Pinus nigra in Europe: distribution, habitat, usage and threats

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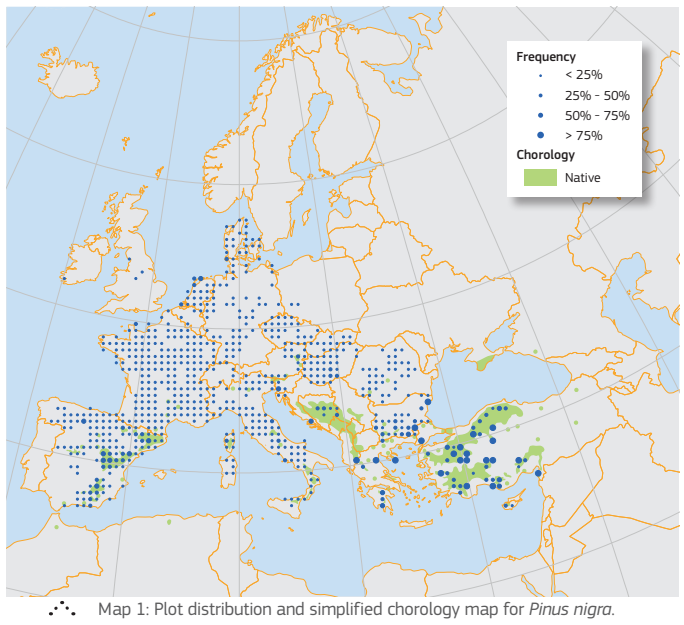
***Pinus nigra* J.F. Arnold, known as European black pine or black pine, is a fast-growing conifer with a wide but fragmented distribution across Europe and Asia Minor, predominantly in mountain areas. It has also become naturalised in some areas in North America. It is subdivided into several distinct subspecies and its taxonomic status is still a subject of debate among specialists. Black pine regenerates with difficulties after a fire event, particularly during periods with extreme droughts when the development of seedlings can become challenging. This is thought to trigger a reduction of its habitat in southern Europe; on the contrary in Central Europe the climate amelioration might generate an expansion.**

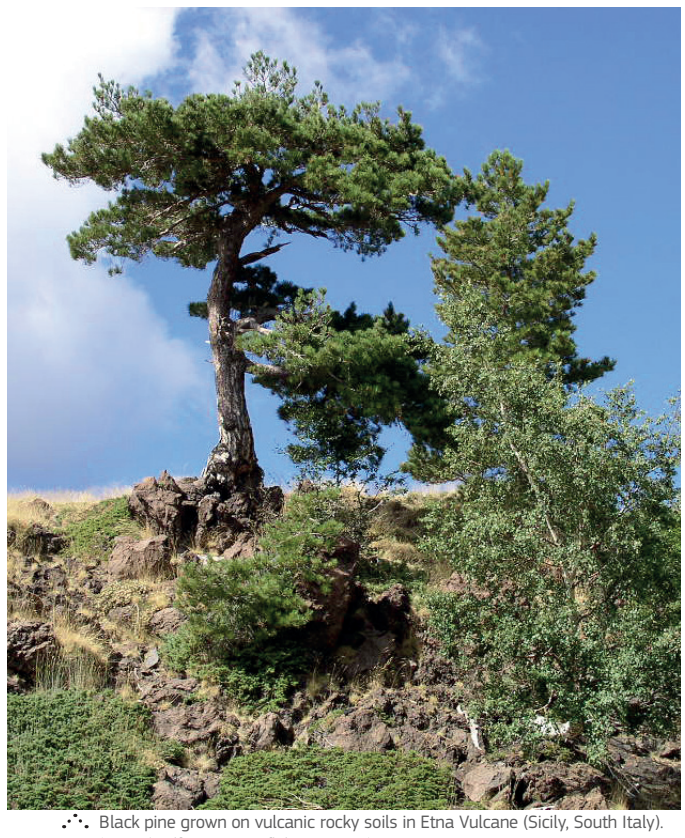
Black pine (*Pinus nigra* J.F. Arnold) is a large evergreen conifer commonly reaching 30 m, but exceptionally it is capable of attaining heights up to 40 m[1, 2]. Its bark is usually a dark greyish brown to black (giving rise to its Latin name "nigra") and becomes deeply furrowed longitudinally on older trees[3]. On young individuals, the crown is conical, becoming umbrella-shaped on older trees[4]. Needles are in pairs 8-15(19) cm long, 1-2 mm in diameter, straight or curved, and finely serrated[1, 2]. They normally persist on the tree for 3-4 years (exceptionally up to 8)[5]. Black pine is **monoecious**. Male catkins are yellow, while female **inflorescences** are reddish. Cones are **sessile**, 4-8(9) cm long, 2-4 cm wide and yellow-brown in colour[1, 2]. They ripen in the autumn of the second year, and open in the third year. Cones contain 30-40 seeds. The seeds are grey, 5-7 mm long, with a wing 19-26 mm long[4]. It is a long-lived species, with a life span of over 400 years[6]. One specimen in Germany (the "Vier-Brüder-Baum" from its four main stems) is reported to be over 1 000 years old and with a girth over 7 m[7].



Map 1: Plot distribution and simplified chorology map for *Pinus nigra*. Frequency of *Pinus nigra* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *P. nigra* is derived after EUFORGEN[48].

Distribution

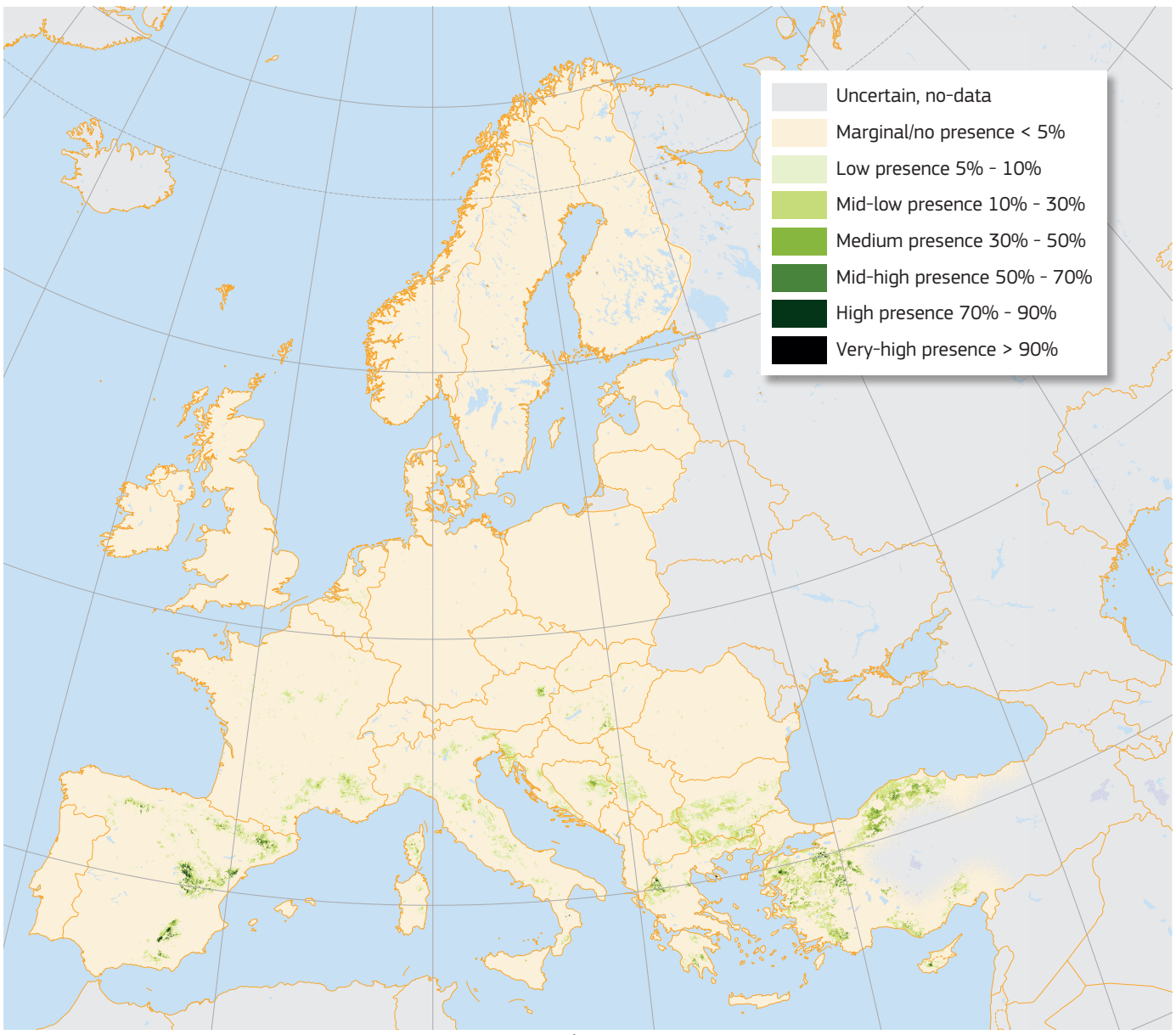
The past distribution of black pine in Europe is difficult to reconstruct. This because past occurrences based on both pollen and charcoal (widely used to reconstruct past species distribution) cannot be easily recognised at the species level[8]. However, more localised studies mainly based on macrofossils suggest that large populations of black pine were already present during the late Pleistocene and the Holocene in the north-western Mediterranean basin (see [9] for a review). These populations are thought to have followed a substantial decrease during the Holocene as a consequence of climate warming at the onset of the Holocene as well as increased human activities during the last millennia[9]. This led to the current fragmented distribution of black pine extending from North-Western Africa through southern Europe to Asia Minor[10, 11]. Black pine presently covers more than 3.5 million hectares[4], making it one of the most widespread conifer species in the Balkans and Asia Minor. Its widest distribution worldwide is in Turkey, with more than 2.5 million hectares[12]. Outside Europe, it was also introduced in the United States (where it is known as Austrian pine) in 1759[13], and has now become naturalised in parts of New England and the Great Lake States[14]. As a result of climate warming the future distribution of black pine is thought to change considerably but the response is likely to be different depending on the geographic region[15]. In the Mediterranean regions climate warming increases water stress and thus has a negative influence on the growth of this species[16, 17], whereas in central Europe climate amelioration is thought to lead to an expansion[18, 19]. Two main subspecies of black pine are recognised: *Pinus nigra* subsp. *salzmannii* (Corsican pine), occurring in the east of the range from Morocco and Spain to South France and Corsica, and *Pinus nigra* subsp. *nigra* (Austrian pine), occurring in the west of the range from Austria and North-East and Central Italy through Balkans up to Turkey and Crimea Peninsula. However, more than 100 Latin specific, varietal, and formal names have been recorded by different authorities and there is no general consensus[4, 20-22].



Black pine grown on vulcanic rocky soils in Etna Vulcane (Sicily, South Italy). (Copyright Alfie Ianni, www.flickr.com: CC-BY)

Habitat and Ecology

Black pine stands exist at altitudes ranging from 350 m in Italy to 2 200 m in the Taurus Mountains, the optimal altitudinal range being between 800 to 1 500 m[5]. It can grow on a variety of soils, from **podzolic** sands to limestone, often dependent on region and climate[21]. The Austrian pine subspecies is more able to tolerate exposed chalk and limestone than Corsican pine[23]. However Corsican Pine is more often found in coastal areas as it is more resistant to salt wind than most other pine species[21]. Black pine can grow in both extremely dry and humid habitats with considerable tolerance of temperature fluctuations[11]. It is a light-demanding species, but it shows higher shade tolerance than Scots pine (*Pinus sylvestris*)[24]. It is resistant to drought and wind[4]. It grows in pure stands or in association with other broadleaved or conifer species, in particular *Pinus sylvestris*. It is also commonly found in association with other pines such as dwarf mountain pine (*Pinus mugo*), Aleppo pine (*Pinus halepensis*), Italian stone pine (*Pinus pinea*) and Heldreich pine (*Pinus heldreichii*)[4, 21, 22].



Map 2: High resolution distribution map estimating the **relative probability of presence**.

Yellow male flowers clustered at the top of the shoot. (Copyright Wouter Hagens, commons.wikimedia.org: PD)

Yellow-brown maturing cone: they ripen in autumn of the second year.
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Corsican subspecies of black pine (*Pinus nigra* subsp. *salzmanii*) on flank of Paglia Orba Mountain (Albertacce, Corsica Island).
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Importance and Usage

The stems of black pine have been widely used in the past for naval construction[17]. As a result of its ecological flexibility, it is one of the most widely used tree species for reforestation worldwide[4, 25, 26], and it is considered a potential substitute for indigenous coniferous species in Central Europe under future climate scenarios[19]. Despite its relatively narrow native range, the broad European distribution range of black pine covers several areas with high erosion rates such as the European mountain systems[27]. It is very efficient for degraded soil colonisation and its adventitious roots are suitable to be exploited for deep reinforcement and soil strength enhancement[28, 29]. Along with more late succession species (e.g. in some degraded areas of the Southwestern Alps, *Quercus pubescens, Acer opalus, Sorbus aria*), this pioneer tree has proven effective for controlling soil erosion and landslides and for land rehabilitation[4, 29, 30]. The salt-tolerant subspecies Corsican pine has been exploited for stabilising coastal dunes along the North Sea[21]. Its wood is durable, rich in resin and easy to process. It is highly suitable for indoor flooring (the Vienna State Opera House stage is made from black pine wood[31]). In the Mediterranean area, it is used not only for general construction (doors, panelling, staircases, etc.) and furniture, but also as fuelwood, while the pulp is exploited for paper[21]. Black pine is also widely planted in parks or in urban and industrial areas thanks to its tolerance to pollution and striking visual form[31].

Threats and Diseases

The fungi *Dothistroma pini*[32, 33], *Lophodermella* spp.[34] and *Sphaeropsis sapinea* (*Diplodia pinea*)[35-37] can cause severe damage to the needles. Black pine is highly vulnerable to the pine processionary caterpillar (*Thaumetopoea pityocampa*)[38, 39]. It may also be severely attacked by the Red band needle blight (*Mycosphaerella pini*, syn. *Dothistroma septosporum*)[38, 40, 41]. This blight has been reported to cause significant damage to Corsican pine plantations in the United Kingdom, to the extent that it is no recommended for longer planting there[23]. As many other pines, black pine is highly susceptible to the pine lappet moth (*Dendrolimus pini*) and vulnerable to the pitch canker (*Gibberella circinata*)[38]. The fungus *Brunchorstia pinea* can cause shoot dieback and cankers[42]. Pine trees can also be infected by *Bursaphelenchus xylophilus*, commonly known as pine wood nematode, which causes pine wilt disease[43, 44]. Black pine is among the hosts to the bark beetle *Ips pini*[45]. Fires may damage black pine stands, altering the plant community composition in favour of typical post-fire communities with perennial grass species as well as other tree species such as maritime pine (*Pinus pinaster*), Aleppo pine (*Pinus halepensis*), holm oak (*Quercus ilex*) and/or kermes oak (*Quercus coccifera*)[9], which are more fire resistant in some of the climatic conditions where black pine lives[46]. This is also because relatively few black pine seedlings develop after a fire event[47].

Black pine with the old signs of resin tapping activities in a plantation near Bad Vöslau (Lower Austria).
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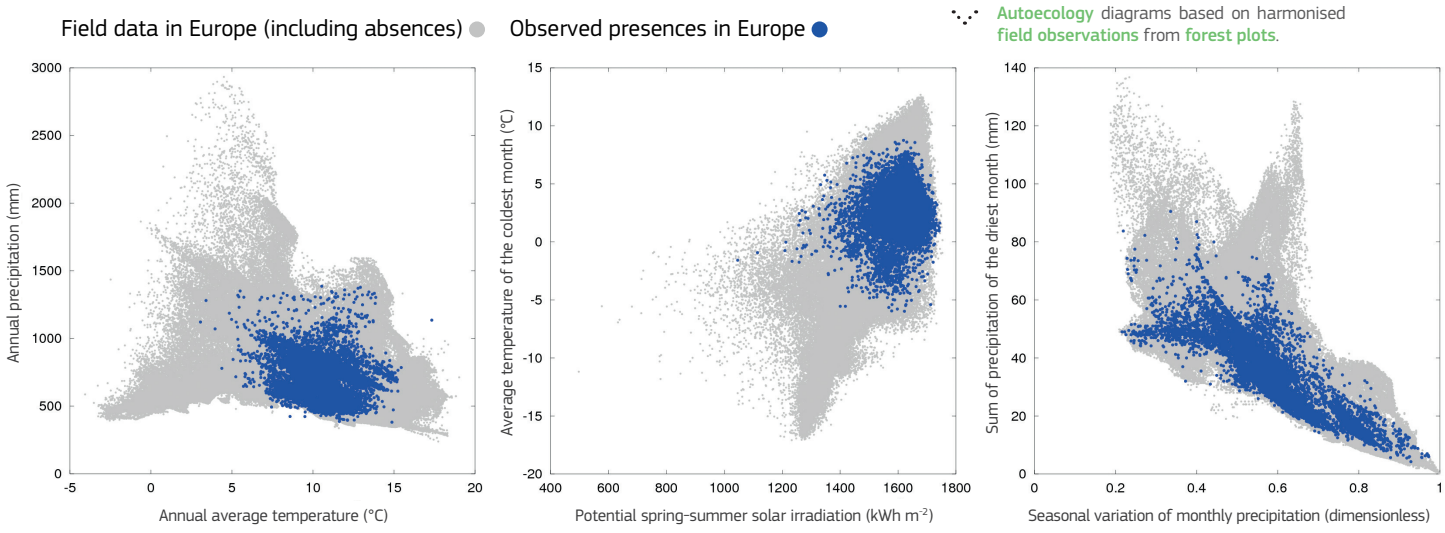

Autoecology diagrams based on harmonised field observations from forest plots.

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