

ORIGIN AND CHARACTERISTICS OF SICILIAN FIR (*ABIES NEBRODENSIS*) (LOJAC.) MATTEI SPECIES

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Abstract:

Abies nebrodensis, commonly known as the Sicilian fir, is a rare conifer endemic to the Madonie Mountains of Sicily, Italy. It is a relict species with origins dating back to ancient Mediterranean forests and was rediscovered in the mid-20th century after being thought extinct. The tree is up to 15m tall, with straight round trunk, and a conical crown shape. It is recognized by its dark green flattened needles, upright cones, and adaptation to rocky mountain habitats. Because of its extremely limited natural population and ongoing habitat loss, it is considered critically endangered and is protected by conservation programs. Historical and archaeological evidence indicates that *Abies nebrodensis* once had a wider distribution and cultural significance in Sicily. Protecting this critically endangered species requires urgent action to preserve its habitat, reduce human impact, and support restoration programs.

Key words: *Abies nebrodensis*; origin; characteristics; rare species.

INTRODUCTION

Sicily is the widest island in the Mediterranean and the biggest of Italian regions with a surface of 25,711 km² (Sferlazza *et al.* 2017).

Forests are predominantly found in the island's mountains and are mainly located within the Regional Natural Parks (Etna, Madonie, Nebrodi, Sicani and Alcantara). There are also wide surfaces covered by artificial forest populations formed by conifers and broadleaf trees. Sicily with its 274,454 hectares of forests is one the Italian regions with the lowest tree density coefficient, about 10.6%, and the total forest surface amounts to 512,121 hectares (considering also the other woody lands) (Hofmann *et al.* 2011).

Forests with sessile oaks (*Quercus petraea* (Matt.) Liebl) and downy oaks (*Quercus pubescens* Willd.) cover almost 85,000 hectares (about 17% of the regional forest surface), 6% of the overall forest surface is covered by Holm-oak forests and the Sicilian beech forests represents about 3% with an area of 15,964 hectares. There are also Chestnuts with about 11,500 hectares (2.3% of the regional forest surface).

A higher percentage is represented by pine forest with 105,460 hectares (21% of the total forest surface) from the sea level up to the higher mountain horizon involving: *Eucalyptus* ssp., Mediterranean conifers (e.g. *Pinus halepensis* Mill., *Pinus pinea* L., *Pinus pinaster* Ait., *Cupressus* species., *Cedrus* species.). The most used species found on the mountainous and sub-mountainous areas are the black pine and the Corsican pine, cedars, sometimes mixed with the Greek fir, Douglas fir and other mountain broadleaf trees (*Acer pseudoplatanus* L.) (Sferlazza *et al.* 2017).

Abies nebrodensis, commonly known as the Sicilian fir, is a rare and highly endangered conifer endemic to the Madonie Mountains of north-central Sicily. Once believed extinct, this species has garnered considerable scientific and conservation interest since its rediscovery in the mid-20th century. Characterized by its distinctive morphological features and ecological specificity, *A. nebrodensis* serves as a striking example of a relict species that has survived dramatic environmental and anthropogenic changes over the centuries. Its critically limited distribution, historical significance, and unique anatomical traits make it not only a priority for conservation but also a valuable subject for studies in biogeography, forest ecology, and Mediterranean biodiversity. This study explores the species' biological characteristics, ecological context, historical range, wood anatomy, and cultural uses, providing a comprehensive overview of the factors shaping its past, present, and potential future.

OBJECTIVE

The objective of this paper was to study the origin and some macroscopic characteristics of Sicilian fir (*Abies nebrodensis*, Lojac.) Mattei species, as well as its social and economic importance. The study emphasizes the species' historical background, morphological features, ecological role, and its contribution to biodiversity conservation, forestry, and environmental sustainability.

ECOLOGY OF THE SPECIES

A. nebrodensis is currently restricted to steep, arid mountain slopes at elevations ranging between 1,400 and 1,600m above sea level. These harsh, rocky environments further limit the potential for population growth and natural regeneration. The species is extremely rare, and its conservation status is cause for serious concern. As of 2017, the International Union for Conservation of Nature (IUCN) reported the existence of only 25 mature individuals in the wild, underscoring the species' critical vulnerability. With its reduced natural population, the Sicilian fir is the rarest conifer in Europe (Pasta *et al.* 2020).

Although reforestation and replanting initiatives have been implemented in recent decades, these efforts have yielded limited success. A major obstacle to effective recovery has been the ongoing pressure from local agricultural activities, including grazing and land-use competition from nearby farming communities, which compromise seedling survival and habitat integrity. In recognition of its dire conservation status, the IUCN has officially classified *A. nebrodensis* as "critically endangered". Moreover, the European Union has designated it as a "priority species" under Annex II of the Habitats Directive (92/43/EEC). This designation carries significant legal and environmental implications: if the areas where the species naturally occurs fall within any of the habitat types listed in Annex I of the same directive, those regions must be declared "Special Areas of Conservation" (SACs). This protective status mandates stricter management measures and long-term conservation planning aimed at preserving both the species and its fragile habitat. (IUCN Red List 2017).

GEOGRAPHICAL DISTRIBUTION

A. nebrodensis is an endemic conifer species with a highly restricted and fragmented distribution limited exclusively to the north-central region of Sicily, Italy. Specifically, it is found within the Madonie Mountains, a subrange of the Sicilian Apennines.

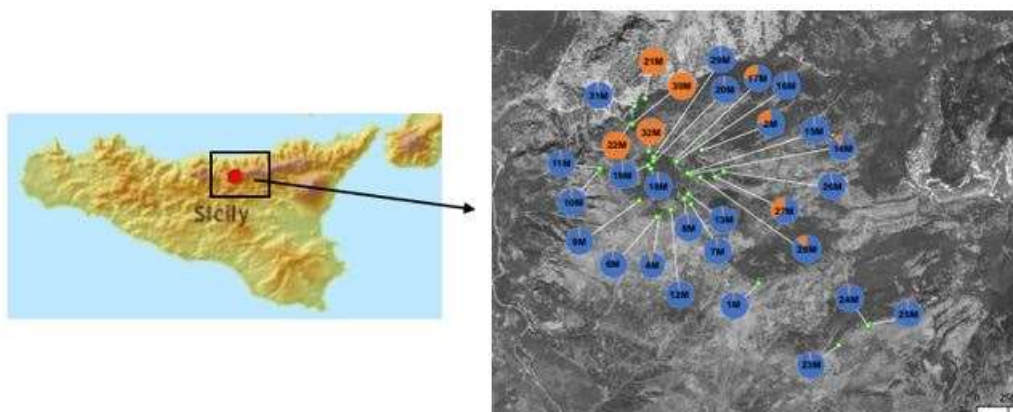


Fig. 1.

Geographical distribution (a) of the 30-adult trees from the unique population of the Sicilian fir (*A. nebrodensis*). The coloured piegraphs represent the membership probability of each individual (Source: del Valle *et al.* 2024).

The Sicilian fir was widespread across Sicily from the Paleogene to the Holocene (Tinner *et al.* 2016).

Despite historical speculation about its wider past presence, including possible occurrence in the Nebrodi Mountains, current data confirm that the species no longer grows there. According to the International Union for Conservation of Nature (IUCN) Red List, *A. nebrodensis* is now confined to a very limited area within the Madonie Mountains and is classified as CR-D in the Red List of Endangered Species (<https://top50.iucn-mpsg.org/species/1>).

The species is restricted to steep and relatively dry slopes situated between Vallone Madonna degli Angeli, Monte Scalone, Monte Pene, and Monte Cavallo. All of these locations fall within the administrative boundaries of the Municipality of Polizzi Generosa, reinforcing the extreme narrowness of its geographical range. The current population includes of 30 adult trees having a dispersed distribution, (Fig. 1) and 118 seedlings older than 5 years. This population occupies about 84 ha within the Madonie Natural Park in Sicily (Venturella *et al.* 1997).

This highly localized distribution underscores the precarious conservation status of the species, which is categorized as Critically Endangered. The ecological specificity and topographical isolation of these mountain slopes further limit opportunities for natural expansion or migration, making the conservation and management of the existing population particularly urgent (IUCN Red List, 2017).

HISTORICAL REFERENCES

The first proper mention of the *Abies nebrodensis*, was first recorded in an Italian university journal, Bollettino del R. Orto Botanico di Palermo (1908), in which the researcher G. E. Mattei describes the tree, highlighting that this species was already nearly extinct, and it was hard to locate living, intact examples in the Madonie mountains (Mattei 1908).

Pasta (2020), created a synthetical map of this species that compiles all known records of *Abies* in Sicily, based on a variety of data sources. While the study presents several notable findings, a significant advancement in laboratory techniques, specifically in distinguishing the pollen, wood, or DNA of *Abies alba* from that of *A. nebrodensis* was essential for refining the reconstruction of the historical distribution of Sicilian fir.

The analysis of ancient DNA is still underway and is expected to contribute further to this objective. Current reconstructions of vegetation history, based on pollen analysis, suggest that *Abies* was once more widely distributed across Sicily, including at lower elevations than where it is currently found, until around 1000-100 BC. A marked decline, followed by local extinctions, occurred on most of the island's mountain ranges from at least the early Middle Ages onward.

Although historical sources indicate that firs still grew on the slopes of Mount Etna during antiquity, they likely disappeared from that area prior to the 17th century. Severe deforestation driven by human consumption and agricultural expansion caused them to vanish from the volcano long before the 17th century. The presence of dialectal place names referring to Sicilian fir suggests that *A. nebrodensis* was once well known and probably still grew on the southern slopes of the Nebrodi Mountains and the summit of the Erei Mountains until a few centuries ago. In the Madonie range, the species likely approached near-extinction by the 18th century, if not earlier. The evidence supports the hypothesis that *A. nebrodensis* originally occupied a broader altitudinal range, spanning both the sub-Mediterranean vegetation zones, currently dominated by deciduous oaks at elevations between 900 and 1,200-1,300m, and the montane Mediterranean zones, now characterized by beech forests above 1,200-1,300m (Pasta *et al.* 2020). This perspective offers a more nuanced reconstruction of the species' historical distribution across Sicily's mountain ranges.

In 1980, a reported subfossil trunks of both species in the bogs of Pizzo Catarineci which provide key historical and ecological insights into the past distribution, confirming also the coexistence of these species in the Sicilian highlands. This finding holds considerable significance. First, it supports the case for introducing *A. nebrodensis* to additional sites in Sicily where the risk of genetic introgression from other *Abies* species is lower and where appropriate mesoclimatic conditions exist—an approach already proven successful with other relict species. Second, it suggests that cultivating Sicilian fir in other parts of Europe could be beneficial, as *A. nebrodensis* may complement other native conifers in efforts to mitigate the impacts of climate change on forestry, because these are highly adapted to drought and heat. Remarkably, it was not until 1957 that the species was rediscovered in the Madonie Mountains, where a small remnant population had survived in isolated, inaccessible locations, marking one of the most significant botanical rediscoveries in modern Italian conservation history (The top 50 Mediterranean island plants 2017). Actual natural range is in fact reduced to a single and small population located in the Madonie mountain, in Sicily (Italy); within the population only 29 adult trees are considered to belong to this species (Morandini *et al.* 1994).

More recently, a biostratigraphic and chronological reassessment of the site at Urgo di Pietra Giordano suggests that the previously reported dates for the wood remains were significantly overestimated—likely by about 5,000 years. The wood is now believed to date from approximately 5,000 to 4,000 years ago, rather than the originally suggested 10,000 years (Pasta *et al.* 2020).

GENERAL DESCRIPTION OF THE SPECIES

A. nebrodensis is a coniferous tree species characterized by a single, upright stem which, based on observations of cultivated specimens, can reach a height of at least 20m and a trunk diameter of up to 75cm (Fig. 2a). Mature individuals typically exhibit a broad, conical crown that contributes to their distinctive silhouette. The bark varies significantly with age: in younger trees, it is smooth and light grey, but as the tree matures, it transitions to an orange hue and becomes increasingly thick, rugged, and scaly in texture. The foliage consists of relatively short needles, ranging from 10 to 22mm in length and 2 to 3mm in width (Jasinska *et al.* 2016) (Fig. 2 b, c). These needles are laterally flattened in cross-section and show notable variation in apex, from rounded (obtuse) to slightly pointed (mucronulate). The needles are short, keeled and very rigid.

The needle scars on the twigs are smaller than those of *Abies alba*; they are circular and feature a distinct central umbo (Farjon 2010).



Fig. 2.

Abies nebrodensis at the Sir Harold Hillier Gardens, UK (29 September 2014).

Image © Jan De Langhe - Arboretum Wespelaar. a. tree; b. stiff branchlets; c. short leaves; d. cones in the Orto Botanico di Roma. Image John Grimshaw.

(Source: <https://www.treesandshrubsonline.org/articles/abies/abies-nebrodensis/>)

The needle upper surfaces are a dark green, while the undersides are distinctly striped in blue-green. Arranged in two rows on either side of the twig in a horizontal plane, the needles are evergreen and persist throughout the year. The reproductive structures are upright cones, typically 8 to 12cm in length, although in some cases they may reach up to 20cm when fully mature (Fig. 2d). These cones are composed of spirally arranged seed scales, which are slightly hairy toward their distal ends. Each seed scale is associated with a bract that features a small central projection, or tip. At the base of each scale, two light brown winged seeds are inserted, facilitating wind dispersal.

Morphologically, *A. nebrodensis* is closely related to the European silver fir (*Abies alba*), but can be distinguished by certain traits, notably its more resinous buds and comparatively shorter needles. Decussate branching and glabrescent young twigs are also specific characteristics that define the Sicilian fir (Venturella *et al.* 1997).

These subtle differences are important for taxonomic identification and have implications for understanding the species' evolutionary relationships and ecological adaptations. (Pasta *et al.* 2017).

The only microscopic description of the wood of *Abies nebrodensis* species was made by Arena (1959). The evaluation was carried out on samples from one tree found in a private garden in Palermo.

This author stands out as the only one to highlight specific anatomical features that may assist in distinguishing the wood of *Abies nebrodensis* from that of *Abies alba*.

Among the differences observed, the most significant included the length of the rays up to 87 cells in *A. nebrodensis* compared to a maximum of 45 in *Abies alba* and the tracheid length, which in *A. nebrodensis* reach 4,030µm in earlywood and 4,305µm in latewood, values exceeding those reported for *Abies alba* (2,246µm and 3,321µm, respectively).

Additional distinguishing features include the presence of crystals, which are abundant in the tracheids of *A. nebrodensis* but rare in those of *Abies alba*, and the occurrence of starch in the radial parenchyma, which is much more common in *A. nebrodensis*. Following their initial study, Biondi later confirmed the larger size of both tracheids and tall rays (multiseriate cells running perpendicular to the tracheids) in *A. nebrodensis*. (Bertollani *et al.* 1984).

APPLICATIONS OF THE WOOD

A significant insight into the historical use and possible past abundance of *A. nebrodensis* comes from the analysis of wooden artefacts in Sicilian cultural heritage sites. Romagnoli (2007), analysed 150 wood samples from the 12th-century AD wooden ceiling of the Palatine Chapel in Palermo, a UNESCO World Heritage Site.

The results revealed that approximately 69% of the samples could be identified as belonging to the genus *Abies*. More notably, based on distinctive anatomical characteristics, 35 of these fragments, accounting for 23% of the total, were attributed specifically to *A. nebrodensis*. This finding suggests that *A. nebrodensis* may have been more widespread and accessible during the medieval period than it is today. The presence of such a high proportion of *A. nebrodensis* in an important royal and religious structure also implies that the species held economic and symbolic value at the time, likely being harvested locally from now-depleted forested areas (Pasta *et al.* 2020).

Historical and archaeological evidence suggests that Sicilian fir (*A. nebrodensis*), once held both symbolic and practical significance in the cultural and economic life of ancient Sicily.

During the 8th to 5th centuries B.C., several Greek colonies located in northeastern Sicily minted coins bearing the unmistakable silhouette of a fir tree. This imagery is a strong indication of the tree's prominence in the landscape and its possible cultural importance during that period. In the centuries that followed, fir wood valued for its strength, durability and low density, was widely used in construction.

Notably, it was employed for making doors and roof beams in churches throughout northern and eastern Sicily, with this practice continuing up until the end of the Middle Ages. Such extensive utilization suggests that fir forests were once sufficiently widespread to support sustained harvesting. However, over time, a combination of human-induced and natural factors led to the dramatic decline of *A. nebrodensis*. Logging, land clearing for agriculture, and frequent fires, along with climatic fluctuations, altered the composition of forest ecosystems. These disturbances facilitated the expansion of more competitive deciduous species, such as European beech (*Fagus sylvatica*), oak species (*Quercus petraea*, and *Quercus cerris*), which increasingly outcompeted the fir in its native habitats. As a result of this prolonged ecological pressure, *A. nebrodensis* disappeared from public awareness and was presumed extinct for many decades (Pasta *et al.* 2017).

CONCLUSIONS

Sicilian fir (*Abies nebrodensis*), is a relict conifer species of exceptional ecological, historical, and cultural significance, now teetering on the brink of extinction. Once a widespread and economically valuable component of Sicilian Forest ecosystems, it has been reduced to a critically endangered remnant population confined to the harsh slopes of the Madonie Mountains. The species' distinct morphological features, restricted habitat range, and limited regenerative capacity highlight both its taxonomic uniqueness and ecological fragility. Historical records and archaeological evidence strongly suggest a broader past distribution and cultural importance, making its current status all the more poignant. While past reforestation efforts have met with limited success, new insights into its wood anatomy, paleoecology, and genetic distinctiveness offer hope for future conservation strategies. Preserving *A. nebrodensis* requires urgent, coordinated action to safeguard its remaining habitat, mitigate anthropogenic pressures, and explore assisted reintroduction in ecologically suitable areas. In doing so, we not only protect a singular species but also honor a deep botanical legacy rooted in the natural and cultural history of Sicily.

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