ANNALS of SILVICULTURAL RESEARCH

The pine forest of Linguaglossa on Mount Etna: an example of integration between local resource use and conservation of natural values

Journal:	*Annals of Silvicultural Research*
Manuscript ID	ASR-2024-0019.R3
Manuscript Type:	Research Paper
Date Submitted by the Author:	13-Dec-2025
Complete List of Authors:	La Mantia, Tommaso; University of Palermo, Agricultural, Food and Forest Sciences Cavallaro, Antonio; University of Palermo Russo, Irene; University of Palermo Bueno, Rafael; University of Palermo, Pividori, Mario; University of Padua, TESAF
Keywords:	Biodiversity, forestry, human and natural history

The pine forest of Linguaglossa on Mount Etna: An example of integration between local resource use and conservation of natural values

Tommaso La Mantia[1]*, Antonio Cavallaro[2], Irene Russo[3], Rafael Silveira Bueno[1], Mario Pividori[4]
[1] - Università degli Studi di Palermo, Dipartimento di Scienze Agrarie, Alimentari e Forestali
[2] - Via Manzoni, 59 - 95015 Linguaglossa (CT), Italy
[3] - Via Camillo Benso Conte di Cavour, 10 – 33028 Tolmezzo (UD), Italy
[4] - Università degli Studi di Padova, Dipartimento Territorio e Sistemi Agro-Forestali (TESAF)
*Corresponding author: rafael.dasilveirabueno@unipa.it

DOI: https://doi.org/10.12899/asr-2693

Abstract
One of the most important Sicilian forests for landscape and biodiversity is the Ragabo forest, located within the municipality of Linguaglossa in the northeastern part of Mount Etna. The tree species in this forest consists almost exclusively of Calabrian pine (*Pinus laricio* Poir. subsp. *calabrica* (Loud.) Cesca et Peruzzi). Due to the abandonment of economic activities over the last few decades, the forest is partially transforming into a mixed forest with broadleaf species such as beech and oaks. This is an example of how human societies and cultures have historically created habitats that are peculiar today and can be preserved only through the continuation of traditional local practices. In fact, although it is a habitat maintained by human activity, many animal species (birds and insects) are associated with it. This study traces a thousand-year history of tree planting for resin and wood extraction in Sicily and offers suggestions for the recovery and improvement of these important economic activities, resin extraction and wood use, while maintaining landscapes of high wildlife value.

Keywords: Biodiversity, forestry, human and natural history, tapping pine, wood use, Calabrian pine

Introduction

Forest communities native to the Mediterranean have been strongly modified by human action. On the other hand, as is often the case in the Mediterranean, where human influence is millennia-old, many agro-silvo-pastoral systems created throughout history are very rich in biodiversity and possess extraordinary landscape value (Blondel 2006, Blondel et al. 2010). However, in recent decades, many of these historical systems have been abandoned or have undergone processes of agricultural intensification leading to major changes in biodiversity, landscape configuration, and socio-economic balance (Geri et al. 2010, Sirami et al. 2010). Therefore, their conservation depends on the maintenance of traditional practices, as noted by Marull et al. (2015), who consider how new approaches to nature conservation recognize the ecological role of these Mediterranean cultural landscapes.

Attention to these systems dates back to the second half of the last century, for example, in England, Rackham initiated the census and study of "Ancient Woodland" (Rackham, 1980). Since the Ministerial Conference on the Protection of Forests in Europe (MCPFE) held in Vienna in 2003, the cultural, social, and historical values of forests have become references for sustainable forest management (Agnoletti et al. 2007). The “Globally Important Agricultural Heritage Systems” (GIAHS) program, launched in 2005 by the FAO, has reinforced the identification of the values of man-made landscapes, albeit primarily focused on agricultural rather than forest landscapes.

All of this has affected Italian forestry legislation, the 2018 framework law (TUFF - Testo unico in materia di foreste e filiere forestali) and the National Forest Strategy (the application tool of TUFF) continually refer to the historical, cultural, and social values of forests. In addition, Italy recently passed a law amendment to include “monumental forests,” as distinct from “monumental trees” and “old-growth forests” which are already protected by law. Many forest systems are the result of the action of modifying original forest formations and are now recognized in Italy as having an important historical and socio-economic value, such as cork oak forests, manna ash forests, chestnut forests,

etc. Their recognized value for biodiversity means that many of them are included among the habitats of the Natura 2000 network. However, there is a clear awareness of the role humans play in modifying and shaping new forest landscapes that are important for biodiversity, landscape, history, and cultural values (Agnoletti, Santoro, 2018). Their preservation depends on the conservation of their traditional productive functions, as recognized by the "National Forestry Strategy.".

A traditional activity in Italy that is no longer practised but has been rediscovered in other Mediterranean countries is resination, i.e., the incision of certain species of gymnosperms to obtain resin. Among these traditional practices, resin extraction or tapping involves cutting through the outer layers of a tree to collect its sap or resin.

Pine resin was used as early as the Roman period (Colombini et al. 2005), and particularly significant is the history of the resination of the forests of Calabria, which intersects with the events of the expansion of Rome, the Bruzi (or Brettii, a people who inhabited Calabria from the 4th century BC), and the Carthaginians. Various authors (Cicero, Strabo, Dionysius of Halicarnassus, Pliny) speak of the production of resin in that period, on which there is an extensive bibliography (see De Caro 1985; Rende 2020).

The resin, known as pitch, was used for many purposes, including food and medicine, and to make “Greek fire,” a primitive but effective incendiary bomb, but its most widespread use was for waterproofing barrels, and above all, ships (calafatage).

Pine resin is an important tree defense element and a source of terpenes (da Silva Rodrigues-Corrêa et al. 2013). It is considered a non-woody forest product and can be separated into two fractions: rosin, which is the solid fraction, and turpentine, which is the volatile one. Resin derivatives are today used by the pharmaceutical, cosmetic, and food industries. An important use is in the chemical industry for the production of paints, adhesives, insecticides, and disinfectants.

Since the middle of the last century, not only the collection of resin but also the use of pine wood in Etna's pine forests has ceased. Despite the lack of accurate descriptions of the socio-economic aspects related to the use of resin, all history texts regarding Mount Etna refer to this use and that of pine wood.

It should also be considered that the preservation of traditional practices, and thus the presence of humans on the land, is a valuable fire prevention method, following a Spanish proverb: “an abandoned resinous mountain is a mountain that will burn” (Santiago Michavila Puente-Villegas *in litteris*) (Damianidis et al. 2021).

Based on these considerations, the purpose of the present study was (1) to conduct an ethnographical investigation regarding the uses that led to the formation and conservation of the Linguaglossa Calabrian pine forest on Mount Etna, and (2) to evaluate the importance and opportunity of potentially reviving the cultural and economical practice of tapping and wood use in this forest.

Materials and Methods

Study Area

The Ragabo forest falls within the municipality of Linguaglossa (CT) (Fig. 1). The state-owned area covers about 1200 ha, in part with glades (open rocky areas) in the area of Piano Provenzana, composed of 460 ha of oak forest and 680 ha of pine forest in which the predominant species is *Pinus nigra*, which grows between 1000 and 2000 m a.s.l. on the northern slope of Mount Etna.

The shrub layer at higher elevations consists of *Juniperus communis* L. At lower elevations, pine is associated with chestnut (*Castanea sativa* Mill.) and deciduous or evergreen oaks (*Quercus* spp.). At the same time, at the upper limit, pines are associated with beech (*Fagus sylvatica* L.), aspen (*Populus tremula* L.), and Etna birch (*Betula pendula* Roth. var. *aetnensis* Raf.).

The area falls within Etna Regional Park and within an EU-protected Natura 2000 site (ITA070013 - Pineta di Linguaglossa). The pine forest grows over lava flows, and the continuous production of ash and lapilli creates optimal conditions for the presence of pine in the area.

Calabrian Pine

The Calabrian pine, according to some authors (Cesca and Peruzzi 2002), is considered taxonomically independent from *P. nigra*, and they name is *Pinus laricio* Poir. subsp. *calabrica* (Loud.) Cesca et Peruzzi. *Pinus laricio* is found in stands of high environmental and landscape value in Corsica, Calabria, Sicily, and Tuscany.
Etna pine grows up to 2300 m high in isolated stands. Its presence at altitudes typical of deciduous forests is due to the continuous eruptions that enhance its role as a pioneer species, along with human intervention that has favored the species (Fig. 2).
The trunk can reach up to 40-50 m in height, is particularly straight with average diameters ranging between 65 and 80 cm but may grow up to 100 cm. Pine stands are striking in their appearance, characterized by high densities, great heights, and rather small diameters when related to height (Giacobbe 1937).
The root system is very robust and capable of adapting even to rocky environments with little soil.
The wood of this species is characterized by a very extensive yellowish-white sapwood and a particularly resinous heartwood tending to dark red.
But the presence of resin is certainly the most interesting aspect from an economic and cultural point of view. From the harvested resin, thinners and paints can be produced. The resin is also used in the traditional medicine of Etna (Barbagallo et al. 2005).

The historical research on the use of resin and wood
The research was developed through two main directives: the historiographic one, in order to reconstruct the ancient production process, and the analysis of the current conditions of the Ragabo pine forest and potential ecological changes in the future.
The information was obtained from bibliographic sources, but above all by reading historical forestry and chemical journals. The main source of information was the historiographic documents retrieved from the historical archives of the municipality of Linguaglossa by one of the co-authors, A. Cavallaro.
In these documents, the name of the Lombardi Company operating in the pine forest in the 1950s was deduced. Interviews were conducted with those few people who came into contact, directly or indirectly, with such use of the forest. A meeting was also held with the current owner of the Lombardi company in Bientina, Pisa, where further historical information was retrieved.

Results

Ancient history between wood uses and resination

The use of the Calabrian pine wood of the Linguaglossa forest is mentioned by all authors who speak of the Ragabo forests, starting with the Greeks and Arabs (Pace 1958, see Sala et al. 2020 for a review). The Calabrian pine forests of Etna were in fact used by the colonies of Magna Graecia, from which logs were obtained for boat building but also "pitch" for waterproofing boat wooden hulls (Barreca et al. 2008). Such use was so intense that Scuderi (1828), citing Diodorus Siculus, already reports a decrease in pine forests at the time. With the Arab domination from the mid-9th century to the end of the 11th century, information about the forest and its uses became more detailed, and it is possible to infer that the name Ragabo is derived from the Arabic "Rahab," which would mean precisely forest (Crimi 1999). Throughout the centuries, the materials used to build houses in Etna's municipalities have mostly come from these forests (Barreca et al. 2008).

Ovid imagines that Ceres, in search of the kidnapped Proserpina, lit two splinters of deda (small portions of resinous wood used to quickly light fires) extracted from the Etna pines. The presence of the forest is the basis of the foundation of the village of Linguaglossa (Cavallaro 2019). The name of the town (Linguaglossa) is thought to derive from the mispronunciation of "Big tongue grossa," a

name given to these peoples because of the incomprehensibility of the language to locals. The father of Sicilian history, Tommaso Fazello, in his work "De Rebus Siculis Decades duae" of 1558, writes, describing “Lingua Grossa,” famous because of that forest, which make pitch (the resin in the past was called pitch). Filoteo degli Omodei (1591) described in detail the techniques of extracting from portions of wood (teda or deda). In the coming centuries, the techniques evolved, and resin was obtained by wounds or incisions involving the bark and the first woody rings.

This activity was initiated by peoples originating from northwestern Italy (Lombardians) who installed a considerable community in Sicily. In many municipalities, they still retain a dialect language other than Sicilian and are called "Lombard municipalities of Sicily." These peoples arrived following the Norman occupation of the Island (1061-1091), between the end of the 11th century and the beginning of the 13th, and responded to specific needs of demographic policy aimed at repopulating large areas of the interior emptied by the clashes between Arabs and Normans. Although called "Lombards," they came from different regions of Northern Italy (Emilia-Romagna, Lombardy, etc.) (Giacomarra 2015). There is proof of the existence of the town of Linguaglossa as early as 1145, as inferred from a privilege of King Ruggero II (Cavallaro 2010). Other authors have also written about resin extraction (Bembo 1496, Carrera 1636). The identification of the pine resin function of the Linguaglossa pine forest is further confirmed by the dialect name given to the species, *sapinus,* which derives from sapa or sap. Another potential origin would derive *sapinus* from the Gallic sap in addition to Pinus, hence *sappinus,* or resin-pine or pitch-pine. The expression *"zappino"* became part of legal jargon in 1822, when the Forestry Administration of Naples cited it to define how pine trees were cut (Fiorucci 2018).

As Cavallaro (2010) reports, in 1634 the Ragabo forest was at the center of an exceptional event: the liberation of the town from feudal rule. Since the beginning of the 17th century, the people of Linguaglossa demanded that the forest become collective property (Demanio) which was granted only after the payment of substantial compensation to the baron. The subjugation was stipulated on February 21, 1634, at the Notary Gregorio Comunale of Messina, and in the deed the "Bosco di Ragabo" was also mortgaged along with many other properties. The decision to use the forest as collateral confirms the importance it had for the town of Linguaglossa. In Linguaglossa the so-called “consuetudini” (i.e., the rules that governed daily life) were instituted, and therefore it is not unlikely that grazing and timbering rights had been granted since Norman times (1061-1198), as noted in the privilege of 1145 (Cavallaro 2010). As Cavallaro (2010, pp. 17) writes, "it was certainly the presence in the territory of the great Rahab forest that prompted the need for rules to be certain for the exploitation of such a delicious land....". Ferrara (1793) refers to the birth of the town of Linguaglossa "for the reason of that forest, where are the trees that make pitch.” Ferrara, however, from what he writes, seems to indicate a decline in resining in favor of timber production: "An immense forest covers all around the second Region or flanks of Etna ... has fed on its flanks vast woods, which have administered in every time matter for the construction of a great number of ships, vessels, and other considerable works," after which he adds, "Filoteo says that in his time black pitch was drawn from them; turpentine is now made from them, but in small quantities.".

The local economy was not based only on the agricultural development of the territory but was, above all, the exploitation of the forest, from which working trunks, resin and all its derivatives were obtained, but also fuel and grazing. Customary laws regulated grazing, acorn harvesting, and the use of the forest and its products. For centuries, this allowed for intense exploitation, which led to significant socio-economic development for the population that received the benefits. In 1819, with the promulgation of the new "Code for the Kingdom of the Two Sicilies," a comprehensive code of civil, criminal, and commercial laws, as well as Roman and Sicilian laws, and general and local customs, was established. Later, the customary laws regulating forest exploitation were replaced by the "Usi Civici," as they were approved on April 4, 1839. Scuderi (1828), in his "Treatise on the Woods of Etna," writes about the use of pine trees to make charcoal, boards, and "teda," but also notes that unregulated uses were damaging the forest. About its use as lumber, he writes, "The boards of the Wild Pine are less compact, less durable, and less susceptible to cleaning than those of fir but

are appropriately employed in more work ... and among others in the construction of our sea-woods.". About resin, he writes, "today it is no longer produced, perhaps because this indigenous product cannot hold a candle to the equal foreign product. But this is certainly a branch of industry that should be promoted, because not only could we extract pitch from our pine trees, but also all the other kinds, which are manipulated with their resinous juice, such as yellow resin, tar, turpentine, aqua di ragia, black smoke, and others: and these would preserve for the benefit of our labor producers a value of no small moment, even if they were limited to domestic consumption.". The pine forest was of special interest in terms of timber, as confirmed by the data reported in Cavallaro (2013). The inhabitants of Linguaglossa, as mentioned above, have always enjoyed the forest according to the right of civic use. However, the fire of 1838 made it necessary to limit civic use to reduce the damage to the forest to the following uses only: "(1) collecting dry wood; (2) cutting trees to make houses, presses ... by making application to the Mayor [...]; (3) To graze all species of animals from the sixth of December until the fourth of October ...; (4) To sow ...; (5) To take snow.".

The institution of civic use seemed to be able to assure the municipality, at least initially, to control and safeguard the state property and at the same time to obtain economic revenues. Based on a sort of ranking list, less well-off families were given the opportunity to take material from the forest free of charge; for the rest of the population, a decrease in the cost of timber equal to one-third of its value applied. The Forestry Authority was responsible for allocating plants and regulating their harvesting (Crimi, 1999). However, the harvesting of plants took place on an almost daily basis, thus leading to a progressive depletion of the forest in favor of only a few. It was not until 1909 that the city council of Linguaglossa approved the regulations for the exercise of the civic uses of timber and grazing in the Ragabo communal forest, reserving the right to suspend such use if the forest needed care for improvements or reconstitution. The wood was transported by archaic means with the use of oxen, and it was precisely to facilitate transport that a cable car was inaugurated on September 18, 1922 (Cavallaro 2013), desired by the then administration of Linguaglossa. This structure allowed the transport of 120 pine logs per day. The construction of the cable car proved to be a great detriment to municipal coffers. It also hardly ever worked, suffered several acts of vandalism, and was set on fire several times. For these reasons, as early as 1933, it was no longer used. In 1947, the first section of the Mareneve road was built, which was intended to enhance the Ragabo forest and which connected the Ragabo forest to the Linguaglossa train station.

Its construction was planned not on the already existing track on Etna's northern slope but on a completely new route. The results of this choice were to the detriment of the forest itself, which thus found itself fragmented, modified at the ecosystem level, and deprived of a good part of its biomass. To this day, the Mareneve slope remains the only link between Linguaglossa and Piano Provenzana, the well-known ski resort on northern Etna. Beginning in 1947, uses became more intense and occurred in ways aimed at creating an uneven-aged stand. Level cuts began to be practiced with the release of 50 to 60 plants per hectare. Such treatment was also preserved with the "Forest Management Plan for the Ragabo Forest of the Municipality of Linguaglossa" by Prof. De Gaudio (1951), as Di Benedetto et al. (1964) write, "properly prepared by the State Forestry Corps" and of ten-year duration (1951-1960). The plan took care to double the number of reserves per hectare but was effectively interrupted by the 1956 fire that destroyed 388 hectares of the forest. It is believed that the 1956 fire, of arson origin, was intended to conceal illegal cutting and, therefore, the immense damage that had been perpetrated against the forest in the previous decades. The fire destroyed a woody mass that should have produced over the next 10 years, effectively interrupting a first attempt at rational management. Starting in 1956, another form of treatment limited to only a few parcels was introduced, involving clear-cutting in groups with reserves. Cuts were between 1,000 and 2,000 square meters, and 50 reserves per hectare were released. The treatment was later extended to the entire forest.

Resination Activity in the Last Century

Resin production in Italy grew notably from the early 1900s, particularly during the Fascist period, sparking debates between Sicilian forester Andrea Giacobbe and Professor Francesco Carlo Palazzo,

a pioneer of forest chemistry (La Mantia 2021). Although resination activities in Etna date back centuries, they became systematically organized after 1911 (Palazzo 1923), gaining momentum after World War II when resin imports were disrupted (Megha 1950). The "industrial" use of resin from the Ragabo forest began around 1924 (Palazzo 1949).
Palazzo and Giorgi (1948) describe experiments on Etna and the establishment of distillation plants in Catania and on Etna itself (producing “Acquaragia di Pino Etneo”), while Crivellari (1958) discusses different resination techniques. Despite satisfactory results from the Giuseppe Lombardi Company of Lucca, transportation costs hampered profitability: resin was transported by jars from Linguaglossa to Giarre (CT) by truck or train, then shipped to Lucca.
Municipal resolutions from 1950 document the assignment of 50,000 Calabrian pines over four years to the Lombardi company. Trees selected for resining had to have a stem circumference of at least 100 cm, with a price of 16 lire per tree (1950 campaign). Resination practices used the American-German scraper system (Mazek method), involving two incisions converging at 45° toward a vertical groove, allowing resin to flow abundantly. Although the wounds often healed over time, typical "fishbone" scars (still visible today) mark trees that were tapped (see figures 3-8 for examples).
Resining operations included:

- Setting up base camps near selected trees
- Peeling bark
- Making incisions with scrapers and hatchets
- Attaching terracotta jars to collect resin
- Harvesting resin every 30 days (sometimes every 2–3 weeks during peak productivityThe

Lombardi company, initially a manufacturer of wine and oil crates, shifted after 1944 to resin and wood production, later expanding into soaps and solvents. Prof. Palazzo praised Lombardi as a model for the "healthy outlines of a resin industry," highlighting two critical factors for success: increased resin production per tree and improvements in product quality through advanced distillation techniques (Palazzo 1949). He also suggested intensifying resin extraction from trees destined for felling (dead resin technique).
However, by the late 20th century, resination activities had ceased in Sicily, accelerated by factors such as the high costs, competition, and a devastating forest fire in 1956.

Forest Management in the Ragabo Forest (1963–1972)
For the decade 1963–1972, the drafting of the forest management plan for the Ragabo forest was entrusted to Prof. Giuseppe Patrone, known as the father of forest management in Italy, following the initiative of the Municipal Administration of Linguaglossa and the Forestry Inspectorate of Catania (Patrone, 1964). Patrone's objectives were twofold: to increase forest productivity and to consolidate two crucial public functions—hydrogeological defense and landscape conservation. The Plan clearly reveals an emerging sensitivity toward aspects previously overlooked, introducing a new approach to forest management compared to earlier practices.
Patrone observed that Calabrian pine regenerated easily at upper elevations through both clear-cutting and hole-cutting methods. The choice between these options depended primarily on the area's aesthetic and recreational tourism value. Thus, above 1550 meters, clear-cutting was adopted with a reserve of 60 trees per hectare. Below 1550 meters, in tourist areas, pit or strip clear-cutting was employed (0.1–0.3 hectares), with some reserves also maintained.
Thinning was deemed necessary to regulate stand density, made feasible by the newly created rolling track. Studies accompanying the management plans (Cantiani 1964; Cascio 1964; Corona et al. 2009) helped define the dendrometric parameters and productivity of the pine forest. Although no specific research has yet addressed the wood characteristics of Etna pines, the close genetic and environmental similarity to Calabrian pines suggests their good quality, long recognized in historical uses. Moreover, investigations into cellulose quality (Palazzo & Palazzo, 1930) found the Etna pine's product comparable to that of Sila pines.
Although overall forest management is generally poor, the silvicultural practices of Etna's foresters employed sophisticated techniques such as the use of long ladders to access the highest parts of the

trees, cut side branches and obtain knotless trunks (La Mantia, unpublished). Until the mid-1990s, the Ragabo pine forest was the only one in Sicily classified as a selected forest for high-quality seed collection (Morandini & Magini 1975).

The Ecological Value of the Ragabo Forest

The superior quality of pine wood compared to other species (e.g., beech, oak) historically led to selective logging practices: broadleaf species were used as firewood, while pine wood was reserved for construction.

In 1959, Pirola and Zappalà wrote that parts of the pine forest likely arose from differential deforestation in mixed forests to gather firewood. Similar observations were made by Di Benedetto et al. (1964) and Mercurio & Spampinato (2008), who described how continuous, selective logging favored pine regeneration at the expense of broadleaves.

Selective logging, ongoing until the mid-20th century, created a human-driven ecological disclimax. Without human intervention, studies suggest that deciduous oak species would have prevailed due to their superior regeneration under canopy cover (Giacobbe 1937, Fig. 9).

Today, this unique habitat has high conservation value. Studies confirm the avifaunal richness of the forest (La Mantia et al. 2014, 2023; Barreca et al. 2010), hosting Sicily's only stable populations of the siskin and the crossbill —the latter of significant biogeographical importance (Massa et al., 2022)— as well as a high diversity of cerambycid beetles (Baviera et al. 2005).

Interestingly, positive interactions between resinated pine forests and biodiversity conservation have also been noted in Spain and Portugal (Soliño et al., 2018; Palma et al. 2016).

Finally, it is significant that the Ragabo (Linguaglossa) larch pine forest was among the 21 old-growth forests officially recognized by the Sicilian Region in November 2024.

Proposals for Restoring Resin Tapping and Wood Use

The rise in transportation costs and the general crisis in the forestry sector have made resin tapping increasingly less economically viable throughout Italy. As early as the 1970s, resin began to be imported from Greece, Portugal, and Spain. Nevertheless, in recent years, resin has found new applications, ranging from the pharmaceutical to the food industries.

A variety of products are now derived from resin, including thinners, household goods, depilatory waxes, and high- and low-voltage cables. Recently, the Lombardi company has initiated the production of *resin oil*, a blend of rosin, turpentine essence, and boiled linseed oil, which is utilized in manufacturing processes worldwide. However, the company currently imports already distilled resin from Vietnam and purchases Spanish turpentine essence for niche markets such as the do-it-yourself sector, incurring significant costs. Moreover, in some sectors, natural resins have been replaced by synthetic alternatives. As López-Álvarez et al. (2023) note: “In traditional producing countries (e.g., Spain, USA, France, Portugal), resin production continuously increased until approximately the 1980s, when the market was liberalised and practically monopolized by emerging producers in subtropical countries, dooming the production in traditional areas to practically disappear... The emergence of synthetic resins also contributed to the decline of resin tapping exploitations.”.

Despite these trends, several European projects have recently revitalized resin tapping activities (see Incredible Forests project). Furthermore, new market demands are emerging, driven by the need to substitute petroleum-based products with renewable bioproducts, with pine resin offering potential uses ranging from printer inks to jet fuels (López-Álvarez et al. 2023). Currently, Spain and Portugal are the European countries most actively engaged in relaunching the resin sector, focusing efforts on enhancing domestic production, including through genetic improvement programs for *Pinus pinaster* (García-Méijome et al. 2023; Palma et al. 2012).

However, evaluating the feasibility of restoring these activities relies not solely on the quantity of resin produced but rather on the multiple services that pine forests can simultaneously provide: tourism (linked to traditional activities), landscape conservation, economic benefits from diverse

product uses, and environmental services such as biodiversity preservation and maintaining a positive carbon balance through wood product usage.

Optimizing the production function is contingent upon establishing local extraction, distillation, and transformation chains to obtain turpentine and rosin. Community involvement is key, particularly where opportunities for ecotourism and broader forest engagement arise. However, the costs of establishing even a small resin distillation plant must be considered, particularly where transport expenses render raw resin processing uneconomical.

In Italy, the pursuit of a quality, certified product is essential. Certification of non-wood forest products (NWFP) requires adherence to specific principles, including:

1. Sustainable exploitation limits,
2. Development of a niche market to guarantee high product quality.

In this context, managing the Ragabo Forest according to integrated plans that promote resin production, or joint wood and resin production, becomes crucial. It would be both desirable and necessary to recover, revise, and adapt the management proposals developed by De Gaudio and Patrone for the Linguaglossa forest. Implementing these historic plans would enhance the Ragabo Forest's value, anchored by the prestige of their authors.

Importantly, revitalizing resin tapping in the Ragabo Forest would not exclude other uses. Activities such as pastoralism, timber harvesting, and recreation have historically coexisted with resin tapping (Di Benedetto et al. 1964), reflecting a model perfectly aligned with the current NWFP framework and alternative recreational markets.

An illustrative example is the cork industry, which has seen a remarkable resurgence, generating extensive ecotourism routes and promoting local cultures and economies around cork landscapes (La Riccia et al., 2023).

A similar model could be successfully applied in the Municipality of Linguaglossa, which already exhibits the necessary characteristics for tourism development and valorization of traditional forest practices. The economic implications could be substantial, as evidenced by experiences in the Sila National Park, where visitors can tour resin-engraved pine trees and learn about traditional tapping methods (see Il Sentiero della Pece).

Lastly, the critical role of historical processes in shaping habitats and landscapes should not be overlooked, as is often the case (Anderson 2006). Difficulties in obtaining precise historical data have limited a full reconstruction of resin tapping and wood use history in Linguaglossa. Nonetheless, future research—including the study of unpublished notarial documents—may illuminate how Europe's current biological and cultural diversity results from complex historical and ongoing environmental and land-use dynamics (Agnoletti and Emanueli, 2015).

Acknowledgements

Heartfelt thanks are extended to Luca Lombardi and Orsi Bruna (brand manager) for sharing valuable information on their family history and providing photographic materials. This historical research would not have been possible without the support of the staff of the Library of Agricultural, Food and Forestry Sciences (SAGFO), particularly Daniela Patti, and many Italian librarians.

Special thanks also to Sara Maltoni of the Office "Valorizzazione Filiere forestali e cooperazione internazionale della Regione Sardegna," responsible for the "Incredible project," for providing crucial information and facilitating contacts with Portuguese and Spanish colleagues—especially Santiago Michavila Puente-Villegas, who kindly introduced us to the proverb cited in the paper. The research was conducted within the studies on the distribution of the *Pinus* genus in Sicily, as part of the project *"Studio per l'implementazione delle specie per le quali è obbligatoria la raccolta di materiale di moltiplicazione"* ("Study for the implementation of species for which the collection of propagation material is mandatory"), funded by the *Dipartimento Regionale dello Sviluppo Rurale e Territoriale* of the *Assessorato Regionale dell'Agricoltura, dello Sviluppo Rurale e della Pesca Mediterranea – Regione Siciliana* under the *PSR Sicilia 2014–2020, Sottomisura 15.2*.

References

Agnoleti M. (Ed.), Anderson S., Johann E., Kulvik M., Kushlin A.V., Mayer P., Montiel Molina C., Parrotta J., Rotherham I.D and Saratsi E., 2007 - *Guidelines for the Implementation of Social and Cultural Values in Sustainable Forest Management. A Scientific Contribution to the Implementation of MCPFE - Vienna Resolution 3*. IUFRO Occasional Paper No. 19: 25 pp. ISSN 1024-414X.

Agnoletti M., Santoro A. 2018 - *Rural Landscape Planning and Forest Management in Tuscany (Italy)*. Forests 9 (8): 473 (17 pp.). https://doi.org/10.3390/f9080473.

Agnoletti M., Emanueli F. 2015 - *Biocultural Diversity and Landscape in Europe: Framing the Issue. In "Biocultural diversity in Europe*" (Agnoletti, M., Emanueli, F. ed.), SpringerVerlag, Environmental History 5: 1-1- 18 pp.

Anderson S. 2006 - *Land-use and landscape histories: the role of history in current environmental decision. In M. Agnoletti (Ed.),* The Conservation of cultural Landscapes (pp, 174-182). CAB International.

Barbagallo C., Meli R., Savoca F., Nicotra M. 2005 - *Indagine sugli usi popolari delle piante medicinali della Sicilia centro-orientale*. Boll. Accad. Gioenia Sci. nat. 37(364), (2004): 83-157.

Barreca L., Marziliano P.A., Menguzzato G., Scuderi A. 2010 - *Avifauna e struttura nella pineta Ragabo (Linguaglossa, CT)*. Forest@ 7: 223-233.

Barreca L., Coletta V., Gentile F., Marziliano P.A., Scuderi A. 2008 - *Struttura delle pinete di laricio dell'Etna: il caso della pineta Ragabo*. In O. Ciancio (Ed.), Atti del Terzo Congresso Nazionale di Selvicoltura per il Miglioramento e la conservazione dei boschi italiani. Taormina (ME) (pp. 16-19). Accademia Italiana di Scienze Forestali.

Baviera C., Bella S., Turrisi G.F. 2005 - *Acanthocinus aedilis (Linnaeus, 1758) nuovo per la fauna siciliana (Coleoptera Cerambycidae)*. Naturalista sicil. XXIX (1-2): 77-81.

Bembo P. 1496 - *De Aetna ad Angelum Chabrielem liber*. Impressum Venetiis: in aedibus Aldi Romani, mense februario 1495 [II.1496].

Blondel J. 2006 - *The 'design' of mediterranean landscapes: a millennial story of humans and ecological systems during the historic period.* Human Ecology 34: 713–729 DOI 10.1007/s10745-006-9030-4.

Blondel J., Aronson J., Bodiou J.-Y., Boeuf G. 2010 - *The Mediterranean Region: Biological Diversity in Space and Time*. Oxford University Press Inc., New York.

Cantiani M. 1964 - *Tavola alsometrica delle pinete di laricio dell'Etna.* L'Italia Forestale e Montana 19(3): 98-115.

Carrera P. 1636 - *Il Mongibello descritto in tre libri*. G. Rossi, Catania,

Cascio A. 1964 - *Tavola cormometrica del pino laricio dell'Etna*. L'Italia Forestale e Montana 19(3): 116-122.

Cavallaro, A. 2019 - *Io sono la porta del gregge*. Copyright Antonio Cavallaro Monti - Linguagrossa.

Cavallaro A. 2013 - *Sfruttamento del bosco Ragabo – Teleferica*. Copyright Antonio Cavallaro Monti - Linguagrossa.

Cavallaro A. 2010 - *Placet Domino: Consuetudini ed usi civici di Linguaglossa*. Copyright Antonio Cavallaro Monti - Linguagrossa.

Cesca G., Peruzzi L. 2002 - *Pinus laricio Poir. and P. leucodermis Antoine: karyotype analysis in Calabrian populations (Southern Italy)*. Caryologia 55(1): 21-25. DOI: 10.1080/00087114.2002.10589254.

Colombini M.P., Giachi G., Modugno F., Ribechini E. 2005 - *Characterisation of organic residues in pottery vessels of the Roman age from Antinoe (Egypt)*. Microchemical Journal 79: 83– 90.

Corona P., Cibella R., La Mantia T., Chiriacò M.V. 2009 - *Sistemi di tariffe di cubatura per le fustaie di pino d'Aleppo, pino laricio e pino domestico della Sicilia.* L'Italia Forestale e Montana 64(2): 121-1278.

Crimi V. 1999 - *"Rahab" Il bosco Ragabo di Linguaglossa*. Azienda Foreste Demaniali della Regione Siciliana. Arti Grafiche S. Pezzino – Palermo.

Crivellari D. 1958 - *Risultati di alcuni esperimenti sulla resinazione del Pino Laricio di Calabria*. L'Italia Forestale e Montana 13(3): 107-124.

Damianidis C., Santiago-Freijanes J.J., den Herder M., Burgess P., Mosquera-Losada M. R., Graves A., Papadopoulos A., Pisanelli A.. Camilli F., Rois-Dı´az M., Kay S., Palma J.H.N., Pantera A. 2021 - *Agroforestry as a sustainable land use option to reduce wildfires risk in European Mediterranean areas.* Agroforestry Systems 95: 919-929.

da Silva Rodrigues-Corrêa, K.C., de Lima J.C., Fett-Neto A.G. 2013 - *Oleoresins from Pine: Production and Industrial Uses.* In: Ramawat, K., Mérillon, JM. (eds) Natural Products. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-22144-6_175.

De Caro S. 1985 - *Anfore per la pece del Bruzio*, Klearchos XXVII: 21-32.

De Gaudio F.S. 1951 - *Piano di assestamento della foresta Ragabo periodo 1951-1960* (Unpublished).

Di Benedetto G., Poli E., Tomaselli R. 1964 - *Rinnovazione naturale nella pineta di Linguaglossa*. Annali Accademia Italiana di Scienze Forestali 13: 71-109.

Ferrara F. 1793 - *Storia generale dell'Etna: che comprende la Descrizione di questa Montagna.* Catania.

Filoteo degli Omodei A. 1591 - *Aetnae topographia*. Ristampa 1992 Sanfilippo D. Ed., Catania.

Fiorucci E. 2018 - *ll fitonimo zappino, etimologia e diffusione. Il caso dell'eteronimo di Fontegreca (CE*). Forest@ 15: 3-17 [online 2018-01-23].

García-Méijome A., Rozados Lorenzo M.J., Fernández Blanco E., Martínez Chamorro E., Gómez-García E. 2023 - *Resin-tapping production in* Pinus pinaster *Ait. stands in Galicia (NW Spain): effects of location, number of faces, wound width and production year.* Forests 14 (*128*): 1-13. https://doi.org/10.3390/f14010128

Geri F., Amici V., Rocchini D., 2010. *Human activity impact on the heterogeneity of a Mediterranean landscape.* Applied Geography 30: 370–379.

Giacobbe A. 1937 - *Ricerche ecologiche e tecniche sul* Pinus laricio *Poir e sul* Pinus austriaca *Hoess.* Istituto Poligrafico dello Stato, Libreria.

Giacomarra M. 2015 - *Il trattamento dell'identità in due minoranze storiche di Sicilia. In Studi in onore del prof. Francesco Altimari in occasione del 60° compleanno*. (A cura di Demiraj B., Mandalà M., Sinani S.): pp. 227-250.

La Mantia T. 2021 - *Andrea Giacobbe, un selvicoltore che merita di uscire dall'oblio.* Naturalista sicil. XLV (1-2): 189-224. DOI: https://doi.org/10.5281/zenodo.5713575.

La Mantia T. 2023 - *Il futuro del settore forestale in Sicilia tra funzioni ambientali, sociali ed economiche*. In T. Russo (Ed.) Verso un corretto sistema agroecologico siciliano: per il cibo "giusto", per le foreste e l'ambiente e per la qualità del lavoro. FLAI_CGIL Sicilia.

La Mantia T., Duca R. L., Massa B., Nocentini S., Rühl J. 2014 - *La biodiversità dei boschi siciliani. Parte I: l'avifauna*. L'Italia Forestale e Montana 69(3): 173-193.

La Riccia L., Assumma V., Bottero MC., Dell'Anna F., Voghera A. 2023 - *A Contingent Valuation-Based Method to Valuate Ecosystem Services for a Proactive Planning and Management of Cork Oak Forests in Sardinia (Italy).* Sustainability. 15(10):7986. https://doi.org/10.3390/su15107986

López-Á O., Zas R., Marey-Perez M. 2023 - *Resin tapping: A review of the main factors modulating pine resin yield.* Industrial Crops & Products 202, 117105.

Malquori A. 1949 - *Sopra l'olio essenziale della trementina di* Pinus pinea. In Le trementine italiane. Nuovo contributo alla conoscenza dei prodotti nazionali. III fascicolo. Firenze, Tip. Giuntina, pp. 107-118.

Marull J., Otero I., Stefanescu C., Tello E., Miralles M., Coll F., Pons M., Diana G.L. 2015 - *Exploring the links between forest transition and landscape changes in the Mediterranean. Does forest recovery really lead to better landscape quality?* Agroforestry Systems 89: 705-719.

Massa B., Canale E.D., Lo Verde G., Congi G., La Mantia T., Ientile R. 2022 - *Mediterranean Crossbills Loxia curvirostra sensu lato (Aves, Passeriformes): new data and directions for*

future research. Rivista Italiana di Ornitologia - Research in Ornithology 92(1): 41-60, DOI: 10.4081/rio.2022.574

Megha G. 1950 - *Prezzo di macchiatico della resina delle pinete silane (1945-1948)*. L'Italia Forestale e Montana 5 (1): 22-25.

Mercurio R., Spampinato G. 2008 - *Esperienze di monitoraggio nella riserva naturale integrale nel Parco dell'Etna (Monitoring in the strict natural reserve of the Mount Etna Park)*. Ediguida, Cava dei Tirreni, Salerno, 116 pp.

Meschini A., Longhi G. 1955 - *L'abete bianco sull'Appennino italiano. Atti del Congresso Nazionale di Selvicoltura per il miglioramento e la conservazione dei boschi italiani tenutosi a Firenze dal 14 al 18 marzo 1954* - Vol I – Relazioni (pp. 199-226).

Morandini R., Magini E. 1975 - *Il materiale forestale di propagazione in Italia*. Ministero Agricoltura e Foreste. Roma, Collana Verde, 34, 1-300.

Pace B. 1958 - *Arte e civiltà della Sicilia antica.* Volume I: I fattori etnici e sociali, Società editrice Dante Alighieri.

Palazzo F.C. 1923 - *Problemi e prospettive di un'industria resiniera in Italia*. In F.C. Palazzo (Ed.). Le trementine italiane, dieci anni di esperimenti in tema di resinazione (1936), Firenze, Tip. Giuntina (pp 67-77).

Palazzo F.C. 1949 - *Le trementine italiane. Nuovo contributo alla conoscenza dei prodotti nazionali*. III fascicolo. Firenze, Tip. Giuntina (pp. 94-108).

Palazzo F. C. 1951 - *I possibili orientamenti odierni dell'industria resiniera italiana*. L'Italia Forestale e Montana 6 (1): 6-14.

Palazzo F.C., Palazzo F. 1930 - *Produzione della cellulosa da materie prime siciliane*. Industrie Riunite Editoriali Siciliane, Palermo

Palazzo G., Giorgi E. 1948 - *Due nuove eccelllenti acque ragie nazionali dal pino d'Aleppo e dal pino laricio*. In F.C. Palazzo (Ed.) Le trementine italiane. Nuovo contributo alla conoscenza dei prodotti nazionali. II fascicolo. Firenze, Tip. Giuntina, pp. 94-108.

Palma A., Pereira J.M., Soares P. 2016 - *Short communication. Resin tapping activity as a contribution to the management of maritime pine forest.* Forest Systems 25 (2): eSC11. http://dx.doi.org/10.5424/fs/2016252-08925.

Palma A., Pestana M., Azevedo A. 2012 - *Pine resin sector in Portugal – weaknesses and challenges*. Forestry ideas 18 1(43): 10–18.

Patrone G. 1964 - *Piano di Assestamento dei boschi del Comune di Linguaglossa per il decennio 1963-1972*. Tip. B. Coppini.

Pirola A., Zappalà G. 1959 - *La foresta a Pinus laricio Poir. di Linguaglossa (Sicilia): osservazioni fitosociologiche.* Tip. G. Zuccarello & figli.

Rackham O. 1980 - *Ancient Woodland: its history, vegetation and uses in England*. Edward Arnold, London.

Rende P. 2020 - *La produzione di Pece e Deda nei boschi di Policastro.* Arsac Centro Divulgazione Agricola, 11: 1-35.

Sala G., Pasta S., Maggiore V., La Mantia T. 2020 - *Traditional use of wood in Sicily.* In: La Mantia T., Badalamenti E., Carapezza A., Lo Cascio P. & Troia A. Eds. - Life on islands. Biodiversity in Sicily and surrounding islands. Studies dedicated to Bruno Massa. Edizioni Danaus, Palermo. Pp. 407-439.

Scuderi S. 1828 - *Trattato dei boschi dell'Etna*. Dai Torchi della R. Università degli Studi. Catania.

Sirami C., Nespoulous A., Cheylan J-P., Marty P., Hvenegaard G.T., Geniez P., Schatz B., Martin J-L. 2010 - *Long-term anthropogenic and ecological dynamics of a Mediterraneanlandscape: Impacts on multiple taxa.* Landscape and Urban Planning 96: 214–223.

Soliño M., Yu T., Alía R., Auñón F., Bravo-Oviedo A., Chambel M.R., de Miguel J., Del Río M., Justes A., Martínez-Jauregui M., Montero G., Mutke S., Ruiz-Peinado R., García Del Barrio J.M. 2018 - *Resin-tapped pine forests in Spain: Ecological diversity and economic valuation*. Science of The Total Environment 625(1): 1146-1155.

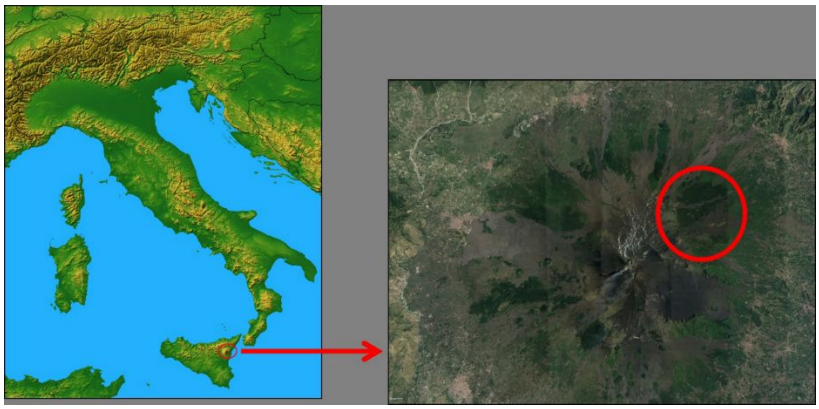

Figure 1 - Map of the study area. The resining area coincides with the Ragabo forest, falling within the municipality of Linguaglossa (CT).

Figure 2 - The trees of pine shows its pioneer capabilities on lava.

Figure 3 - The resin collected in terracotta jars.

Figure 4 - Company owner Giuseppe Lombardi (right) with Prof. Mazek (left), inventor of the Viennese planer (05/04/1950) (courtesy of Luca Lombardi).

Figure 5 - Although in most cases the resination wound was almost completely encompassed by the bark, one can still see the typical fishbone incisions inclined at about 45° to the axis of the tree, traceable to the Mazek method.

Figure 6 - Bark carving tools (scrapers).

Figure 7 - The pine tree has always been the symbolic tree of the Lombardi company.

Figure 8 - The photo of the last resin maker in the pine forest of Linguaglossa Salvatore Tornatore) (Photo A. Cavallaro).

Figure 9 - In the mature pine forest, deciduous oak grow under the pines and tends to replace them.