trial has been established in Britain. This was planted in 1961 in Clocaenog forest in North Wales on a peaty gley soil at 420m asl with an annual rainfall of 1350mm. Four provenances were compared:

- Bedgebury – seed collected from a first generation stand in the national pinetum in Kent of unknown origin. This stand was also the source of much home collected seed in the post-war period.
- Macedonia – seed collected from a natural stand on Mount Pelister.
- Avondale – seed collected from a first generation stand in the National Arboretum in Ireland, also of unknown origin (see Fig. 9).
- Jugoslavia – seed collected from the natural range in the Balkans but the exact location is unfortunately unknown.

The four treatments were replicated four times in a randomized block design in 10 by 10 plant plots at 1.8m spacing. There were insufficient plants of the Bedgebury treatment available so this treatment was only planted in two replicates. The experiment was thinned in 1994 but no other stand or site manipulation (e.g., fertilizer input) has occurred. The experiment was regularly assessed up to 25 years of age and then again at 50 years (Table 2). Analysis of the data was adjusted for the values in the two missing plots.

The results highlight the comparatively slow growth of Macedonian pine in the early years. However, subsequent growth has been good and the height growth is equivalent to that of Scots pine of Yield Class 10. Basal area production, and extrapolated volume production is at least twice what would be expected from Scots pine of that productivity. The data in Table 2 suggest that there may be provenance differences within Macedonian pine that could affect long-term performance. They also suggest that collections from British stands can provide planting stock adapted to British conditions. The apparently poorer performance of the Bedgebury treatment suggests that careful attention needs to be paid both to the number of trees in the source stand to avoid any risk of inbreeding and the quality of these trees.

**Table 2. Growth of four seed sources of Macedonian pine after 50 years.**

Seed source	Mean dbh (cm)	Basal area (m <sup>2</sup> ha <sup>-1</sup> )	Top height (m)	Height at 10 years (m)
Bedgebury	26.9	61.9	19.6	1.3
Mount Pelister	27.6	80.8	19.3	1.8
Avondale	30.1	96.9	19.6	1.6
Jugoslavia	26.7	71.8	18.7	1.3
Significance	P<0.05	P<0.05	ns	
5% LSD	2.2	19.4	na	

## Yield

There is increasing evidence that the species could be a high-volume producer in Britain compared with other pines. A feature is that in comparison with other pine species, basal area growth after canopy closure can be up to 50% greater for a given height. This makes it of particular interest where the risk of windthrow is high. Possible yield classes are between 4 and 14m<sup>3</sup>ha<sup>-1</sup>year<sup>-1</sup> (Jenkins et al., 2012). Table 3

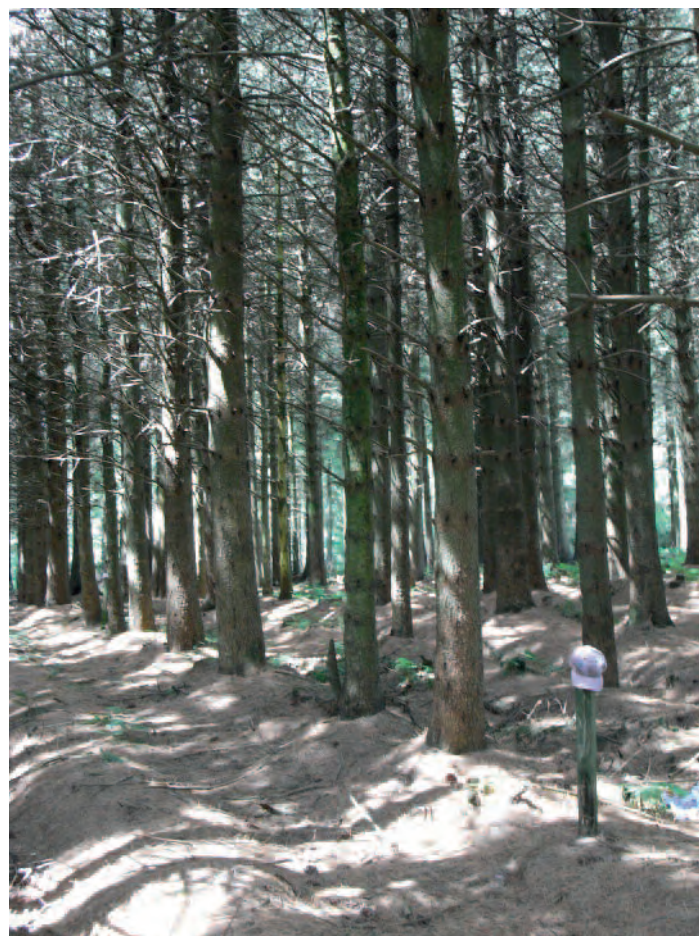


Figure 9. An internal view of the Clocaenog provenance trial at 50 years of age. The plot in the foreground is from the Avondale provenance. (Photo: Dr Bill Mason)



shows the performance of the species in a number of research plots across Britain compared with predictions for unthinned Scots pine stands of different yield classes. While values recorded from individual sites may be inflated (e.g. the site at Naver in north Scotland) because of edge effects in small plots (typically 0.01 to 0.02ha), there seems little doubt that, once established, the species can outyield other pines commonly used in British forestry over a wide range of sites and climate zones.

## Timber and uses

Preliminary studies in Britain (based on four logs from the plot in Kielder – see Table 3) indicate that an important attribute of the wood is its stability compared with other common coniferous timbers; it is also homogeneous although it is soft and its strength is poor. Its density, at around 12% moisture content, is 350 (Ramsay and Macdonald, 2013) to 440 kg m<sup>-3</sup>, which is considerably lower than Scots pine, at 510 kg m<sup>-3</sup>. Slightly higher densities of 410 to 440 kg m<sup>-3</sup> are quoted for continental European conditions. In the Balkans the timber is regarded as durable. The pith is pale-yellowish and strongly resinous, and the core is reddish. *Pinus peuce* wood is highly valued for construction, furniture production, wood-carving and cooperage, although most populations are now strictly protected so that use for these purposes is limited. The wood is stable and easily worked.

The resin of *Pinus peuce* provides high quality derivatives (EUFORGEN, 2015). Its chemical composition is described by Pejowski (1950). In particular, it is said to be a very good substitute for Canada balsam and Cedar oil in optical work.

It is considered to be a valuable ornamental tree and is much planted in Scandinavian parks and gardens, and in its

native habitat it is valued for watershed and avalanche protection.

## Place of Macedonian pine in British forestry

At present the total area of Macedonian pine stands in Britain is in the low tens of hectares. Though its potential has been recognized for some time, it has never been deployed on any scale. This reflects a shortage of seed, difficulties in seed pretreatment and nursery production, and the slow early growth after planting out that makes the species vulnerable to weed competition and browsing. However, the comparatively high productivity on a range of sites and its seemingly low susceptibility to biotic and abiotic hazards, suggest that this pine should be given greater attention in current attempts to increase the resilience of British forests through species diversification. In particular, forestry in the uplands of Britain is often regarded as being too dependent upon very few species. There has been concern for some time to find possible alternative species, particularly to help diversify areas currently dominated by Sitka spruce. Macedonian pine is a possible choice especially because of its resistance to red band needle blight and high-volume production at relatively low tree heights. Though its potential has been recognized for some time, it has never been deployed on any scale. It could also be a valuable component of continuous cover systems since in its natural range it grows well in mixture with Norway spruce and European silver fir (Alexandrov and Andonovski, 2011). Natural regeneration of Macedonian pine has been recorded in a number of the research plots in Britain (WLM, personal observation).

Now that results from various research plots have

**Table 3. Height growth and total basal area production of Macedonian pine in a range of research plots across Britain and comparison with Scots pine. Plots with location in bold type still exist.**

Location: forest and region	Soil	Age of last measurement (years)	Top height (m)	Total Basal area (m <sup>2</sup> ha <sup>-1</sup> )	Notes
Bedgebury, SE England	Podsol	49	17.4	73.3	Plot was windblown in 1987 gale.
<b>Brechfa, mid-Wales</b>	Brown earth	52	23.2	97.6	In Brechfa Forest Garden. See Fig.7.
Bedgellert, N. Wales	Upland brown earth	41	14.2	76.9	Now felled
<b>Bickley, North York Moors</b>	Peaty ironpan	48	18.1	85.8	
<b>Kielder, Northumberland</b>	Peaty gley	63	24.9	74.0	
<b>Kilmun, Argyll</b>	Upland brown earth	38	14.7	72.8	In Kilmun Forest Garden. See Fig. 6.
<b>Shin, Highland</b>	Peat	25	7.9	30.1	See Fig. 8.
Naver, Highland	Peat	39	12.9	95.8	Felled for a wind farm
Scots pine YC 10	na	45	17.1	53.6	All Scots pine yield class data
Scots pine YC 8	na	45	14.9	46.6	based on non-thin models
Scots pine YC 6	na	45	12.6	36.5	(Edwards and Christie, 1981)

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demonstrated the potential of this species on a wide range of British sites, we suggest that the next stage in its deployment should be to establish large plots (2-5ha) in different areas of the country to act as operational trials of its potential. The plants used in these plots should be grown from material provided by new seed collections in the species' native range; one aim of these large plots would be to provide secure British sources for future seed supply should the potential of Macedonian pine be confirmed by these operational trials. Establishing these large plots would also provide the opportunity for more detailed research seeking to improve rates of growth in the nursery and after outplanting. Implementing such a phased approach to the deployment of Macedonian pine could allow this interesting and attractive species to occupy an important position in British forests in decades to come.

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Since retiring from Oxford University in 2006, **Dr Peter Savill** has been working as a Trustee of three charities: Woodland Heritage, the Future Trees Trust and the Sylva Foundation. He has also written *The Silviculture of Trees used in British Forestry* (CABI, 2013) and edited *Wytham Woods – Oxford's ecological laboratory* (OUP, 2010).

**Bill Mason** was a silvicultural researcher at the Northern Research Station near Edinburgh for three decades before retiring in 2012. He is now a Research Fellow of Forest Research, is involved in EU Cost Actions on 'Mixed Forests' and 'Non-Native Species', and is the current Chair of the Continuous Cover Forestry Group.