**Pinus cembra** in Europe: distribution, habitat, usage and threats

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Arolla or Swiss stone pine (**Pinus cembra** L.) is a slow-growing, long-lived conifer that grows at high altitudes (up to the treeline) with continental climate and is able to resist to very low winter temperature. It has large edible seeds which are dispersed principally by the European nutcracker. The timber is strong and of good quality but it is not a commercially important species because of its slow growth rate and frequent contorted shape. This pine is principally used to protect slopes and valleys against avalanches and soil erosion. In alpine habitats it is threatened principally by tourism development, even if the recent reduction of mountain pasture activities is allowing this pine to return in many areas.

**Pinus cembra**, known as Arolla pine or Swiss stone pine, is a slow-growing, small to medium-sized evergreen conifer (10-12 m height, occasionally 20-25 m), which can live up to 1,000 years. The crown is densely conical when young, becoming cylindrical and finally very open. It grows commonly in a curved or contorted shape, but in protected areas can grow straight and to considerable sizes. Needles are in fascicles of five, 5-9 cm long. Arolla pine is a monoecious species and the pollination is driven by wind. Seed cones appear after 40-60 years, they are 4-8 cm long and mature in 2 years. The wingless seeds are large and edible (7 x 10 mm). Genetically the Arolla pine is close to the Siberian stone pine (**Pinus sibirica**), and they can hybridise.

Some authors consider them as subspecies. This Arolla pine is considered a glacial relict of the Siberian pine. Distribution

Arolla pine grows in the Alps chain, from the Maritime Alps in France to the Julian Alps in North Slovenia, and it is more abundant in the eastern sector. It occurs also in isolated groups in the Tetra Massif, the Carpathians and the Transylvanian Alps. It had a wider range in Europe during the last glaciation, then with rising temperatures it suffered a sharp fragmentation as a consequence of its natural competition with Norway spruce (**Picea abies**), which isolated the Arolla pine in the highest elevations.

- **Plot distribution and chorology map for Pinus cembra**
  - Caption: Frequency of Pinus cembra occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native spatial range for *P. cembra* is derived after EUFORGEN.

**Habitat and Ecology**

This pine grows in the timberline of the alpine and subalpine zone with continental climate, from 1100 m to 2500 m and sometimes over 2700 m in Italian Alps developing into a bush habit. It is one of the most cold-hardy trees known, resistant to frost thanks to its evergreen foliage in which the water content can be reduced to a minimum during winter. It can reach temperatures in winter down to -43°C and in summer between -6°C and -10°C without damage (two to three year old needles). It is sensitive to late frosts in spring and drought stress mainly in lower zones. It grows better in fresh-humid, deep and well-drained soils. The substratum type is not particularly significant, growing both in calcareous or siliceous conditions. Arolla pine rarely is found in pure stands, probably because the optimal habitats have been transformed into pastures. In fact, it is more frequently found with other tree species forming open conifer forests and woodlands up to the tree line. It is associated principally with larch (Larix decidua), with dwarf pine (**Pinus mugo**) where the soil is disturbed by landslides, with green alder (Alnus viridis) where avalanches are more frequent, or with Norway spruce (**Picea abies**) in lower elevations. Seed dispersal is principally driven by the corvid Eurasian nutcracker (Nucifraga caryocatactes), which has a mutualistic relationship with the pine. This bird, covering distances up to 15 km, can collect more than 25,000 seeds every year, storing them in many small deposits on the ground as a food winter reserve. Some of these reserves are abandoned and seeds can germinate. Other animal species contribute to seed dispersion, such as woodpeckers (Dryobates martis), dormouse (Glis glis), and dormouse (Glis glis).

- **Map 2: High resolution distribution map estimating the relative probability of presence.**
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Outside its natural range, it is planted in parks and arboreta especially in northern Europe.

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**Importance and Usage**

Arolla pine is not an important timber tree economically, as it grows slowly and with irregular shapes, so forestry practices tend to favour other species in alpine habitats, such as the larch.[1,2] This pine has as a more ecological and protection function for slopes and valleys against avalanches and soil erosion.[3] The wood is resistant to woodworm infestations. Gremmeniello obtusiventer and Keratocarpon juniperi, which lead to mortality of young plants (seedlings).[4,5] In the Alps, the larch bud moth Zopherophora diniana has a species form genetically differentiated and specialised for defoliating the Arolla pine.[6,7] However, the sporadic outbreaks do not influence the presence of the pine or its dominance in mixed forest with European larches.[8,9]

**Threats and Diseases**

Since Neolithic times human activities (alpine farming, intensive grazing with cattle, timber exploitation) have brought the treeline in the Alps down and turned much of the ancient alpine forests into pasture woodland. The recent abandonment of intensive grazing with cattle, timber exploitation) have brought back in many areas[10] the natural alpine biodiversity of this pine is principally caused by tourism development: in particular ski runs, ski lifts, roads and parking lots.[11] Damage to young seedlings by grazing animals can create gaps in the age distribution[12]. Deep snow layers lasting until late winter or spring causes browning needle diseases by the snow mold fungi Phacidiium infestans, Gremmeniello obtusiventer, and Keratocarpon juniperi, which lead to mortality of young plants (seedlings)[13,14] in the Alps, the larch bud moth Zopherophora diniana has a species form genetically differentiated and specialised for defoliating the Arolla pine[15,16]. However, the sporadic outbreaks do not influence the presence of the pine or its dominance in mixed forest with European larches.[17,18]

**References**