

The *Pinus pinea* L. woodlands along the coast of South-western Spain: data for a new geobotanical interpretation

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Abstract

The origin and natural range of the Stone pine (*Pinus pinea* L.) has been questioned for more than a century. In this work, we focus the investigation on one of the most important and controversial regions, viz., the Iberian Peninsula and, specifically, the Huelva and Cadiz populations in Andalusia, one of the most representative population cores. Although some authors maintain that it is an autochthonous Iberian species, most of them consider it to be exotic. From this idea, many works have been done and a syntaxonomic scheme has been created, which is accepted by the majority of the scientific community, not including *Pinus pinea*, nor its formations, since they are considered as man-induced forest crops. However, Stone has been present for several thousand years in the Iberian Peninsula and in the territory studied, as several paleobotanic and historical data show, proving that *Pinus pinea* is an autochthonous species of this region. This is a clear consequence to the field of geobotany, since – at least – the Stone pine woodlands from the Iberian Southeast must be considered as communities predominated by an autochthonous species that must be included in the syntaxonomical schemes.

Introduction

Distribution Area of Pinus pinea

The Stone pine (*Pinus pinea*) is a species that can be found around the Mediterranean basin. In this work, we focus the investigation on one of the most important and representative populations of the Iberian Peninsula, specifically the woodlands located along the coast of South-western Spain (Figure 1).

For a long time, questions concerning the origin and natural range of Stone pine have caused most the controversy among the scientific community dedicated to studying Mediterranean geobotany. Since the 19th century (Desfontaines 1799; Fraas 1876; Boissier 1884; Philippon 1895; Post 1889, 1896 in Feinbrun 1959; Laguna 1883, etc.) and throughout the 20th century, comments and manifold allusions to this

question have been made in different published works.

Most authors recognise the difficulty of drawing up its natural range, due to the management of this species by man for a long time (Ceballos and Ruiz de la Torre 1979; Quézel 1980; Costa Tenorio et al. (eds) 1997). Perhaps because of this difficulty we find a wide range of opinions in the references, more or less well presented, some of them complementary, but in many cases even radically opposed.

Some authors such as Rikli (1943, in Agrimi and Ciancio 1994), Feinbrun (1959), Critchfield and Little (1966), Fenaroli and Gambi (1976, in Agrimi and Ciancio 1994), Debazac (1977) and Agrimi and Ciancio (1994) state that the species is autochthonous all over the Mediterranean basin; on the other hand, other authors limit its natural range exclusively to the eastern Mediterranean and Asia Minor (Ceballos and Ruiz de la Torre 1979).

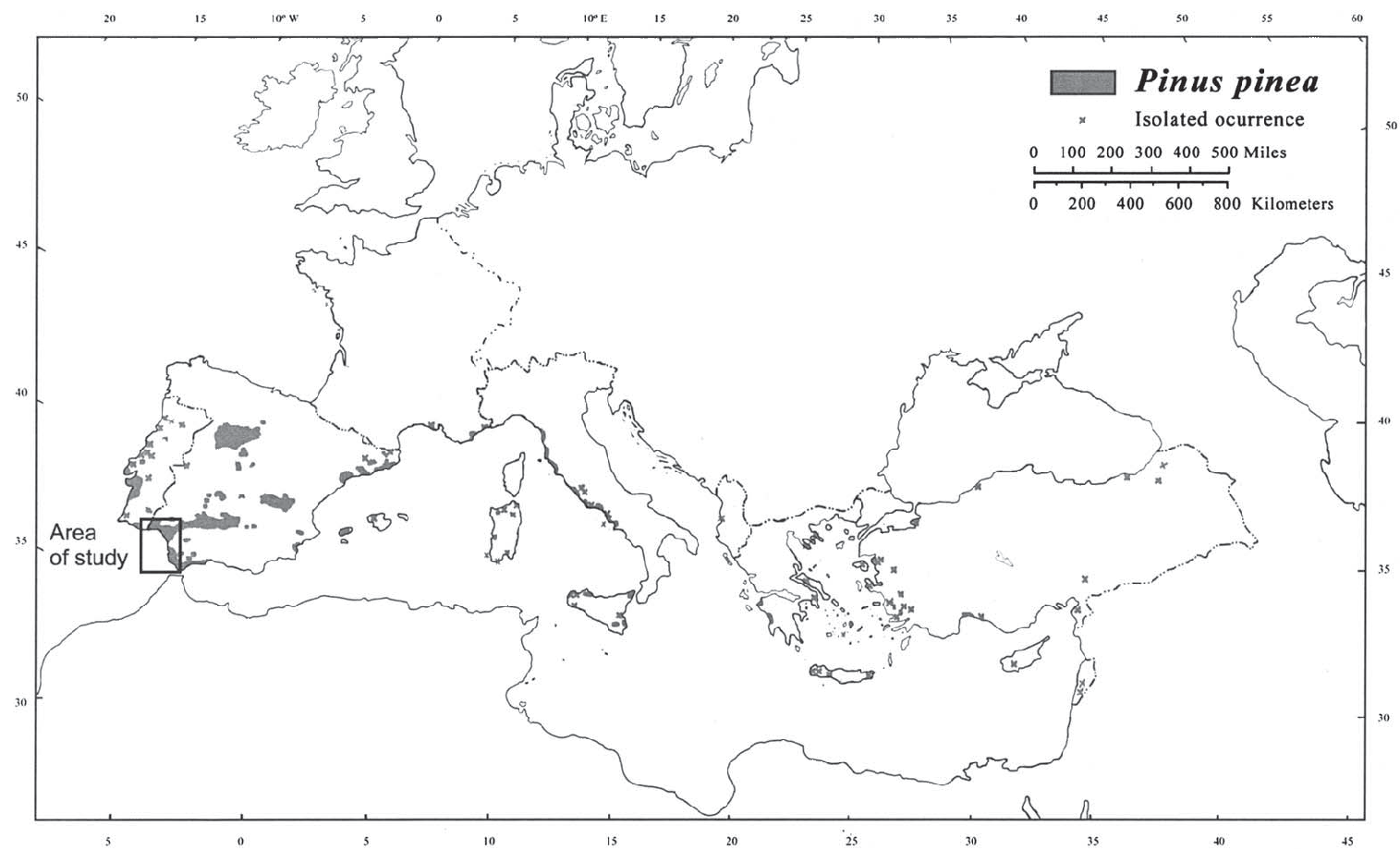


Figure 1. Current distribution map and location of area of study.

Yet other authors, such as Eig (1931, in Agrimi and Ciancio 1994) and later Rikli (1943, in Agrimi and Ciancio 1994), unit its natural range to the western Mediterranean, concretely, the Iberian Peninsula. Font i Quer (1954), González Bernáldez (1977), Quézel (1980) and Costa Tenorio et al. (eds.) (1997), among others, also consider the western Mediterranean forests to be wild. Rikli (*op. cit.*) even states that, except for or the Greek Peloponnese peninsula, it is a rare species in the western Mediterranean, where most of the forests were introduced a relatively short time ago. On the other hand, Feinbrun (1959) thinks that its origin is in Portugal, Spain, Corsica, the Italian Tyrrhenian coast, the Peloponnese peninsulas and the Asia Minor coasts.

Pinus pinea in the Mediterranean countries

On a more “local” or “regional” scale, this debate or whether Stone pine populations are wild or man-introduced has been reproduced intensively in many countries.

In the far western area of its range, the Turkey pine forests are probably the least controversial. Except for Rikli (1943, in Agrimi and Ciancio 1994), who doubts the wild character of some populations, most of the authors assume that they are natural or semi-natural populations. Firat (1943, in Agrimi and Ciancio 1994) designates as wild the pine woodlands from the Smyrna region, an opinion shared by Mirov in 1967 (in Agrimi and Ciancio 1994) for the pine woodlands located between Turkey and the former USSR, and by Walter (1968, in Agrimi and Ciancio 1994) for the coastal pine woodlands of the Adalia gulf (in front of Cyprus). Papaioanu (1954, in Konstantinidis 1995) thinks that the forests from Kalanema and Czak-Cai must be natural or semi-natural since, in his opinion, the Stone pine has not been cultivated in the eastern Mediterranean. Abi-Saleh et al. (1976) and Quézel (1980) and, more recently, Agrimi and Ciancio (1994) also accept the forests in Turkey as natural.

The island of Crete is another important point in this subject: Boissier 1884 (in Feinbrun 1959) does not consider *Pinus pinea* as wild, while Endlicher (in Agrimi and Ciancio 1994) shows a completely opposed idea when stating that it comes from this island. Rikli (1943, in Agrimi and Ciancio 1994) states that it is rare but wild in Crete (just as in Cyprus), while Pavari (1955, in Agrimi and Ciancio 1994) supports the idea that *Pinus pinea* definitely comes from Crete and Asia Minor.

The Stone pine woodlands in The Lebanon were considered by Post (1933, in Feinbrun 1959); Bouvarel (1950) and Berjaoni (1952) as being of man-induced origin, an idea refuted years later by Feinbrun (1959) with several data: historical, ecological, floristic, and the presence of Stone pine trees with ages around 500 years. Accordingly, he thinks the Stone pine communities must be considered as climax communities due to edaphic reasons (sandy and poor soils). Later Abi-Saleh et al. (1976) and Quézel (1980) in agreement with Feinbrun, also consider the Lebanese populations to be natural.

The Greek populations have also been a subject of discussion. Papaioanu (1935, in Konstantinidis 1995) thought that the Stone pine came from the island of Corfu (western Greece) and that the current small trees were the remains of ancient, vast pine forests. Konstantinidis (1995) says that, according to Landerer, it is autochthonous to the Ios and Naxos islands (two Cyclades islands in the Aegean), but Papaioanu affirms that these have an anthropic origin, coming from estate crops that have become naturalized. Later, other authors followed this idea: Reichinger (1943, in Konstantinidis 1995) maintains that the Aegean pine woodlands are the naturalized remains of crops, and Wreight (1972, in Konstantinidis 1995), by means of palynological data, verifies Stone pine presence in the Kaiafa region of western Greece, at least 2,300 years ago, in the 3rd century B.C., although he thinks they were probably planted by the Romans. Rikli (1943, in Agrimi and Ciancio 1994) and Feinbrun (1959) maintain that the Stone pine is autochthonous to the Peloponnese peninsula, an idea supported by Konstantinidis (1995) who thinks it has been in the East Mediterranean for several thousand years, even before man's existence, and that it is probably natural in Greece. Konstantinidis (1995) suggests that the Teofrastos descriptions (4th century B.C.) for the Peloponnese pine forests allude to *Pinus pinea* and make reference to the same areas where some populations of this species can be found today; this also coincides with the data obtained by Wreight (1972, in Konstantinidis 1995) in the Kaifa lake soundings. Furthermore, he states that, according to some linguists, the names of some islands allude to pine trees, and that, in the Atos (Chalkidiki) region there are some documents from the 3rd century A.D. proving the presence of pine woodlands. Several factors lead to the conclusion that the forests were made up of *Pinus pinea*. According to Papangelos (1972, in Konstantinidis 1995), these were pure Stone pine

woodlands that currently can be seen in Sithonia. Romanas (1989) also mentions the Sithonia pine woodlands, which he also reckons as having a natural origin, while suggesting saying that the presence of *Pinus pinea* in the Tripotamos and Vourvourou region was prior to the year 1,300 A.D. Finally, just as Feinbrun did with the Lebanon pine forests, Konstantinidis (1995) argues in favour of the natural origin of the Stone pine in Greece for ecological reasons such as its perfect adaptation to climate and soil in the areas where it is currently found.

The natural character of the Italian populations has also been widely discussed. Zodda (1903, 1905, in Agrimi and Ciancio 1994) using fossil remains from the Messina region (Sicily) considers it as natural; Pavari (1955, in Agrimi and Ciancio 1994) mentions natural Stone pine presence in Sicily, and Arrigoni (1967 in Agrimi and Ciancio 1994) maintains that the sole natural population in Sardinia can be found in the coastal dunes of Portixeddu-Buggerru, an idea assumed years later by Mossa (1990). Arrigoni also describes this pine forest as paraclimatic. Corti (1969), in addition, thinks that the Stone pine is autochthonous to Italy. However, some authors think the Stone pine was introduced into Italy by the Greeks in relation to their worship of the goddess Cibeles, or, as other authors point out, by the Etruscans (Zangheri 1936, Giacomini and Fenaroli 1958; Giacomini 1968, in Agrimi and Ciancio 1994). Subsequently, the Romans could have spread the cultivation over different areas, such as the coast, where it eventually became naturalized. Bernetti (1987, in Agrimi and Ciancio 1994) assumes the species was artificially introduced, and that in some places, such as the Tuscany coast, it was cultivated on big farms ever since the Roman era. He also believes the species became naturalized from these plantations, currently constituting wild substitution communities.

In the Fos-sur-Mer region in France, Triat (1975) found pollen from approximately 4,000 years ago which he ascribes to this species. Briquet (1910) and Dupias (1963) (in Agrimi and Ciancio 1994) mention pines on the southern coast which they consider wild. Perrin (1954) only considers as wild the populations from the Camargue, stating that most of the pine woodlands of the country have an artificial or semi-wild origin.

On the North African shores of the Mediterranean, no natural populations can be found from Israel to Morocco, a fact which, according to Boudy (1950, in Agrimi and Ciancio 1994) cannot be easily explained,

since the distribution area of the species is the western Mediterranean, and other Iberian species are to be found in the Maghreb. Some authors attribute this absence to human activities, and others to climatic reasons, such as an excessive xericity (Costa Tenorio et al. (eds) 1997).

The natural character of the Iberian Peninsula forests has been, and still is, widely discussed. The Iberian populations come to nearly 60% of the total land covered by the species all over the world. Most of these populations are located in Spain, where Prada et al. (1997) calculated nearly 175,679 ha, which gives an idea of the importance of the question addressed in this work.

Rikli (1943, in Agrimi and Ciancio 1994) in agreement with Eig (1931) affirmed that the most extensive natural Stone pine populations can be found on the Iberian Peninsula: for example, the populations in the Cadiz bay and at the mouth of the Guadalquivir river in Andalusia, in the Portuguese Algarve, and on the inner plateaus of Castile. Years later, some authors such as Font i Quer (1954), Feinbrun (1959), González Bernáldez (1977), Quézel (1980), Agrimi and Ciancio (1994), Costa Tenorio et al. (eds) (1997), Gil (1999), also considered this species as wild in the Iberian Peninsula, although they admit that man may have extended its range. Recently, Pérez, Galán and Cabezudo (1999), Martínez García (2000), Pérez et al (2001) also assume that *Pinus pinea* is an autochthonous species from the South-western part of the Iberian Peninsula.

However, the most widespread opinion throughout the second half of the 20th century, especially among Spanish authors, is that the *Pinus pinea* natural area is in the eastern Mediterranean, and that the populations in the central and western Mediterranean basin were introduced by man a long time ago (Ceballos and Ruiz de la Torre 1979).

The South-western Spain pine woodlands: a geobotanical interpretation

Rivas-Martínez, one of the botanists that boosted the idea of “artificiality” for pine forests, established this trend of opinion (Rivas-Martínez 1966), when writing that the potential theoretical climax of areas with pine woodlands “would be included in *Oleo-Quercetum suberis*” and that “the inner coastal areas, on sandy and rather stable soils, pseudogley podsollic sands, would have a climax vegetation made by forests with cork trees and wild olive trees”, rejecting

any possible influence the Stone pine might have upon the natural vegetation of the area. He goes on to say that “Man has destroyed most of these natural forests, planting instead pine trees (*Pinus pinea*)”. With this statement, one of the most characteristic communities of the plant scenery is relegated to the anthropic plantation designation.

From then on, the hypothesis of an original woodland (without pines) destroyed and substituted by Stone pine plantations, consolidates and stands as the assumed and unquestionable truth. It also constitutes the starting basis, afterwards used by many other authors that write geobotanical and phytosociological works on the area. In these publications they state that the area currently occupied by pine trees corresponds to Sabine and Juniper woodlands (according to the proximity to the sea), rejecting any possible function of the Stone pine in the vegetation series of the area.

Thus, García Novo et al. (1975) in spite of verifying that pines are integrated into the natural dynamics of moveable dunes, in their study about the Doñana dune ecosystems clearly differentiate between natural vegetation and Stone pine woodlands. They state that “the natural vegetation remains at the East of Torre la Higuera show that they were constituted by a Juniper (*Juniperus oxycedrus* L. ssp. *macrocarpa* (Sibth. and Sm.) Ball.) open forest and more on the inside, by the Sabine (*Juniperus phoenicea* L.) just reaching a certain distance (200 to 300 meters) from the beach, being predominant where sheltered by the dunes”.

Later, in a study about the vegetation in Doñana, Rivas-Martínez et al. (1980) insist on the idea of rejecting any influence of the Stone pine upon the vegetation series of the area. In this study, they assign two associations as the potential vegetation of the sand pits in the dune system: *Rhamno oleoidi-Juniperetum lyciae* Rivas-Martínez (1964) 1975 and *Rhamno oleoidi-Juniperetum macrocarpae*. Both from the *Juniperion lyciae* alliance Rivas-Martínez 1975 [currently *Juniperion turbinatae* Rivas-Martínez 1975 corr. Rivas-Martínez 1987], *Pistacio-Rhamnetalia alaterni* order, *Quercetea ilicis* class Br.-Bl. 1947. The first one is a psammophytic and xerophytic community mainly constituted by chamaephytes and shrubs, the Sabine, *Juniperus phoenicea* subsp. *lyciae* [currently *Juniperus phoenicea* subsp. *turbinata* (Amaral Franco 1986)] being the predominant species. This is the “mature stage of the coastal dune ecosystem, usually established out of reach of the salted sea wind”. It settles on sandy and acid soils,

where the water table is more than a meter and a half deep. The second association is a community quite similar to the first one, since it is a Sabine woodland with Juniper trees. It settles in the same kind of sandy soils, but nearer to the sea, being therefore influenced by the brackish sea effects.

In another work, Asensi and Díez Garretas (1987) assume this idea, as well as the syntaxonomic scheme made by Rivas-Martínez et al. (1980). The only difference is that they do not say anything about pine woodlands.

Summing up, and as a result of this line of thought, one of the most important Iberian Stone pine populations, such as those located near the southwest coast of Andalusia, in the Huelva and Cadiz provinces, does not appear in any of the associations from the vegetation series of this area (Rivas-Martínez 1966, 1987; Asensi and Díez Garretas 1987; [Rivas-Martínez et al. 1980](#)).

This has been – and probably still is – the most widespread opinion among the scientific community. However, as mentioned above, it does not have the unanimity of all the authors. In fact, a reference revision shows that some authors have supported the idea that, despite the existence of many man-induced forests, pine woodlands are a part of the natural plant patchwork of the area (González Bernáldez 1977; Monteagudo 1992; Morla 1996, Costa Tenorio et al. (eds) 1997). This interpretation had been advanced many years earlier by Font i Quer (1954) when stating that pines “are usually the trees that best grow” in coastal dunes, although he doubted the wild character of the sand pit forests in the Mediterranean coast, since he affirmed that they were profusely planted. He also stated that in some cases these reforestations took place “after a total destruction of former pine woodlands, probably wild in the area”. Finally Font i Quer affirmed that “it is very hard, for example, not to consider as autochthonous the pine woodlands in South Andalusia, from Cadiz to Huelva”.

Recently, Pérez, Galán and Cabezudo (1999) y Pérez et al. (2001) also consider *Pinus pinea* as a natural species in Andalusia but, unlike former authors, they give it a secondary role. In effect, while the first group speaks about pinewoods, which is to say, communities where *Pinus pinea* has a key-role that defines the vegetal community, Pérez, Galán and Cabezudo (1999) y Pérez et al. (2001) think that *Pinus pinea* is just another, although characteristic, species from the named “occidental coastal Sabine shrubs”, a dense shrub community dominated by xe-

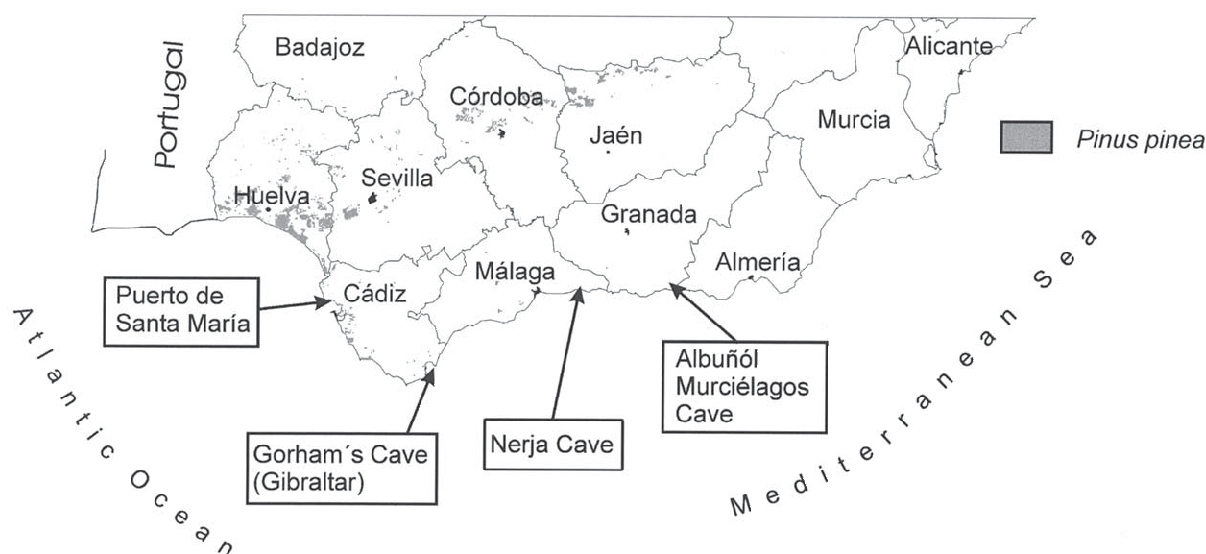


Figure 2. Location of archaeological data.

rophytic micro-Spermatophyta plants (*Juniperus turbinata* y *J. oxycedrus*) – belonging to *Osyrio quadripartitae* – *Juniperetum turbinatae* association (Rivas Martínez 1975) Rivas Martínez, T.E. Díaz, Fernández González and J.C. Costa 1990 [currently synonymous to the *Rhamno oleoidi* – *Juniperetum lyciae* association Rivas-Martínez (1964) 1975 previously mentioned].

Method

The solution to the previously raised controversy lies in a better understanding of the vegetation history. In this way during the last few years, a new way of study is helping to decide this discussion thanks to the use of data from other subjects such as History, Archaeology or, in particular, Palaeopalynology. Thanks to all these data a solid-based hypothesis could be established about the vegetation that has existed during the last millennia, the natural vegetal dynamics of the territory, the impact of the anthropozoogenic activities and future possible evolution.

As a working method for preparing this article we have carried out a bibliographic compilation of historical, archaeological and paleobiogeographical (mainly paleopalynological) data referring to the coastal pinewoods of the Spanish Southwest. The synthesis and analysis of an important and disperse data volume have permitted the assesment the idea

that *Pinus pinea* is an exotic species of the regional flora and that its formations have their origin in more or less old man-made reforestation.

Results and Discussion

Paleobiogeographical data

The data obtained from different archaeological sites show the presence of the Stone pine in different areas of the Iberian Peninsula during the Tardiglacial and throughout the Holocene (Figure 2).

In Gorham's Cave (Gibraltar), Metcalf (1958) found charcoal and pinecone pieces from *P. pinea* in layers that, according to Oakley (1958) correspond to the Pleistocene, specifically to the Mousterian and the Upper Palaeolithic eras. The oldest level datings were 49.200 ± 3.200 BP (Gil 1999).

Another important archaeological point in our study is the Nerja Cave (Malaga) where, in different studies, several authors have found pine remains that have been identified as coming from the Stone pine. Badal (1991) and Badal (1997, in Gil 1999) using ^{14}C dating, got a sequence out of Stone pinecones, kernels and charcoals from $18,420 \pm 530$ years B.P. (Upper Palaeolithic). Jordá et al. (1983, in López García 1988) also found acorns, kernels, and cereal remains in a late Neolithic layer (these remains were ^{14}C dated from 4,000 years B.C.). In 1987, in another

excavation campaign, the Jordá team found new evidence of Stone pine use during the Neolithic era: “plenty of bract remains from the Stone pine, used as heat source” (Sanchidrián et al. 1987). These data show that people inhabiting this cave (located 158 meters above sea level and 1 km. away from the sea) used the Stone pine as fuel as well as for food. Obviously, this species must have been in the neighbourhood of the cave, a fact corroborated by Guillén (1986) when studying the vegetation of the area. This author states that despite the “almost total lack of pollen grains in the different archaeological layers”, the presence of other remains prove the existence of Stone pine – among other species- in the neighbourhood, and goes on to say “the Stone pine, *Pinus pinea* L., was probably one of the most abundant trees during other eras, as vegetable remains from the first periods, in which the cave was occupied, back up”.

In the entrance dump of the Abunol Murciélagos Cave (Granada), López García (1980) found “some pine cone bracts (*Pinus pinea*), some kernels, and *Quercus* wood”. In another work, López García gives two datings obtained in this cave (7.440 ± 100 and 5.400 ± 80 B.P.), although there are doubts regarding the age of these remains.

Near Puerto de Santa María (Cadiz), at a site where the oldest layers date from the 7th century B.C., Chamorro (1991) found plenty of pine scales and kernel fragments, which he undoubtedly identified as coming from Stone pines.

All these data show that *Pinus pinea* is not an exotic species to the Iberian flora, since they give information about its presence during periods in which it seems hard to believe that people carried wood and kernels over long distances. As a consequence, the following question arises: what is the natural range of this species in the Iberian Peninsula? Although this is not an easy question to answer, in recent decades several archaeological, palynological and historical works have been published with information that can be of help when trying to clarify this question, at least broadly. For our purposes, the most valuable studies are probably those with pollen sequences acquired in peat site surveys, since they give an “image” of the vegetation evolution over a wide space of time.

Several of these studies have been done near the Huelva coast (Figure 3): El Asperillo (Caratini and Viguier 1973; Stevenson 1984); Laguna de Las Madres (Menéndez Amor and Florschütz 1964; Stevenson 1985) and El Acebrón (Stevenson and Moore 1988). The ages of the sites varies, but as a whole they

give information that covers the last 4-5 thousand years.

All of them verify, to a greater or lesser extent, the presence of *Pinus* along the layers. They also show the community evolution in a dynamic environment where, along with ecological factors, the anthropic activities also had a considerable influence.

The authors of these works agree when pointing out the presence of more or less open Stone pine woodlands when the deposits started to grow, with *Quercus* formations in some points, the presence of *Juniperus*, and hydrophyte and hygrophite communities. They verify several phases, alternating deforestation and forest recovering, although the general trend is the progressive decrease of forest areas. Deforestations are related to anthropic activities, as several data show: the increase of *Vitis* and fire indicators such as *Cistus* and coal layers, or ruderal species such as *Rumex*, *Plantago*, *Chenopodiaceae*, *Anthemis* and *Artemisia*. Meanwhile the increase of pollen values of wooden species, i.e., forest recovery, is related to a lack of or a decrease in perturbations.

Sometimes it has been said that *Juniperus* has taken over *Pinus* in stabilized dunes (Stevenson 1985). This is hard to assume if we bear in mind the diversity of ecological niches that have survived over the last thousand years, and especially, the competitiveness and ecological requirements of every taxon: *Pinus* (probably *P. pinea*) versus *Juniperus* (Sabine and Juniper with almost complete certainty). The combination of ecological factors in the Huelva coastal sand pits – predominance of sands, and accordingly, the water table depth, dune dynamics, etc. – allows several species such as *Pinus pinea*, *Juniperus oxycedrus*, *Juniperus phoenicea* and *Quercus suber* to find enclaves to settle, making up a plant scenery mosaic (Costa Tenorio et al. (eds) 1997).

Finally, an increase in the amount of *Pinus* remains, and the appearance of an exotic taxon, the eucalyptus (*Eucalyptus* sp.) can be observed in the upper layers of some surveys, such as the ones made at “Laguna de las Madres” (Stevenson 1985) and “El Acebrón” (Stevenson and Moore 1988). Through several information sources it has been possible to know that this species was introduced and cultivated at the end of the 19th century and the beginning of the 20th century. This has been useful to date the most recent increase of *Pinus* values in the area, which is verified from those years on. Additionally, this increase coincides with the abundant existing histori-

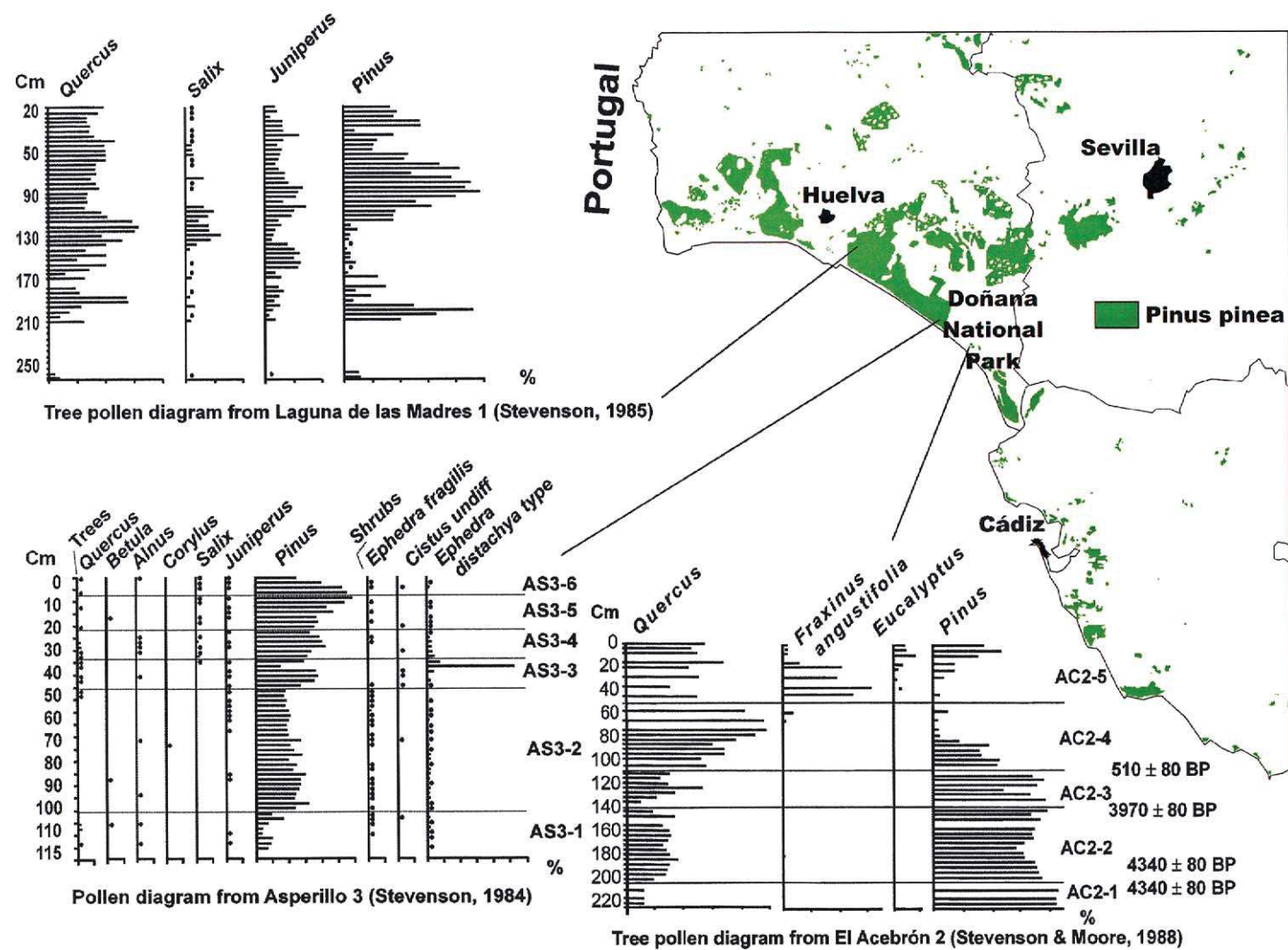


Figure 3. Curves and pollen site location.

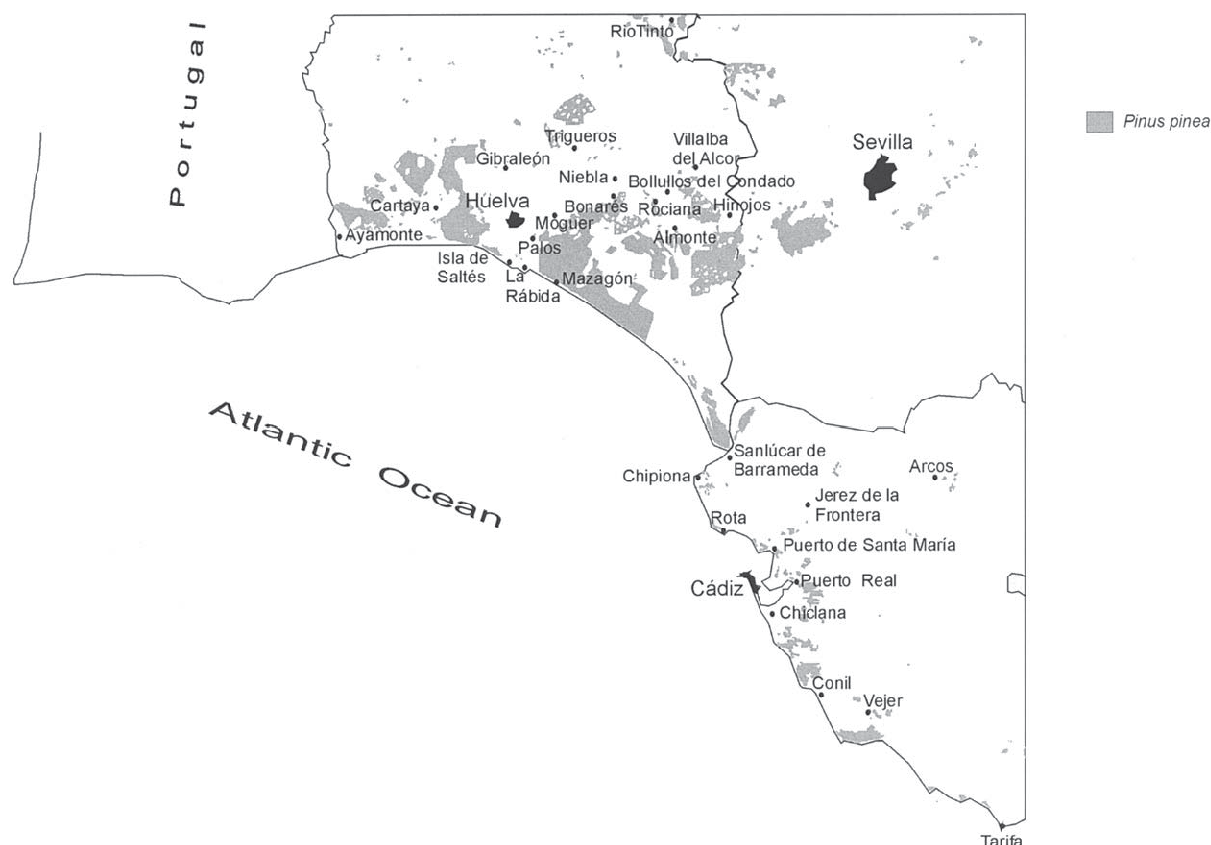


Figure 4. Location of historical data.

cal information on reforestation activities, as can be seen in the “Historical Data” section below.

Paleopalynological works mention curves for *Pinus*¹, *Quercus* (sometimes differentiating between deciduous and evergreen) *Juniperus*, etc. but never for the concrete species, due to the difficult task of identifying the species through pollen grains.

As with other genera, this uncertainty can be solved through an autoecology analysis for each of the species, and studying the ecological environment during the last thousand years.

Stevenson (1984) thinks that, in this area and throughout the Holocene era (from at least 13,000 years ago), there has been a truly xero-thermic climate, with coastal dunes, which has been very favourable for the autoecology of the species, as was

defined by Ceballos et al. (1966)². This is why several authors such as Morla (1996) state that the data from these surveys can be attributed to *Pinus pinea*, due to the integration of the species in the ecosystem and in the natural dynamics of the land, and because it is the only species that significantly appears in the area. Prada et al. (1997) agree with this idea and affirm that Stone pine presence “would at least be linked to soils similar to those where the species is settled nowadays, basically in those areas where the species usually did not grow or where it did not dominate more demanding species such as *Quercus*”.

Historical data

There are plenty of historical or archaeological references related to the Stone pine (its products and uses) in the southwest of Andalusia, although the further we

¹Caratini and Viguier (1973) faced with this uncertainty, talk about “*Pinus halepensis*, *Pinus pinea*” percentages.

²Ceballos et al. (1966) define *Pinus pinea* as a heliophyllous, xerophyllous and relatively thermophyllous species, that prefers soils that are siliceous, sandy, loose and deep.

go back in time, the less references we find. Many of these references belong to localities where today we can still find stands of this species or from close zones (Figure 4). Besides the archaeological sites mentioned above, we have some references from the Tartessus era, the Romans, the Muslim period, the Reconquest, and especially, from the end of this era until today.

Pre-Roman period

Martín de la Cruz (1985) studied a Neolithic-Calcolithic site from the Papa Uvas village (Huelva) dated by ¹⁴C as from 2,160 B.C. When reconstructing the vegetation landscape around the village, as well as its evolution, he describes, from his own deductions and on the basis of the works done by Menéndez Amor and Florschütz (1964) and Caratini and Viguié (1973), the presence of pine woodlands, among other formations.

Some of the works state that during the Tartessus period in the 8th century B.C., an intense agriculture and metallurgy was developed in the low Guadalquivir, in population cores such as Almonte, Huelva, Niebla, Trigueros, etc. (Figure 4) (Ruiz Mata and Fernández Jurado 1986, in Martínez Montes 1999). Besides, according to Martínez Montes (1999), during this period “there was a considerable dense Phoenician population in the coastal line, since the 8th century B.C.”. All this economic activity produced a demographic increase that, together with agricultural, livestock and mining activities (Gil 1999 cites the use of pine tree wood for constructing mining wheels in the Huelva mines), had as a consequence an important deforestation that manifests in some pollen profiles.

Not only agriculture, but also livestock, hunting and wild fruit harvesting have been a food source for primitive populations, a fact that gives some valuable information: in the “Castillo de Doña Blanca” Phoenician site, next to Puerto de Santa María (Cadiz), Chamorro (1991) found Stone pine trees from the 7th century B.C.

Period of Roman domination

More references bearing witness to pine forest presence are obtained from other Stone pine products: wood, resin, pitch and raw materials traditionally appreciated and demanded. Some information from the Roman domination period (from the 3rd century B.C. to the 5th century A.D.) reflects this fact.

Gil (1999) outlines shipbuilding, which required a great amount of wood and a constant provisioning

due to the short life of the ships. Also necessary was wood for barrels and casks, resin for sails and ropes, as well as tar and pitch, “products widely used, especially for ship caulking”. This was already evidenced by Estrabón (1st century B.C.) in his *Geografía* (Meana y Piñero 1992, in Gil 1999; Blázquez 1986a) who wrote “Turdetans used to export pitch” and “the shipyards in Turdetania³ worked with wood from their own country”. Martínez Ruiz (1999) stresses the extraction of pitch. He takes some quotations from the map made by Lombard (1959), representing two production areas in the Huelva/Algarve coastal pine forests, where resin-derived products, such as pitch, were obtained. He also mentions the presence of pine formations in La Rábida.

This sort of exploitation meant a strong pressure on forests, the coastal ones being the worst affected, according to Gil (1999): “Hispania, pitch and ship producer, lost its coastal pine forest quite fast”. This must be added to the mining, livestock and agriculture development, whose wealth during Roman Hispania was outlined by several geographers. One of the regions usually mentioned by them is Andalusia: the Guadalquivir valley and the current province of Cadiz. In several areas, such as the Jerez and *Gades* region, wine was one of the main products that, due to its high quality, was exported to Rome in jars sealed with common pine resin (Blázquez 1986b).

This agricultural and forest wealth in Hispania is shown in the emblems and carvings of city-made coins. One of the cities, Olont in the province of Huelva – although the exact location is unknown – minted coins with pinecones at the end of the Republic and during the Augustus period (1st and 2nd centuries B.C.) (Blázquez 1986b).

Period of Muslim domination

Abellán (1996) compiles a series of texts from the Muslim domination period in Cadiz, one of them making reference to the city: “province of al-Andalus, at a certain distance from Italic, one of the Seville cities. Twelve miles is the length of this peninsula, from South to North, the maximum width being one mile. It is covered by rich vegetation crops. The livestock is mainly composed of goat herds. Pines and brooms grow in the wooded part of the peninsula”

³According to Blázquez (1986), Turdetania was, as Estrabón said, the old Tartessus territory whose borders stretched south of the Guadiana River as far as the Andalusian coast.

(text from 1327 of Al-Himyari: *Kitab ar-Rawd al-Mi'tar*, 290-298).

Another Al-Himyari quotation that mentions pine woodlands can be found in Bazzana and Cressier (1989). Al-Himyari, based on texts from the 12th century geographer Al-Idrisi, describes the Saltes island in the Odiel estuary (Huelva): "...this island has the most beautiful kind of pine tree, evergreen pastures and fresh water springs...". Bazzana and Cressier (1989) affirm that, as pointed out by the Arab authors, from approximately the 10th to 12th centuries, this island was a rich place where several agricultural products could be exploited, as well as pastures for livestock and pinewood. He also mentions the presence of pine trees in the 13th century after the Reconquest.

More references about the presence of pines during the Upper Middle Ages can be found in the study made by Lirola Delgado (1993) about the Omeya Caliphate fleet. This study compiles information from Muslim geographers that lived during the 10th and subsequent centuries. It talks about the al-Andalus shipyards and the areas producing raw materials for fleet construction, such as wood and pitch. The study highlights the works made by Lombard, who locates the great timber areas in the Mediterranean area during the Upper Middle Ages, citing among them the South of Portugal, particularly "the Algarve pine forests" that supplied the Silves and Santa María del Algarve arsenals. Two islands from the latter are mentioned, stating that they must be the "dos Cães" islands "where pines used to grow". More shipyards were located in Seville, Algeciras, Cadiz, and the Saltes Island.

From the Reconquest to 17th century

Information from the 14th to the 16th centuries has been obtained through the municipal bylaws from Puerto de Santa María (scarce during the 14th and 15th centuries) and Chipiona (Cadiz) (Franco Silva 1998).

In 1399 Pedro de León Ponce, fifth lord of Marchena, founded the "Nuestra Señora de Regla" convent (Near Sanlúcar de Barrameda), where he donated, among other things, a pine forest with an area of 80 "aranzadas" (land-measure, primarily for non-arable land; about 71 acres: "*the pine forest in question was in the Salinera woods, which reaches the Laguna Grande site, adjoining the road from Chipiona to Rota*").

Other mentions of pine woodlands are the following: "*the founder gave the convent all the land adjoining the road from Rota to the pine woodlands...*"

"*The rural possessions accumulated by the monastery during the 15th century were in the Puerto de Santa María, Sanlúcar de Barrameda, Rota and Chipiona territories. Most of these manors were cereal lands, pine woodlands, vineyards, and some olive groves*"

"*During these two centuries (...), the community bought 10 aranzadas of land and pine woodland*" among other properties.

Also from the 14th century we have some references to the Gibráleon (Huelva) pine forests. "*El pinal e la barca de Rodrigo Alfonso*" (ancient quote in old Castilian which literally means "Rodrigo Alfonso's pine woodlands and ship") in 1379-1380 provided an income of 1,000 maravedies (Spanish copper coin); Bazzana and Cressier (1989) and Alejano and Martínez Montes (1997) mention a document dated December 14th, 1380, according to which the Medinaceli countess took possession of the Saltes island, and pine cuttings were made "*luego el dicho Ioan Alfonso con omes bonos con algunos e escribano fue a la Ysla e entró e tomó..... e cortó pinos como de cosa de los dichos señores*" (ancient quote in old Castilian that literally means "Then, the mentioned Ioan Alfonso with good men, with some?, and a notary went to the island and entered and seized..... and cut pines..."). Near these pine forests, between the Moguer and Palos territories, González Gómez (1977) (in Alejano and Martínez Montes 1997) informs about the existence of more pine forests, and "*a huge pine tree will be the reference for the boundary markings*".

For the Sanlúcar de Barrameda pine woodlands, there are references from the 15th century (Solano 1972) and from the beginning of the 16th century (1504) in Ladero Quesada and Galán Parra (1984).

The 18th century

The increasing and continuous anthropic pressure upon the natural environment leads to forest overexploitation in the 17th century (Urteaga 1987). This is the reason why, in some power circles, a big concern for forest recovery arises when a raw material as important in this period as wood becomes scarce. In this historical context, the reforestation policy put into practice by the Marquis de la Ensenada and his predecessors must be understood, although, as can be seen below, it would be more precise to say the re-

forestation attempts, since the actions they proposed were in general limited.

A pause should be made to study this period, analysing in more detail the published data because they are especially relevant for this work, since they contain the only historical data referring to old reforestations. These reforestations are exclusively circumscribed to the current Doñana National Park area, where certain works made by Granados Corona and other authors (Granados Corona et al. 1983; Granados Corona et al. 1984 and Granados Corona 1987) date the Stone pine origins halfway through the 13th century. Granados Corona et al. (1984) say that “the Marismillas pine forest plantation dates from 1737 (L-3620); preceding attempts failed, mainly due to pressure of livestock farming.”

This information is basic because many of the authors that defend the idea that the Stone pine is exotic to the Doñana flora back up this data. They state that, from this date on, *Pinus pinea* spread out while new reforestation was being done, reaching the current situation. Granados Corona et al. (1984) say that “the Marismillas pine forest development, from its start until today, has followed an increasing process of great dimensions that has speeded up from approximately a century ago”. In another paragraph, they state “in 1737 the pine woodland had 12 ha, in 1738 covered 44.7 ha, and grew to 67.5 ha by 1739. There is a lot of information about the exploitation benefits and monitoring during 1770, a year in which the pine woodland had an area of 336 ha (L-705)”.

Ojeda Rivera (1987) in his historical study about Doñana and Almonte accepts the ideas proposed by Granados Corona and his co-workers, although certain contradictory information can be found in his book. For example, he quotes the “*Aprovechamientos de tierras eclesiásticas. Su significación en el conjunto de la superficie cultivada municipal*” from the Ensenada Cadastre (1752), where 295 “fanegas” (ancient land measure: the amount of land required to produce one ‘fanega’, i.e., 55.5 litres, of wheat, equivalent to 64 ares, or 6,400 square metres) of pine woodland are registered that, as he states, cover “the cultivated area plus the area planted with pine trees”, although he does not state on what he bases this consumption that those pine forests were planted.

In another paragraph, Ojeda Rivera talks about the land dimensions and about measurement inaccuracy on “pieces of land”, “fragments of land” or “pieces of pine woodland” in several inventories made in the 18th century. Among them, he outlines the “*Inventario*

de Pinares y compras de tierras para agrandar dehesas de los propios de esta villa” from 1740. In another quote from a 1755 dossier, local boundaries are fixed in pastures, lands and “council-owned pine forests”.

In the section “*The greater owners*” Ojeda Rivera cites pine woodlands (according to the de Cruz de Fuentes, 1908 texts) belonging to the Santa María de Gracia Hospital and the Ermita brotherhood: “this brotherhood, founded in 1497 (...) was the richest in Almonte (...). The protocols book dated in 1730 (...), records all its properties (that are not very different from those registered in the corresponding Ensenada Cadastre volume): 7 pine woodland fanegas...”. Another brotherhood also had pine forests: The de la Sangre de Cristo Chapel “belonging to the so-called brotherhood, established in 1549. Its land protocol started in 1695 (A. H. Huelva), it has 65 seats and produces an annual income of 1,232 reales, 19 maravedies, distributed... and 8 r. and 22 m. on pine woodland. It also had 68 fanegas of deforested land and 36 of unproductive pine woodland...”

In a table made by the same author, he details the “*Composition of the agricultural ownerships belonging to the greatest landowner and the annual profit and gross production estimation*” according to the Almonte information from 1751. He mentions 18 pine forest fanegas that only produce 810 reales, being all net profits, that is, he does not have any production expenses. According to this information, the profits from the pine woodlands do not seem insignificant.

Another of the most relevant data from Ojeda Rivera (1987) can be obtained from the “*Noticias de los bienes de propios*”, from the mid-18th century (1740, 1758, 1761 and 1762). These documents – similar to notarial lists – give information about the origin and composition of council properties: at least from 1538 to 1752, the Villa de Almonte Council was carrying out a series of land purchases and exchanges aimed to swell its properties. The notaries that wrote them supposed – but could not prove – that, prior to 1538, the Council owned the main number of pastures, which were considered as its own. This is why we know that in several “spots” (Valdeconejos and Tur-nal Pasture) of the Almonte territory, near Doñana, there were pines on several farms: one had 30 fanegas, another 3, and three of them had 12 fanegas each, in 1674, 1725 y 1727 respectively. These dates are prior to 1736-38, “date of the pine introduction in Doñana” according to Granados Corona et al. (1984) and Ojeda Rivera (1987).

In addition to these data, the Stone pine woodland presence before 1737 can be indirectly deduced by references made about wood and kernel exploitations.

Ojeda Rivera (1987) says that halfway through the 18th century many families made their living from pinecone collection, “an ancient activity in the area”. To carry out this activity, they settled in several forests during winter and spring: Las Marismillas, Los Corrales de Doñana and the private Almonte pine woodlands. The current production data from the Almonte-Hinojos and Moguer-Mazagón pine woodlands (Montero et al. 2000) show that pine trees start their cone production when they are at least 20 years old, although the greater production of a pine woodland takes place when the trees have ages between 40 and 100 years. Thus, supposing the trees were planted from 1737, they would be about 30 years old or even younger, i.e., too young to talk about a traditional, profitable profession.

Even clearer is the table given by this author about “the evolution of production in private properties and their composition”. This table includes a Forest productive sub-sector embracing wood, firewood and pinecone income that produced 17,144 “reales de vellón” (Spanish coin made with a mixture of silver and copper) between 1747 and 1751. The amount of pinecone production in 1747 is completely incompatible with the 10 or 15 years of age of the recently planted (1737) pine forests: at that age, pine trees do not produce pinecones.

As for the wood, the age of the trees and the existing production data do not fit either. Granados Corona et al. (1984) say that “there is plenty of information from 1770 about the exploitation profit and monitoring”, and Ojeda Rivera (1987), according to a quote from 1767, talks about cork oak, holm oak, pine tree, and willow wood production, which the Almonte Council traditionally put up for auction, this being an important episode: “councils such as the one in Almonte continually put up for auction the wood from their lands, a main episode for the funds of those that offer their goods”.

In both cases, supposing these pine forests were planted in 1736-38, as these authors maintain, the trees would be 30 years old, this not having a timber-yielding size high value. The current data about the Almonte pine woodlands (Montero et al., 2000) show that there is no acceptable wood production until trees reach the age of 40 years, and this only happens when the trees have been subjected to silvicultural methods. Thus, assuming the pines were planted in 1737, their

age does not explain the production recorded during subsequent years, or, at the very best it would be difficult, especially if we bear in mind that probably halfway through the 18th century the trees were not yet subjected to current treatments.

Again this does not agree with what Ojeda Rivera (1987) said, viz., that halfway through the 18th century the villages of the area had good incomes from traditional wood auctions, so profitable that they caused conflicts with the new authority, the General Naval Intendancy of Cadiz.

At this point, the information compiled by Bauer (1991) from the report made in 1751 by Joseph Gutiérrez de Rubalcava, a Navy representative to the Doñana reserve forests from the Medina Sidonia house, becomes very important. These forests “had 14 and a half leagues of circumference, and 242,662 trees were counted in them: 222,200 pines (91%), however only 80% of them were useful; the remainder were new trees, 18,000 cork oaks, and 1,119 poplars. In the field of forestry, the “smaller trees” (less than 20 cm. in diameter) have been traditionally distinguished from the “bigger trees” (more than 20 cm. in diameter). We think this last term can be compared with the former “useful” used by the navy technicians. Montero et al. (2000) made some tables about the Huelva pine woodlands including three kinds of densities: high, medium and low. In these tables you can see that diameters over 20 cm belong to pine trees with ages between 25-35 years if they are from Almonte-Hinojos, and between 45-55 if they are from Moguer-Mazagón. These data do not agree with the maximum age (14 years) that would have the trees first planted in 1737, not even in the case of fast-growing trees.

On the other hand, we can approximately estimate the pine area by comparing the Gutiérrez de Rubalcava data (177, 760 useful trees and 44,440 new trees) with the above-mentioned table made by Montero et al. (2000), which also includes the number of trees per hectare in each case. In the greater density case, there would be about 600 trees per hectare, where the useful trees would mean about 300 pine woodland hectares, plus close to 50 hectares of new pine forest (estimating about 900 trees per hectare). In the hypothetical case that these pine woodlands were comparable with the current densest pine forests, they would add up to about 350 ha of pine trees around 25 to 55 years old, an amount that again does not agree with the 12 ha planted in 1737, which grew up to 44.7 in

1738, 67.5 in 1739, and 336 in 1770 (Granados et al. 1983).

All these data suggest that, besides the forests planted from 1737, there were other older forests that would explain the data about “useful” pine trees and about pine cone and wood production.

It seems that a certain plantation planning started under the protection of the Marquis de la Ensenada under a law created in 1748 because of the naval policy (Gil 1999). However, its effectiveness has been questioned by several authors. For example, Bauer (1991) considers as utopian the measures proposed by Gutiérrez de Rubalcava about “planting nearly 900,000 poplars and 373,000 pines” in the Doñana reserve.

It is possible that pine reforestation was carried out in these areas, but, as Gil (1999) thinks, the pine forests created are not plantations, since the seeds come from the region itself. This is the reason why he talks about a pine woodland recovery through several actions: “the Moguer (Huelva) council bylaws established that neighbours must plant a kernel al mud quart for every fanega and a half of land transferred to them by the council (González Gómez 1977)”. The author does not describe how effective these measures were, or the size of the forested area. Another example he mentions following Nash (1904) is about the Riotinto (Huelva) pine forests “originated between 1758 and 1776 by the mine supplier Francisco Sanz, who ordered kernels to be brought from the Niebla county”.

The existence of pine woodlands in the Southeast Andalusian territory during the 18th century seems, indeed, clear (Bauer 1991). From 1748, the Navy representatives went all over the municipalities making reports on the state and composition of their forests. In these reports the *Seville administrative area* is included, which in 1750 had 744,644 pine trees; 220,200 pines were in the Doñana reserve forests between 1749-1751; in 20 villages out of the 37 composing the Huelva administrative area, pines were the most abundant trees with a total amount of 2,928,448 (76%), where 508,348 were “old” trees; in Ayamonte and Cartaya 116,189 trees are recorded, out of which 64% are Maritime pines (*Pinus pinaster*⁴) while only 1% are Stone pines (*Pinus pinea*)”; Around 1750 in

Tarifa there were only 900 pines, in *Xerez de la Frontera* between 1750 and 1754 there were 271,512 pines; in 1753, 1,960,788 trees were counted in the *Cádiz administrative area*, out of which 96% are pines; in the same periods the *Sanlúcar administrative area* had 875, 834 trees in 4 populations including Sanlúcar: 874,784 pines, 450 cork oaks, 447 Lombardy poplars, etc. And finally, in the province of *Malaga* there were only 64,078 Stone pines.

In short, Doñana is the only enclave of the whole studied territory where data about old reforestations (from the middle of the 18th century) have been provided. However, the presence of *Pinus* pollen in El Asperillo as well as in Laguna de las Madres, the numerous references prior to 1737 mentioning pine woodlands “around” and near Doñana, such as the ones from Sanlúcar de Barrameda (the Espíritu Santo pine woodland, the Barrameda pine woodland) and from Almonte (Ojeda Rivera 1987), several indirect data about wood production or the estate of the forests in 1751, the 12-hectare plantation during 1737 with kernels from the “Cartaya pine woodlands”, the fact that all these pine forests were in areas ecologically similar to the Marismillas in Doñana, and finally, the perfect adaptation of the forest to the environment, with high growth rates (De la Hera et al. 1980), lead to the conclusion that if areas such as Las Marismillas did not have pine woodlands in 1737 it was because the anthropic exploitation led to an important deforestation situation.

The 19th and 20th centuries

From the 19th century, there is more precise information in the *Clasificación de los montes públicos de 1859* and the *Catálogo de los montes públicos exceptuados de la Desamortización de 1862*. The latter contains 95 forests with pines from the provinces of Huelva and Cádiz: in 73 of them the pine tree is the predominant species, with an area of 18,519 ha, and in the other 22, which add up to a total of 7,365 ha, the pine tree is one of subordinate species. In four of this last group of woodlands, the cork oak is the predominant species (1,149 ha), while in two other forests, the holm oak (70 ha) is predominant and in the 16 last forests (which add up to 6,146 ha) the predominant species are shrubs.

The total area covered by the 95 woodlands adds up to 25,884 ha: 3,792 ha from the 15 forests in the province of Cádiz and 22,092 ha from the other 80 forests, which are located in Huelva. The owners are mainly the cities where they are located: Almonte,

⁴The presence of the species in this territory creates a difficult enigma. Perhaps the most probable hypothesis is that it is a mistake, since it is the only quotation found on this species in the references reviewed.

Moguer, Cartaya, Chiclana, Chipiona, Bollullos del Condado, Hinojos, Puerto-Real, Rociana, Sanlúcar de Barrameda, Tarifa, Vejér, Conil, Gibralfuente, Bonarés, Ayamonte and Villalba del Alcor.

Three years later the *Catálogo de los montes públicos exceptuados de la Desamortización de 1862* was published. This means an advance as well as a complement to the 1859 classification: on the one hand it includes the scientific name of the species, which eliminates any possible doubt about the forest identity, and on the other hand, 55 forests have as a predominant species “*Pinus pinea* L., Stone pine”, which matches in general terms with those included in the work made three years earlier.

In the province of Cadiz 3,028 hectares out of the total of 20,328 ha were covered by the Stone pine woodlands, and 17,300 were in Huelva, basically located in the same councils as during the *Clasificación de los montes públicos* of 1859.

The information included in these documents is quite valuable despite the possible measurement defects, since it corroborates the existence of a great Stone pine forest area, around 20,000 ha, between the Huelva and Cadiz provinces, approximately 150 years ago.

Halfway through the 19th century, the technicians’ and the State administration’s concern about the existing deforestation situation and its sometimes disastrous consequences increases. As a result, the 1877 Act of Reforestation, Promotion and Improvement of State Forests was drawn up, although it was not a very effective act since it lacked funding. Successive natural disasters (floods, inundations, etc.) increased concern among influential Administration circles about the pitiful forest situation and the need for reforestation, (Gómez Mendoza 1992). This was a slow process which took several years to express (Water Act of 1879, R. D. February 3rd 1888, *Systematic plan on hydrographic sources reforestation*, etc.). In this context are included the reforestation and dune-fixing works that started at the end of the 19th century and the beginning of the 20th century.

There are several documents and studies about these works that review what has been done (Cuerpo Nacional de Ingenieros de Montes 1909, 1910; Bermejo y Durán 1926; Cueto 1999, etc.). All of these show the way reforestations are done in several areas: The Huelva dunes (Isla Cristina, Punta Caimán), and the Rota and Puerto de Santa María dunes; the Vejer de la Frontera dunes, and the Tarifa dunes in Cadiz. The species used are also mentioned: mainly

Stone pine, although also Maritime pine (*Pinus pinaster*), Canary Islands pine (*Pinus canariensis*), Monterey pine (*Pinus radiata*), Casuarina trees (*Casuarina* sp.), cypresses (*Cupressus* sp.), acacias (*Acacia* sp.), eucalyptus (*Eucalyptus* sp.), Mousehole trees (*Myoporum laetum*), etc.

The work about Reforestation and Piscicultural Restocking Inspection (Cuerpo Nacional de Ingenieros de Montes 1909), has an interesting paragraph about the II Perimeter, in the Vejer Dunes, giving information about the presence of Stone pine woodlands, and about the use of its seeds in reforestation: “The Vejer Dunes are located in the “Breña alta y baja” State forest, which has an area of 2,075 hectares, being half overrun by sand. The area wooded by the Stone pine (350 hectares)...” This report also summarises all reforestation works carried out until the end of 1907, when just 100 hectares of different coastal sites of Cadiz had been forested. Later, these works were increased, so a considerable area of the dunes of the Southwest of the province had been forested till the half of the 20th century, 2000 hectares to be precise (Cueto 1999).

Another important event in the Spanish forest history was the creation of the State Forest Heritage in 1941. One of its main functions was to continue and intensify the reforestation works, which it carried out until the eighties.

De la Lama (1951) verified the vegetation condition in Huelva in 1941: “(...) it was basically deforested from Moguer to the house of the only guard from the Ibarra Reserve in “El Acebuche”, making up a great sandy plain covered by bushes, interspersed by small freshwater lagoons and by some isolated groups of ancient eucalyptus or pine trees (...). The Moguer forests, and, further to the Northeast, the eucalyptus or pine woodlands from the Dutch company “Forestal de Villarejo”, basically constituted the sole reforested areas”. He also affirms that *Pinus pinea* is the autochthonous species in the Almonte area.

Later on, he takes stock of the first ten working years. In the following table (Table 3) we transcribe the original figures about reforested areas until December 31st 1950⁵, not taking into account the reinforcement plantings made: “*Eucalyptus (glóbulus, rostrata, etc.)* 11,769.8187 ha; Pine trees (*pinea* and

⁵The author contributes with two figures. The one herein expounded includes the reforestations made by the Brigade and those already existing in the forests at the time of falling into the hands of the Service.

pinaster) 20,125.1406 ha; other species (guayale, acacias, holm oaks, cork oaks, etc.) 1,385.0500 ha; total reforested area: 33,280.0093 ha”.

He also gives information about the average reforestation pace in those ten years (2,800 new hectares per year), although at the start in 1941 the pace was only 500 hectares per year (400 of Stone pine sowing and 100 for eucalyptus planting).

Reforestation with this species have continued afterwards and until today. These reforestation have decisively helped the current landscape pattern of the area. There is plenty of information about these works, as well as statistics that will not be analysed herein since they are not valuable enough for the aims of this work.

Conclusions

The presence of *Pinus* remains during the Tardiglacial and the Holocene, identified as *Pinus pinea*, the *Pinus* pollen sequences, and the historical references are unquestionable proofs that verify that the Stone pine is an autochthonous species to the Iberian Peninsula.

In the territory under study, i.e., the area next to the Cadiz and Huelva coast, the continuous *Pinus* pollen sequences obtained in peat deposits demonstrate its wild nature. The autoecology analysis and the historical and archaeological quotations seem to prove that this pollen comes from *Pinus pinea* L.

The evolution observed in the mentioned pollen graphs is, in general, coherent with the historical data. The general trend verified in the pollen profiles is, despite some temporal increases, a progressive decrease of *Pinus* and a decrease of forest cover as a whole, which can be related to the progressive increase of the different anthropic activities. Finally, an increase of *Pinus* pollen is observed during the 20th century, a fact that can be perfectly associated with the reforestation activities carried out in the area by the forest services.

The previous references about these last reforestation are scarce. The most important ones, from the geobotanical point of view, are those described by Granados Corona and his co-workers who brought to question the Pine woodland origin, although only in Doñana. However, the paleopalynological, historical and ecological data lead one to think that these interventions must be considered as reforestation with a species previously eliminated by man.

The fact that reforestation have been made does not invalidate the autochthonous and wild character of this species, since a significant amount of current forests, which are basically the result of reforestation made during the 20th century, are on lands previously covered by pine trees. As a consequence, the term “reforestation” can acquire the meaning of creating woodlands again in places where they had previously disappeared due to anthropic causes, and not because an exotic species had been introduced. This idea, first proposed by Font i Quer (1954) has been recently resumed and defended by several authors such as Costa Tenorio et al. (eds) (1997) and Gil (1999).

To sum up, with all the palynological and historical data, a review and modification of the syntaxonomic scheme seems necessary, so that the Stone pine woodlands from Huelva and Cadiz can be included as a natural unit with their own entity. This means reviewing some of the concepts and hypotheses assumed until the present time about the role of *Pinus pinea*, as well as making another geobotanical interpretation about the different plant communities, using as a starting point the palynological and historical data, and other data giving information about the vegetation history. To this effect we consider as very appropriate the opinion defended by Costa Tenorio et al. (1990) about the definition given for communities from a historical point of view.

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