

Castanea sativa in Europe: distribution, habitat, usage and threats

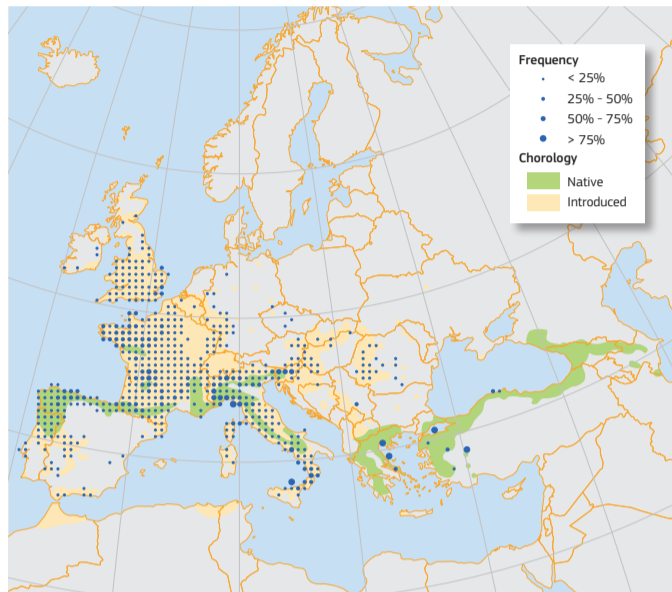
M. Conedera, W. Tinner, P. Krebs, D. de Rigo, G. Caudullo

The sweet chestnut (*Castanea sativa* Mill.) is the only native species of the genus in Europe. The broad diffusion and active management by man resulted in the establishment of the species at the limits of its potential ecological range, which makes it difficult to trace its original natural area. The present distribution ranges from North-Western Africa (e.g. Morocco) to North-Western Europe (southern England, Belgium) and from south-western Asia (e.g. Turkey) to Eastern Europe (e.g. Romania), the Caucasus (Georgia, Armenia) and the Caspian Sea. In Europe the main chestnut forests are concentrated in a few countries such as Italy, France and the Iberian Peninsula. The sweet chestnut has a remarkable multipurpose character, and may be managed for timber production (coppice and high forest) as well as for fruit production (traditional orchards), including a broad range of secondary products and ecosystem services.

The sweet chestnut tree (*Castanea sativa* Mill.) is a medium-large deciduous tree that may reach 30-35 m. When cultivated, the tree is long-living (up to 1000 years) and may also reach a significant girth (up to 12 m at breast height). The bark is brown-greyish and often has net-shaped venations with deep furrows or fissures. Leaves are oblong-lanceolate (8-25 cm long, 5-9 cm broad) with a **dentate-crenate** margin and a brighter green upper leaf surface. This species tree is **monoecious** and flowers develop in late June to July and may be pollinated by wind (more usual in case of dry weather during flowering) or insects (dominating in wet weather conditions). Male flowers are gathered in catkins (5 to 15 cm in length) whereas female flowers are usually positioned at the base of the male ones in the upper part of the current year's shoots. By autumn the female flowers develop into spiny cupules (commonly called bur) containing 3-7 brownish nuts that are shed during (September)-October. Some cultivars, especially the varieties of the Marron-group, develop only one large nut per cupule (rarely up to three). The nut is an **achene** composed of two skins; the external part is shiny brown (pericarp) and the internal is a pellicle adhering to the fruit (episperm), and edible creamy-white **cotyledons**¹.

Distribution

The distribution area ranges from Southern Europe (Iberian Peninsula, Italy, Balkans, Mediterranean Islands) and North Africa (Morocco), to North-Western Europe (England, Belgium) and eastward to Western Asia (North East Turkey, Armenia, Georgia, Azerbaijan, Syria), with an altitudinal range between 200 and 1800 m, depending on the latitude and site aspect^{2,3}. In Europe the sweet chestnut covers an area of more than 2.5 million **hectares** (about the dimension of Sardinia Island). Most of the area (89%) is concentrated in just a few countries (France, Italy, followed by Spain, Portugal, and Switzerland) with a long tradition of chestnut



Map 1: Plot distribution and simplified chorology map for *Castanea sativa*. Frequency of *Castanea sativa* occurrences within the field observations as reported by the National Forest Inventories. The chorology of the native and introduced spatial range for *C. sativa* is derived after several sources^{4,7,21-23}.

cultivation⁴. European settlers introduced the species in other continents, so that chestnut trees or plantations are nowadays present in different parts of South and North America as well as Australia². The broad diffusion and active management by man have resulted in the establishment of the species at the limits of its fundamental niche, which makes it nowadays difficult to trace its original range⁵ and its ecology⁶. The most probable natural range is delimited by several macro-regions: the Transcaucasian region, north-western Anatolia, the hinterland of the Tyrrhenian coast from Liguria to southern Italy along the Apennine range,



Chestnut plantation for fruit production in Bregaglia Valley (Canton of Grisons, Switzerland). (Copyright Patrik Krebs: CC-BY)

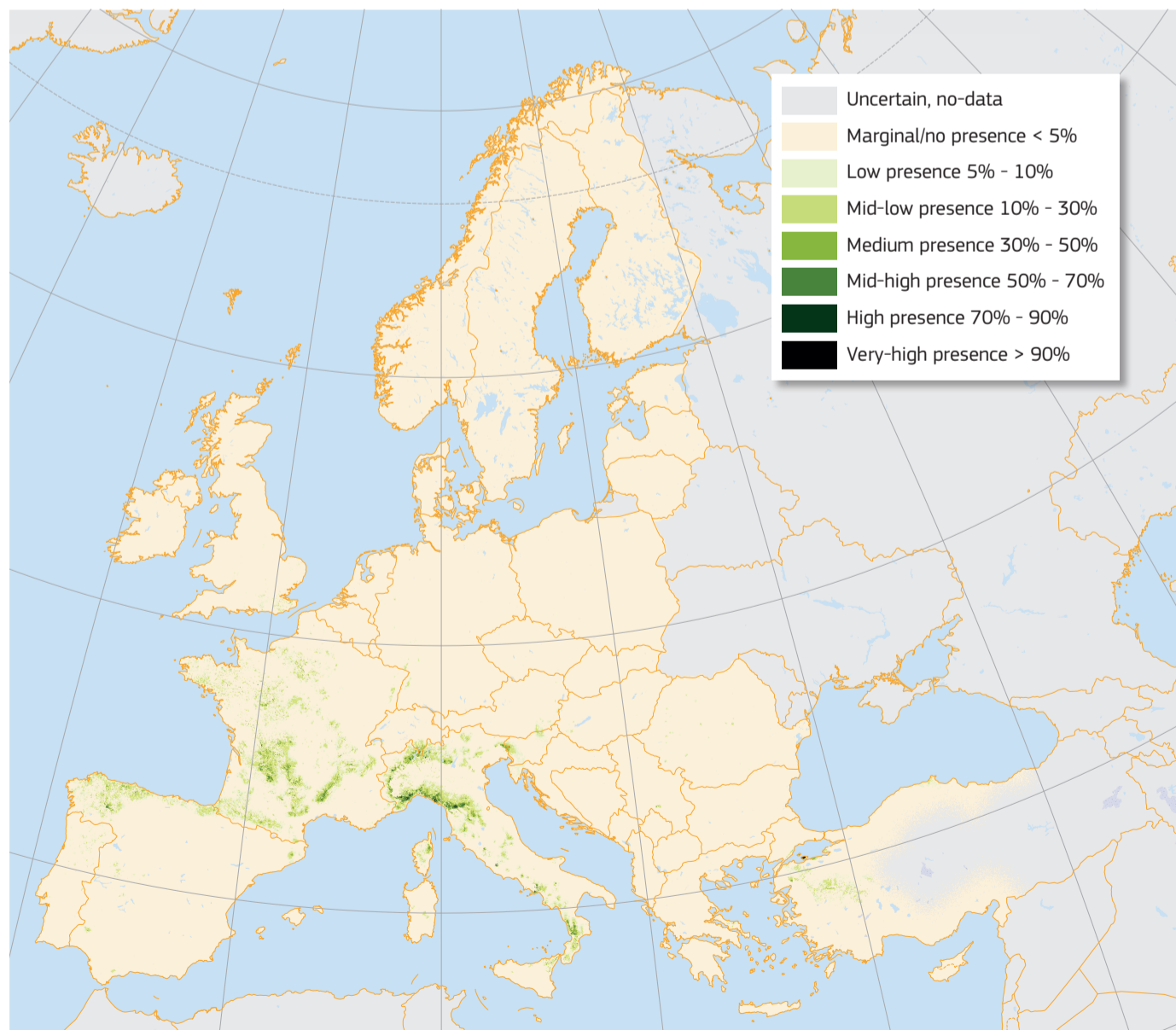
the Cantabrian coast on the Iberian peninsula, and probably also the Greek peninsula (Peloponnese and Thessaly) and north-eastern Italy (Colli Euganei, Monti Berici, Emilia-Romagna)^{7,8}. First unambiguous evidences of chestnut cultivation are reported in **palynological** data of several regions in the Anatolian Peninsula, North-eastern Greece and South-eastern Bulgaria and date back to around 2100-2050 B.C., while Neolithic evidence (4000 B.C.) of cultivation together with walnut and cereals comes from Italy⁸. Nevertheless, chestnut cultivation only took a subsidiary place in the ancient Greek civilization and in the pre-Christian Latin world. The role of chestnut in the Italian territory may have changed at the beginning of the Christian era when people realized that the wood produced from chestnut coppices was so useful and versatile. The Romans may thus have introduced the idea of cultivating the chestnut and in certain cases the tree itself, but no evidence of systematic tree planting exists⁹.



Edible nuts of the sweet chestnut: they are traditionally roasted but can also be candied, boiled, dried, or used as flour. (Copyright Patrik Krebs: CC-BY)

Habitat and Ecology

The sweet chestnut is a warm-temperate deciduous species, that likes a mean yearly temperature ranging between 8° and 15°C and monthly mean temperatures over 10°C during 6 months. The species needs a minimum rainfall that ranges between 600 and 800 mm according to its distribution and interaction with temperatures. The lowest elevations are recommended for the highest latitudes and vice versa¹. The chestnut tree displays a high sensitivity to summer droughts issuing from the combination of high temperatures and lack of precipitation^{10,11}. It does not thrive on limestone, preferring well-drained, from



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

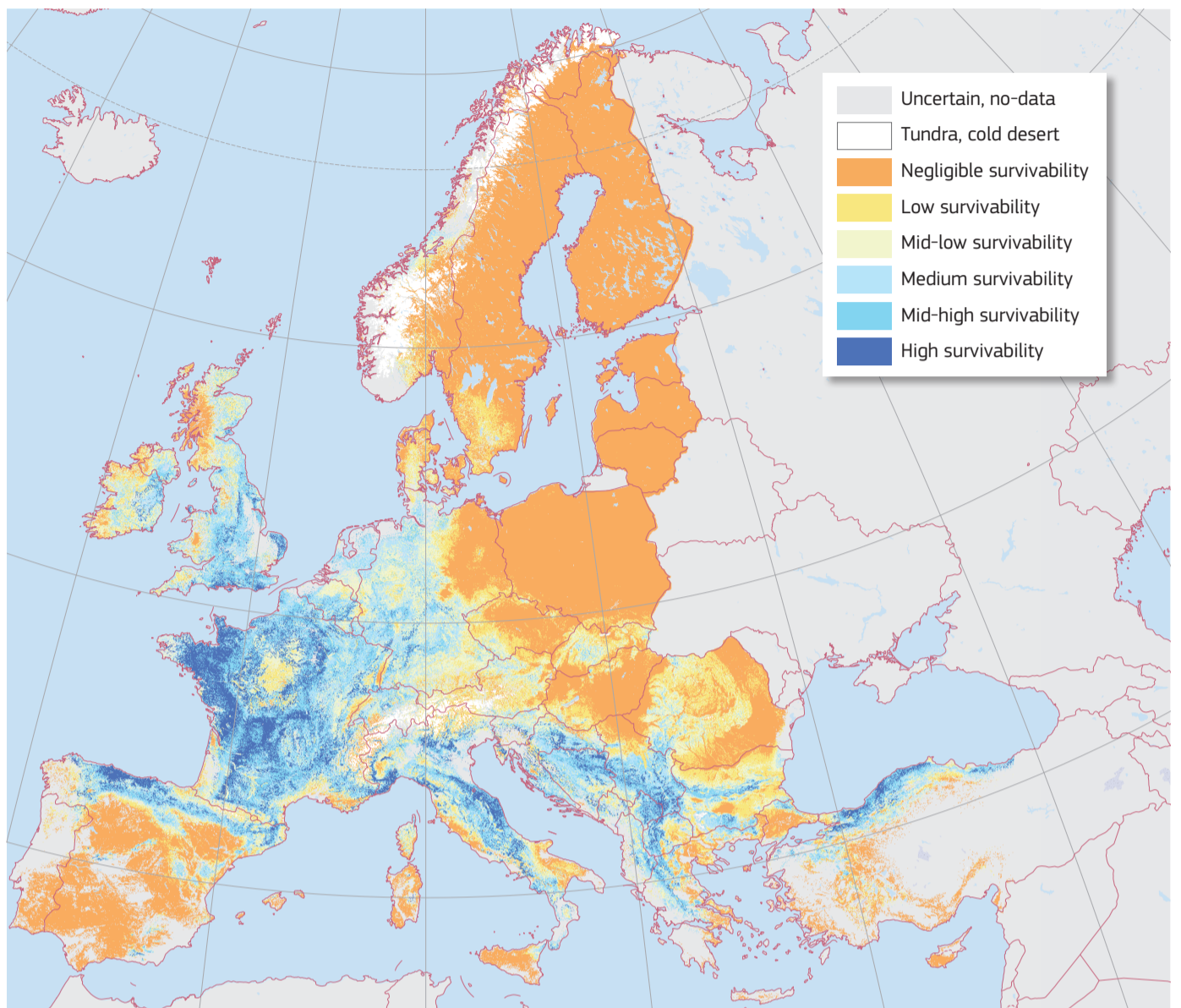
very acidic to neutral soils and nutritionally poor sites¹². This tree can rejuvenate in half-shadow conditions, but needs light for growing from the early pole stage¹. It is sensitive to late frost and very adapted to fire-disturbance (vigorous re-sprouter)⁵. Due to the strong cultivation pressure, it is very difficult to define natural chestnut stands with consociated tree communities. In fact in about 90% of chestnut forests, this tree is pure or the dominant species. A good example of a natural community might be the Georgian chestnut forests where the species grows with other **thermophilous** broadleaved deciduous species such as oriental beech (*Fagus orientalis*), hornbeam (*Carpinus betulus* syn. *Carpinus caucasica*), black alder (*Alnus glutinosa*), field elm (*Ulmus minor*), Cappadocian maple (*Acer cappadocicum* syn. *Acer laetum*), *Quercus* spp., Caucasian zelkova (*Zelkova carpinifolia*), red lime (*Tilia rubra* subsp. *caucasica* syn. *Tilia caucasica*) and yew (*Taxus baccata*)¹³.



Unisexual male and female inflorescences: long yellow catkins of male flowers clustered in bundles and composed of numerous stamens and a solitary female inflorescence comprising an ovoid cupule with styles on top. (Copyright Patrik Krebs, CC-BY)

Importance and Usage

Due to its multipurpose character, the chestnut tree has always been cultivated in different management systems according to the targeted products and services. Chestnut wood is particularly suitable for external use, thanks to its natural high tannin content that acts as a protection against decay. In former times tannin extraction was also a very common use of the timber¹. Due to its high re-sprouting capacity, coppice represents the main type of forest management with about 80% in cover of the chestnut forests, supplying principally fire wood, charcoal, poles (fence, pit-props, etc.), and wood for small products (barrels, shingles, sleepers, etc.). Pure chestnut high forests are rare with a cover of about 10%, producing timber wood for construction, furniture or long poles¹⁴. However, high quality uses of chestnut timber are in some cases limited due to the susceptibility of the chestnut to ring-shake¹. Traditional orchards for fruit production (or groves, as some authors call them), which cover about 20% of chestnut forests, consist of open stands, usually composed of grafted trees because of the **self-sterility** of the species. The orchards for staple food consisted of a mix of varieties with different ripening periods. The edible fruits can be consumed in



Map 3: High resolution map estimating the maximum habitat suitability.

different ways: roasted, candied, boiled, dried, or transformed to flour. Orchards also provided several secondary products such as pasture, hay, mushrooms, berries, etc. In some cases, orchards were also intercropped with cereals¹⁴. Flowers are rich in pollen and nectar and therefore really appreciated for honey production by bee keepers¹.

Threats and Diseases

Traditional chestnut management approaches (i.e. coppices, high forests, orchards) requires continuous cultural inputs. In the absence of management, chestnut stands tend to be invaded by other species and to evolve towards mixed deciduous forests^{15, 16}. With time over-aged and oversized chestnut orchard trees and coppice stools become unstable and tend to uproot¹⁷, disrupting the original chestnut structures within the post-cultural ecosystems. This has caused a severe decrease of biodiversity in the affected regions^{18, 19} and reduced ecosystem service provision²⁰. Further threats for chestnut trees include the ink disease (*Phytophthora* spp.), the spread of the newly introduced chestnut blight (*Cryphonectria parasitica*), and the impact of the Chinese gall wasp (*Dryocosmus kuriphilus*). The latter is a pest introduced in 2002 in Piedmont and now spreading to other regions, although successfully limited by the specific antagonist *Torymus sinensis* where this biological control has been applied. Further source of economic loss for the chestnut growers are fruit damaging insects such as the chestnut weevil (*Curculio elephas*) and tortrices (*Cydia splendana*; *Cydia faggladana*; *Pammene fasciana*)¹.

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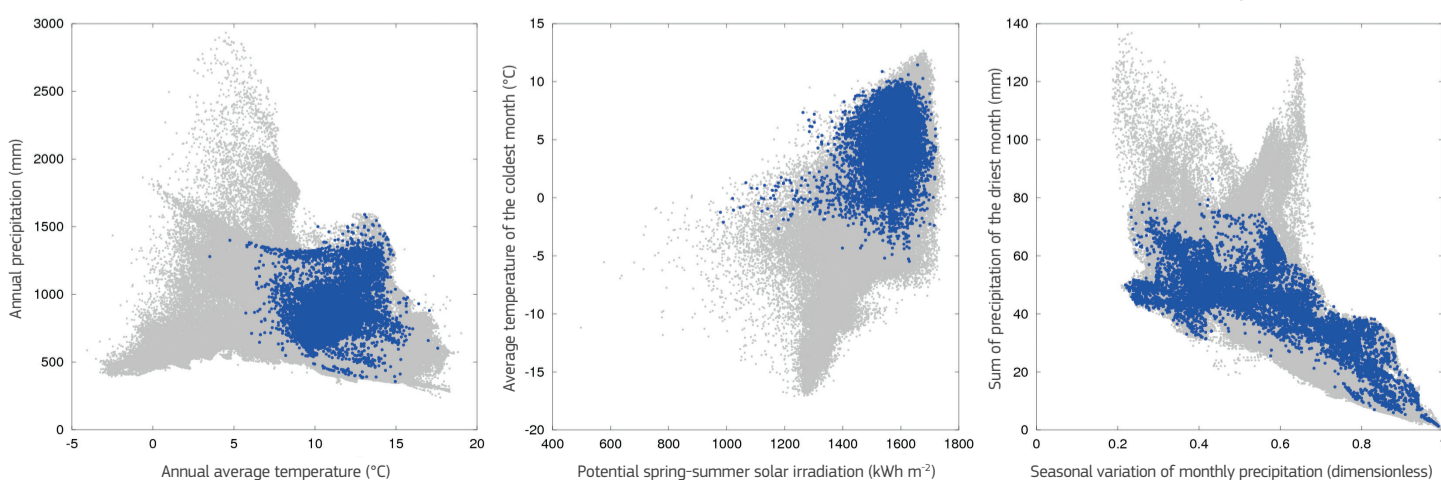
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Oblong-lanceolate leaves, bright green in colour with toothed margins. (Copyright Tracy Houston Durrant, CC-BY)

Field data in Europe (including absences) ● Observed presences in Europe ●

Autoecology diagrams based on harmonised field observations from forest plots.



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