# J. W. Gottstein Memorial Trust Fund

The National Educational Trust of the Australian Forest Products Industries


# A REVIEW OF DRYLAND PINES IN TURKEY, SPAIN, GREECE AND FRANCE

## IMPLICATIONS FOR DRYLAND PLANTATION FORESTRY IN AUSTRALIA

**OWEN DONOVAN**

2001 GOTTSTEIN FELLOWSHIP REPORT

## JOSEPH WILLIAM GOTTSTEIN MEMORIAL TRUST FUND

The Joseph William Gottstein Memorial Trust Fund was established in 1971 as a national educational Trust for the benefit of Australia's forest products industries. The purpose of the fund is *"to create opportunities for selected persons to acquire knowledge which will promote the interests of Australian industries which use forest products for the production of sawn timber, plywood, composite wood, pulp and paper and similar derived products."*

Bill Gottstein was an outstanding forest products research scientist working with the Division of Forest Products of the Commonwealth Scientific Industrial Research Organization (CSIRO) when tragically he was killed in 1971 photographing a tree-felling operation in New Guinea. He was held in such high esteem by the industry that he had assisted for many years that substantial financial support to establish an Educational Trust Fund to perpetuate his name was promptly forthcoming.

The Trust's major forms of activity are,

1. Fellowships and Awards - each year applications are invited from eligible candidates to submit a study program in an area considered of benefit to the Australian forestry and forest industries. Study tours undertaken by Fellows have usually been to overseas countries but several have been within Australia. Fellows are obliged to submit reports on completion of their program. These are then distributed to industry if appropriate. Skill Advancement Awards recognise the potential of persons working in the industry to improve their work skills and so advance their career prospects. It takes the form of a monetary grant.

2. Seminars - the information gained by Fellows is often best disseminated by seminars as well as through the written reports.

3. Wood Science Courses - at approximately two yearly intervals the Trust organises a week-long intensive course in wood science for executives and consultants in the Australian forest industries.

4. Study Tours - industry group study tours are arranged periodically and have been well supported.

Further information may be obtained by writing to,

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He has worked in forestry operations for the past 16 years with the Department of Conservation and Land Management and more recently with the Forests Products Commission.

For the past seven years he has been involved in the Maritime Pine Project, which has established joint venture *P. pinaster* plantations on approximately 10,000 hectares of farmland around Perth Western Australia.

The Maritime Pine Project has been a Government initiative to establish a resource for industry and help combat the land care problems of the agricultural lands in the 600mm to 400mm rainfall zone (also known as Western Australia's Wheatbelt).

Appendix 1 contains Mr. Donovan's application for the Fellowship Award, which outlines his reasons for undertaking this trip.

# CONTENTS


| | PAGE |
|---|---|
| Foreword | ii |
| About the Author | iv |
| Acknowledgements | viii |
| Executive Summary and Recommendations | ix |
| Introduction | 1 |

## TURKEY

| | |
|---|---|
| 1.1 Forestry in **TURKEY** | **2** |
| 1.2 University of Isparta | 7 |
| 1.3 Natural Forests | 8 |
| 1.3.1 Bucak | 8 |
| 1.3.2 Kesan | 9 |
| 1.4 Plantation Establishment | 10 |
| 1.4.1 Isparta | 10 |
| 1.4.2 Biga | 12 |
| 1.5 Plantations | 13 |
| 1.5.1 Isparta | 13 |
| 1.5.2 Bucak | 14 |
| 1.5.3 Aydin | 15 |
| 1.5.4 Biga | 16 |
| 1.5.5 Biga *P. pinaster* | 17 |
| 1.5.6 Kesan | 19 |
| 1.5.7 Sakaya | 21 |
| 1.6 Harvesting | 23 |
| 1.6.1 Bucak | 23 |
| 1.6.2 Kesan | 24 |
| 1.7 Research | 25 |
| 1.7.2 Antalya | 25 |
| 1.7.3 Ankara | 29 |
| 1.8 Nursery | 31 |
| 1.8.1 Bucak | 31 |
| 1.8.2 Aydin | 32 |
| 1.9 Fire Control | 33 |
| 1.9.1 Aydin | 33 |
| 1.10 In Summary | 36 |

## SPAIN


Section 2.1 Forestry in **SPAIN** **38**

2.2 I.N.I.A Madrid 42
2.3 Resin Production 43
2.4 Natural Forests 47
2.4.1 Coca 47
2.4.2 Cuenca 49
2.4.3 Barraca 51
2.5 Plantations 54
2.5.1 Navermosa 54
2.5.2 Valencia *P. halepensis* 57
2.5.3 Vitoria *P. radiata* 58
2.6 Research 63
2.6.1 Seed Centre 63
2.7 Summary of SPAIN 65


## CANARY ISLANDS


Section 3.1 Forestry in the **Canary Islands** **66**

3.2 Gran Canary 66
3.3 Tenerife 71
3.4 Summary of Canary Islands 82


## FRANCE


Section 4.1 Forestry in **FRANCE** **84**

4.2 I.N.R.A Bordeaux 87
4.3 A.F.O.C.E.L Bordeaux 89
4.3.1 Smurfitt Mill, Labourchea 89
4.3.2 Harvesting 90
4.3.3 Storm Damage 91
4.3.4 Smurfitt Paper Mill, Arachon 95
4.3.5 Nursery 96
4.3.6 Insect Damage 98
4.3.7 Hybrid *P. pinaster* 100
4.3.8 Establishment 101
4.4 Summary of France 104

Section 5 Gallipoli **106**

Further Reading 110

List of Figures and Maps 111

Appendix 1 Application for Gottstein Fellowship Skill Advancement Award.

Appendix 2 Travel itinerary while on fellowship.

# ACKNOWLEDGEMENTS

This study tour was made possible due to the generous financial assistance provided by the J.W. Gottstein Trust.

I sincerely thank the trust for awarding me a Fellowship Award and for making my travels and this report possible. I am hopeful that the information in this report and the experience I have gained will be of benefit to plantation forestry in Australia.

I also thank my employer, the Forest Products Commission of Western Australia and in particular Mr. Alan Briggs and Mr. Gavin Butcher for their support and guidance with this Fellowship. I also thank the Forest Products Commission for funding my journey to the Canary Islands.

Several foresters in particular went out of their way to ensure my visit to their "Patch" was worthwhile. Dr Nebi Bilir who for 10 days acted as host and interpreter for me throughout Turkey, Ricardo Alia for making it possible for me to cover half of Spain in a few short days, Jose Climent for the forest tour of a lifetime on the Canary Islands and Pierre Alazard who in four days managed to ensure I visited all points of interest in the magnificent "Landes forest" in France. I must thank Carlos Velazquez and Jose Naravangjoes from the Canary Island Forests Service who gave me the tour of the forests and history of this interesting Island.

I was astounded by the hospitality and generosity shown by fellow Foresters at every site I visited. Considering the language and cultural differences I experienced, I was pleasantly surprised by the amount of information I obtained and disseminated with Foresters across the three countries visited.

My thanks also go to Mr. Trevor Butcher and Mr. David Spencer for the invaluable forestry contacts and travel advice. Thank you to Rosemary Melvey for your help and patience in compiling this report. I must also thank my family; Rebecca, Evan and Rachel for putting up with my days spent emailing foresters in Europe and the weeks I spent crossing the world.

# EXECUTIVE SUMMARY and RECOMMENDATIONS

In Western Australia over the past ten years we have seen a dramatic increase in the establishment of *Eucalyptus globulus* plantations. In a decade over 120, 000 hectares of agricultural land has been planted in the States' South West mainly for wood chip plantations.

The difficulty in expanding the softwood plantation estate in high rainfall sites has been caused by an increase in the land value of properties in the greater than 600 mm rainfall zone. This increase has been driven by the demand for land for horticultural uses and eucalypt wood chip plantations.

At present, the most cost effective areas in the State to establish new *Pinus* plantations are in the less than 600 mm rainfall zone (outside of the wood chip plantation and horticultural zone). In these lower rainfall areas *P. radiata* is generally not suitable due to the poorer soils and drought stress. The **only commercial species** at present that can be established in commercial plantations in the mid to low rainfall zone is *P. pinaster* (also known as Maritime Pine).

This less than 600 mm rainfall zone is outside the traditional forest and plantation area. To make such plantings commercially attractive, a large scale of planting is required to attract industry to invest in new sawmills or relocate old mills to where the future resource will be located. The only other option to this is to accept the long (200 kilometer average) haul distances or cease the expansion of the plantation estate.

The push to plant in this rainfall zone is also an attempt to halt and repair the massive land care problem facing much of the States' agricultural land. It has been estimated that up to 20% of Western Australia's Wheat belt has been lost to salinity or rising water tables in the past 70 years. To create a resource for industry and at the same time assist with the landcare battle is a monumental task. There are many varying estimates but it is generally accepted that to have any significant effect on the water use in a catchment, 20% should be established to deep-rooted perennials. This would involve the strategic planting of approximately 4 million hectares of the States' Wheatbelt!

At present *P. pinaster* is the best suited commercial tree crop for establishment in the Wheatbelt due to its drought tolerance, existing markets and adaptability to poor sandy soils. The challenge ahead is to ensure Pine plantings continue at a rate that will ensure a sustainable resource is achieved in specific areas to make the utilization of the resource viable. A figure of 20,000 hectares in an economic haul distance growing at an MAI of at least 8 $m^3$/ha/ann is generally accepted as the minimum required to set up processing centers such as MDF or LVL plants. Maritime pine is an extremely hardy species but is not suitable for all the landforms in the States' Wheatbelt.

There are other *Pinus* species such as *P. halepensis, P. brutia* and *P. canariensis* existing in Southern Europe that I believe, with some tree breeding, can be used to ensure a sufficient resource is established on sites unsuitable for *P. pinaster*.

The following are my observations and recommendations based on the forests I visited traveling on this Gottstein Fellowship. I accept that the area I currently work in is on the edge of what has been traditionally regarded as suitable for plantations. As land values have pushed plantations out of the traditional high rainfall zone, in Western Australia we have no other option but to consider alternative *Pinus* species that can not only provide a resource for industry, but also help combat the State's land care problem.

Appendix 1 is a copy of my application for the Fellowship Award. This provides further details on the reasons as to why I applied for the Fellowship and the benefits that industry would gain by my study tour. At the end of each section I have also summarised what I believe were the significant findings from each country.

The following lists my findings in relation to the **five main aims of my Fellowship**.

***P. pinaster* Breeding Program**.

I believe I visited enough sites in Spain to have seen demonstrated examples of provenances of *P. pinaster* that have developed a high tolerance to drought and harsh sites. Several stands performed well on rainfall as low as 450 mm per annum and have a tolerance of high summer temperatures similar to that experienced in Western Australia's Wheat belt.

A trial of improved *P. pinaster* hybrids that I visited in France clearly demonstrated the rapid genetic improvement that can be obtained with the use of hybridization of selected provenances. I am confident this method could be used to fast track the improvement of *Pinus* species suitable for low rainfall sites across Australia.

**RECOMMENDATION 1.**

That the FPC or a national forestry body such as the CSIRO seek approval from the Australian Quarantine and Inspect Service to import select *P. pinaster* seed or genetic material into Australia for the purpose of developing a more drought tolerant *P. pinaster*. At present all *Pinus* material is prohibited from importation into Australia from Spain and several other countries due to the risk of possible introduction of Pine Pitch Canker disease (*Fusarium subglutinans f.sp.pini* (syn *F. circinatum*).

**RECOMMENDATION 2.**

Interspecific hybridization is implemented as soon as possible within the Forests Products Commission *P. pinaster* breeding program to help improve drought tolerance and form. This could also improve the commercial range of *P. pinaster* planting across all of Australia.

**Performance of Drought Tolerant Pinus Species.**

It is not possible to fully understand a species tolerance to extremes of climate in a five or ten day visit however, in the following summary I have drawn upon information gained from discussions with European foresters and made comparisons with familiar species such as *P. radiata*. Some of the low altitude and low rainfall provenances of the following species show a high tolerance to drought. I have rated these species with the most drought tolerant being;

1 P. halepensis
2 P. eldarica
3 P. canariensis
4 P. brutia
5 P. pinea
6 P. pinaster
7 P. radiata?

I believe that overall, the best performing species is *P. pinaster,* as it appears to have better vigor than any other species on sites I visited. *P. pinaster* is also well suited to producing most wood products from paper to sawn timber. The only limiting factor with *P. pinaster* appears to be its instability on heavy soils.

The best performing species on drought prone sites with heavier soils appeared to be *P. brutia* due to its relatively good form and the fact that it is utilised for many different products such as paper production, MDF/Particleboard and sawn timber products.

*P. canariensis* is a species worth considering where growth rates could be slower than is normally required to provide a good economic return. This species is well adapted to heavy soils and is drought and fire tolerant. These factors make this species ideally suited to land care type plantings of low management were longer (>60 years) rotations are acceptable.

*P. halepensis, P. eldarica* and *P. pinea* are hardy species but were not commercially important in the areas I visited due to their poor form. Although *P. pinea* was important for seed production I cannot see this becoming a commercial venture as parrots are inclined to damage or eat its pinecones in Australia.

**RECOMMENDATION 3**.

That a national forestry body (such as the CSIRO) drive a *P. brutia* breeding program. State Forest Departments from Western Australia, South Australia, Victoria and New South Wales have significant areas that I believe could be planted to improved stock of this species. It would take a joint effort of several State organizations to ensure that funding was available to improve *P. brutia* to the point were it could be improved so as it had commercially acceptable growth rates for low rainfall plantings.

**RECOMMENDATION 4.**

The Forests Products Commission and CSRIO should develop a joint project to assess the commercial range of *P. canariensis* in Southern Australia. There are several existing plantings that could provide information for a milling study to assess the development of heartwood in mature trees. It would also be interesting to formally assess this species' fire tolerance and success at regenerating from the stump.

**RECOMMENDATION 5.**

That the use of hybridization in the breeding of *P. brutia*, *P. halepensis* and *P. canariensis* could possibly improve these species performance at a rapid rate. This would require a nation wide effort to secure the funding and impetus to ensure such a tree breeding program was completed. An organization such as ALTRIG should be able to obtain the resources necessary to undertake this task.

**Alternative Silvicultural Regimes**.

After visiting many sites and plantations I am confident that at least in the Forest Products Commission, we are leading the world in silvicultural techniques used in the establishment of *Pinus* plantations on low rainfall sites. Apart from the Forestry Department on the Canary Islands, I saw no other organization establishing trees on sites as harsh as those established by the Forest Products Commission's Maritime Pine Project.

The most significant difference in establishment practices I encountered was the use of mechanical or hand weed control in plantations. There appeared to be

very little use of herbicides or fertilizers in most areas to improve vigor or survival. I believe the main reasons why herbicides were not used was the availability of cheap labour or the continued use of past cultural practices.

**RECOMMENDATION 6.**

The Forest Products Commission investigates the potential for Western Australian Foresters to provide consultancy services to Southern European Forests Services. I believe in Western Australia we have the knowledge base of foresters familiar with *P. pinaster* operations that could greatly improve the vigor and utilization of dry land pine species in Southern Europe. This could be achieved with a forester exchange program with countries such as Spain, France and Turkey. Other countries with dry *Pinus* forests such as Italy and Greece should also be considered.

**Assess other countries' methods of integrating Forestry into Agricultural lands**.

In Turkey, Spain and France, the method of establishing vast areas of plantations on agricultural lands appeared to have been simple.

In Turkey, the government owned all common lands and appeared to carry out any works they liked for the good of the country.

In Spain, the government reclaimed unproductive (often abandoned) agricultural lands to re-afforest them with *P. pinaster*. This was also a major land care undertaking as many of these sites were prone to erosion or already were degraded.

Frances' Landes forest was also poor agricultural land that was drained by the State then incentives were offered for landowners to establish plantations. Initially the forest areas were used for resin production but in the 1950's timber production became its principal product.

In all three countries it took the **Vision** and **Commitment** of political leaders to commit the funds and resources to ensure such projects were undertook. Frances Landes forest is possibly the best example of how relatively unproductive land has been transformed into Europe's largest industrial plantation with approximately one million hectares of *P. pinaster* plantation.

**RECOMMENDATION 7.**

The only method I can see of establishing significant areas of commercial plantations in the medium to low rainfall areas of Australia is to develop a tax incentive scheme to encourage landowners to plant tree crops. It would also be of assistance to develop land care based credits, to offset establishment costs of commercial tree crops in the <600 mm rainfall zone.

I believe it will take the joint effort of several States to lobby the Federal Government to implement such a scheme. Funding is already available with the National Heritage Trust (NHT). The issue is a matter of redirecting this NHT funding into more worthwhile ventures such as the Maritime Pine Project and Dryland Afforestation.

**Observe the utilization by industry of high resin content Pinus species.**

Two processing centers were visited during my trip and information obtained from foresters on the use of *P. brutia, P. pinaster* and *P. canariensis* by industry. I have come to the conclusion that when a significant resource is available, industry will adapt or modify processes to utilise alternative species so long as commercial volumes are available.

I found it interesting in Turkey that foresters considered *P. radiata* timber as rubbish wood when compared to the more durable *P. brutia*. In Australia we have reservations on the use of these alterative *Pinus* species as they contain more resin than *P. radiata*. If industry in Turkey can utilize *P. brutia,* then it would be more a matter of us becoming accustomed to working with this alterative species rather than relegating it as an inferior timber.

## INTRODUCTION

Between the 22nd of August 2001 and the 27th of September 2001 I visited natural forests and plantations of pinus species in Turkey, Spain and France. Unfortunately I was unable to visit stands in Greece due to personal illness and a tight schedule. Apart from my visit to the Canary Islands, which was funded by the Forest Products Commission, all other forestry activities were part of the Gottstein fellowship. (I have included the Canary Islands visit in this document).

The report is divided into five main sections, one for each country visited with a separate section for my visit to Gallipoli. I have further divided each section into relevant subjects such as Establishment, Fire control etc. Under each of these headings I have given a separate heading for each location I visited, for example under Nurseries sites I visited in Turkey, Bucak and Aydin nurseries are listed.

At the end of the chapter on each country I have summarized what I considered the significant points. I certainly hope you find this report interesting and informative. I have learnt much from meeting foresters and inspecting stands of pinus species in the countries visited. In this report I have only briefly covered each topic. For more in depth information and technical reports please consider the titles I have mentioned in the list of further reading.

There are many photos in the document as I tried to capture as many aspects as possible on film. I also have several videotapes recorded on the trip, which will be available on CD once I summarize their content. If more information is required on any section in this report please contact the author.

The schedule that I undertook is detailed in Appendix 2.

# TURKEY

Aya Sofia. A typical western image of Turkey

## 1.1 Forestry in Turkey

Turkish pine or Red pine (*Pinus brutia* Ten) is one of the main forest and plantation species in Turkey. *P. brutia* forests constitute one seventh of the total area of forest in Turkey and equates to 3.1 million hectares of forest ( 1.8 million hectares productive and 1.3 million hectares degraded) with an annual production of around 4 million $m^3$ of various wood products.

The species is closely related to *P. halepensis* that grows west of *P. brutia's* range from Greece through to southern Spain. The two species look very similar when in a plantation layout. The simplest method of identifying the species is by their mature cones. *P .brutia* cones are flush with a very short stalk and stand at right angle to the stem (generally in Western Australia *P. brutia* plantings also have better stem form than *P. halepensis*). *P. halepensis* cones are usually on a short stem (1 to 3 cm long) with the tip of the cone pointing back to the trunk.

Figure T1 shows the distribution of the major commercial species throughout Turkey including *P. brutia*. The species is also found on islands belonging to both Greece and Turkey along the west and south coast of Turkey. *P. brutia* occurs naturally from sea level to up to 1500 m above sea level (ASL). The species is well adapted to a Mediterranean climate with hot dry summers and cool wet winters. From the stands inspected, *P. brutia* appears to perform best at low to mid altitudes in areas that experience a mild winter with little or no snow.

In Turkey, 296,000 ha of forested land were planted to *P. brutia* between 1985 and 1991 with yearly average plantings being approximately 42,000 hectares. Areas planted with *P. brutia* account for 37% of the total area planted annually.

Some Forestry statistics of interest from Turkey are as follows (1999):

| | |
|---|---|
| Population | 62,865,574. |
| Turkey has a land area of | 77,945,200 hectares |
| Forest and wooded lands | 20,763,800 hectares |

Ownership of Forests Public 99.9% Private 0.1%

On average 14 million cubic metres of wood products are removed from the production forests each year. A major component of this is fuel wood (6.8 million cubic metres per annum) which is used by forest villages for heating and cooking. The Ministry of Forestry estimates that these forest villages have approximately 25 million inhabitants.

Early in my visit I found out that my definition of a pine plantation (a mono culture growing at an MAI of between 8 to 25 $m^3$/ha/annum) is very different to the Turkish definition, which appeared to be any afforestation (often with mixed species) for commercial or conservation purposes. Several plantations visited were similar in layout and growth rate to Australian plantations of *Pinus* species while others were of mixed species with an MAI of 1 $m^3$ per annum and appeared to be managed more for conservation than wood production.

Some of the plantations were established with mixed species of *P. brutia*, *P. nigra* and *Cedrus libani*. Often afforestation sites were areas where the natural forest had been removed many years if not centuries ago and replaced by grazing for domestic livestock. It was also apparent that on some of these sites there had been little grazing or management for many decades. Generally the slope and soil was too poor or difficult for agriculture. Much of this undulating to steep country was covered with *Quercus cochefira,* a native weed species of little commercial use (generally it was a shrub to 2 m high up to 4 cm diameter: Occasionally it became a poorly formed tree to 7 m).

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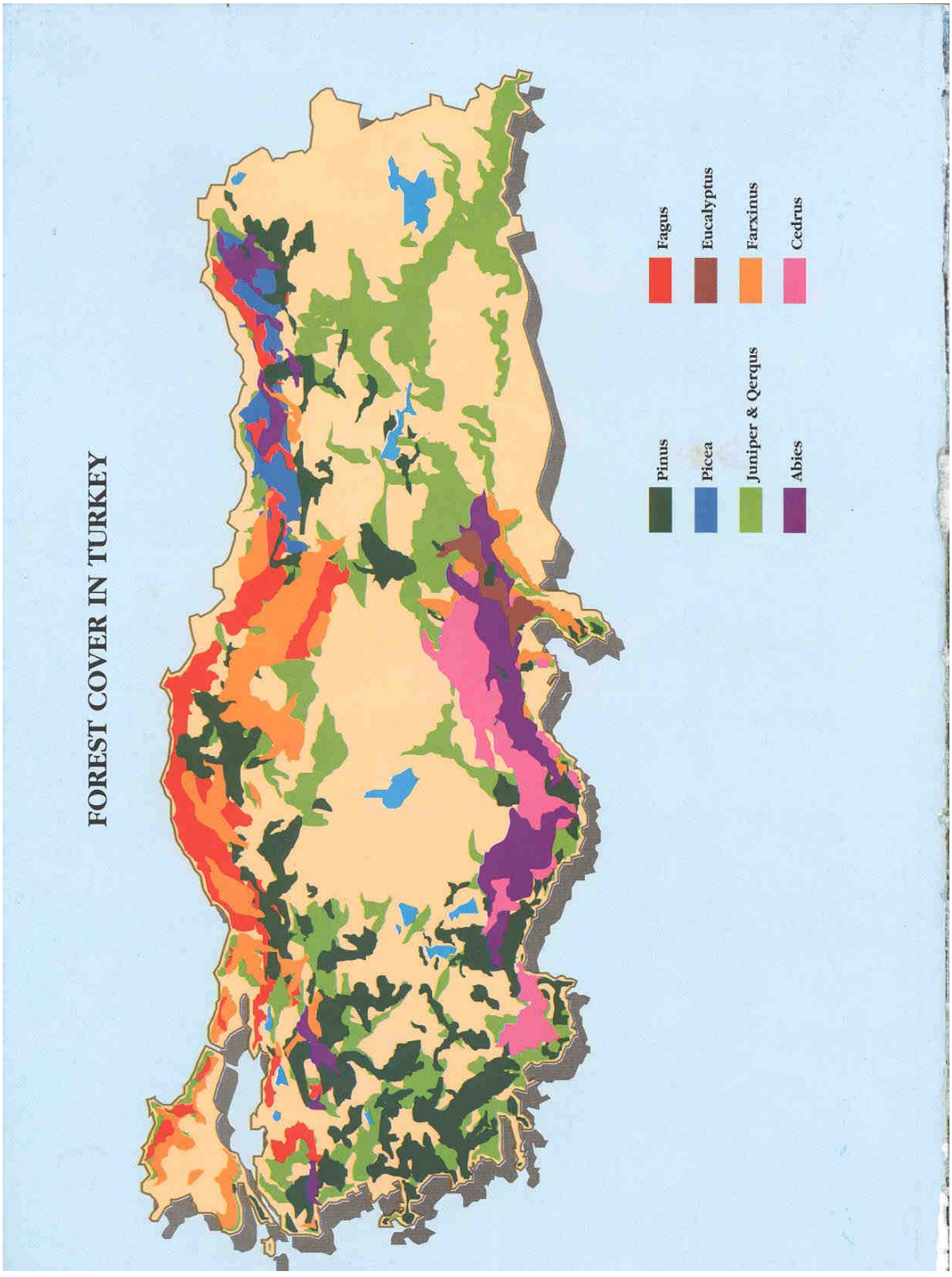


**Figure T1**. Forest Cover in Turkey. The areas marked pinus (dark green) are mainly *P. brutia* and *P. nigra* forests.

The following map (Figure T2) shows areas I visited in Turkey. The line shows the approximate route I took by road through the western part of the country. I have also highlighted cities I visited in yellow.

To judge the distance between points in Turkey one must relate to the main method of transport for all Turks, the BUS. Istanbul to Antalaya is a 12 hour bus trip but only 500 kilometers by air, Istanbul to the capital Ankara is a six hour bus ride for a trip of approximately 400 kilometers.

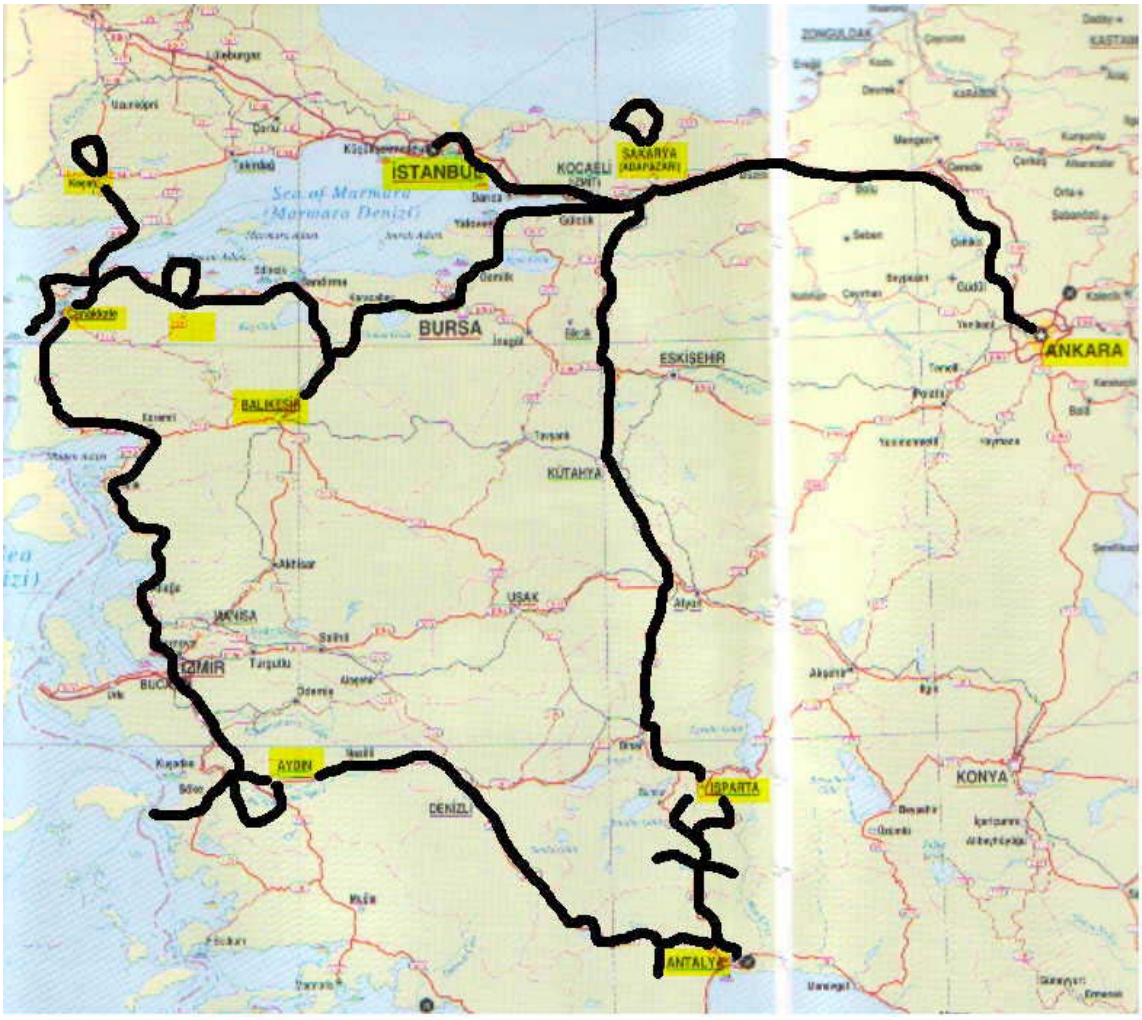


**FIGURE T2**. The route taken through Western Turkey.

## 1.2 UNIVERSITY of ISPARTA.

Faculty of Forestry (Orman Fakultesi)
Suleyman Demirel University

My main contact in Turkey was Dr Nebi Bilir who acted as interpreter and also arranged all my site visits for the 11 days I spent in his country. Dr Bilir has worked for the past 10 years studying various aspects of *Pinus* and *Cedrus* species in Turkey. His field of expertise is quantative genetics. I was extremely fortunate to have Dr Bilir as my guide as he had a sound knowledge of *P. brutia* and contacts in every forestry office we visited.

At the Isparta University I was introduced to many of the staff and given a brief overview of their field of interest along with much Turkish tea. After lunch I gave a power point presentation on plantation forestry in Western Australia, with many pictures on share farming with *Pinus pinaster*. This generated great interest among the 20 or so people present. They were very interested in the use of machines for planting and our prescribed burning in pine plantations. This practice stimulated extensive discussion over the effects of controlled burning on nutrition, soil biota and how it was implemented. Some of the foresters present believed that controlled burning would only harm the forests or plantations. I could only convey the effect of controlled burning on our *P. pinaster* plantations in Western Australia where, in my opinion, if we did not carry out controlled burning we would have such a fuel build up under the canopy that we would be unable to carry out a direct attack on wildfires. This would result in each fire damaging a greater area of plantation. I also believe that the pines from drier climates have evolved with fire and it is possibly one way of nutrient recycling in the drier forest system as we have in some drier *Eucalyptus* forests.

Many of the *P. brutia* forests I visited generally had a thin layer of shed needles on the forest floor. It would seem that there is either more biota in the needle bed causing it to breakdown into the soil or, due to the much colder and longer winter, greater decomposition is possible than I have seen occur under *P. brutia* plantings in Western Australia.

I also spoke at length with Mrs. Bilgin Guller who was carrying out research into the variance in wood properties of the different provenances of *P. brutia*. Mrs. Guller has provided me with several web site addresses of *P. brutia* MDF and paper mills in Turkey (www.ustunkarli.com.tr , www.sabriyamun.com.tr, www.yildizmdf.com.tr, www.yongapan.com.tr and www.sfc.com.tr). I was surprised to find that in 1995 1,350,000 $m^3$ of *P. brutia* was used in the

manufacture of MDF*. P. brutia* is also used in the manufacture of paper although it is often blended with other species such as poplars.

Forestry culture in Turkey is quite different from what most of us are exposed to in Australia. Most Ministry of Forestry offices we visited were large complexes covering 1 to 10 ha's in the center of each town or city. At the entrance to each depot is a boom gate with one or more security guards housed in a small office. These friendly and helpful guards would give us directions or phone ahead to notify the manager of our arrival.

On entering each office there was usually a secretary (always male) who would lead us through to the manager. Turkey is relatively poor country compared to the rest of Europe but a managers office was always large and contained fine wooden floors, furniture and on one occasion feature wood paneling (*P. brutia*) was used in the walls and ceiling. At every office, house, shop and guardhouse I was offered Turkish Tea and warm hospitality. Before we could depart for the forest a driver (which appeared to be his full time job) was usually phoned to bring the 4WD vehicle to the main gate.

Many of the foresters I met through Turkey could speak a little English (most could speak English better than I could speak Turkish). I found my photo album of Western Australian plantation forestry the most efficient way of communicating what my visit was about.

## 1.3 NATURAL FORESTS.

### 1.3.1 BUCAK

The Bucak area contains some of the best-formed (straightest) natural stands of *P. brutia* in Turkey. My impression was that the form of the trees in plantation areas was always better than that of natural stands (even without selection during seed collection). Figure T3 shows a natural stand of *P. brutia* in a dry (700 mm annual rainfall) steep site with a slow growth rate with a rotation of over 100 years. This growth rate is very similar to natural forests of *Eucalyptus* marginata (Jarrah) in Western Australia on similar rainfall. From the sites I visited it appeared that the natural stands were well managed with natural regeneration becoming well established following clear felling. Western Australia has three arboretums that contain trees grown from seed collected in this Bucak area in 1965.

**FIGURE T3.** Clear fell coupes in natural stands of *P.brutia* near Bucak.

### 1.3.2 KESAN

Seeing stands such as in Figure T4 reminded me how important it is to obtain the correct seed source for Australian conditions. The local foresters regarded this as a reasonable stand as it was one of very few natural stands left in the Kesan area. My impression was that some foresters considered these natural stands with poor form to be more valuable than the better formed plantations because they were natural stands. I believe most plantation foresters consider a good tree to be a straight tree. In natural stands there is often more interest in gnarly old trees that have character than stems with gun barrel straight boles.

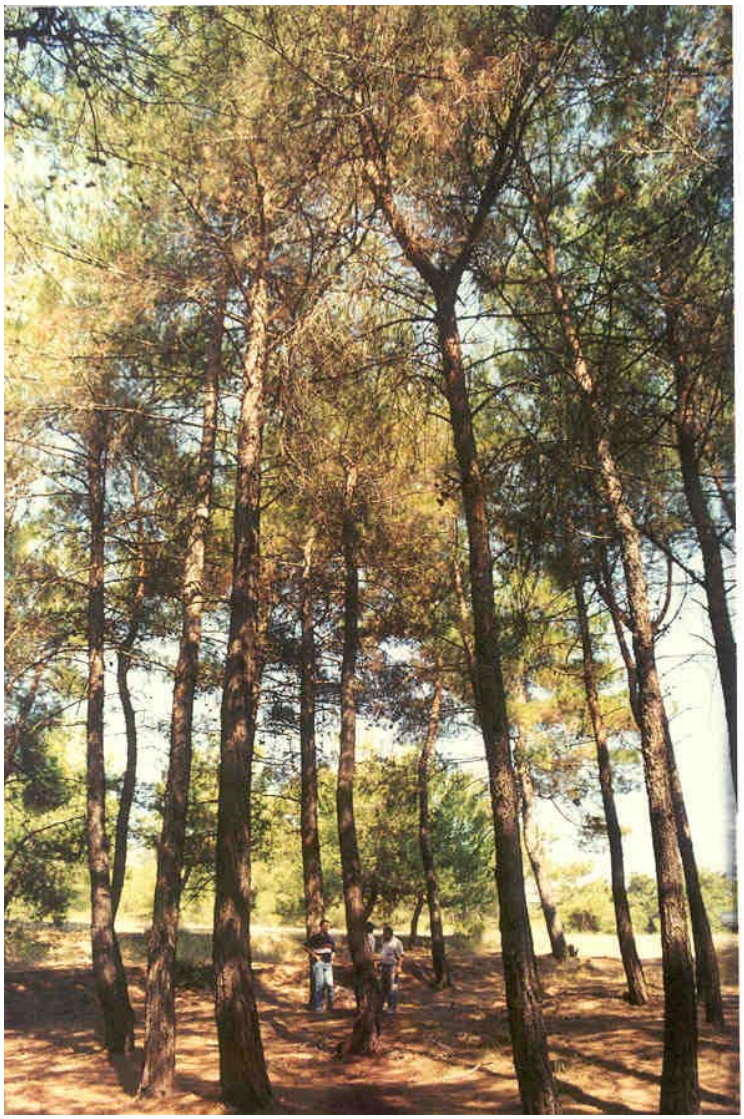

**FIGURE T4**. Poorly formed *P. brutia* (due to negative selection) Near Kesan.

## 1.4 PLANTATION ESTABLISHMENT

### 1.4.1 ISPARTA

Plantation establishment on former agricultural sites was similar to pine establishment in Australia. The Oak scrub, which was present on every site, was cleared and wind-rowed by bulldozers with root rakes. It was interesting to see local villagers then used the windrows of debris as a fuel source for cooking and heating. A second pass with the bulldozer using a standard triple ripper was used

to make the soil easier to work. Burning of any remaining debris was NOT allowed on any site.

The soil on almost every site I visited throughout Turkey and Spain was similar to that shown in figure T5. The soil has a $CaCO_2$ base (very similar to Australian Marl) and is generally neutral to very alkaline. The soil is easily worked, as it is reasonably friable but appeared to very poor at retaining moisture. Even though my visit was at the end of summer I was still surprised at how dry and lifeless this $CaCO_2$ soil was.

**FIGURE T5**. $CaCO_2$ soil typical of *P. brutia* range through Turkey.

The cost of establishing plantations in Turkey was around $1000 Australian dollars per hectare (at the time of my trip the exchange rate was $2 Australian = $1 U.S. or $1Australian = $776,000 Turkish Lira). As all planting sites were on public land, the land value was not considered a cost of establishment. Standard establishment was with rows around 3 m apart with 2 m between trees giving a stocking rate of around 1650 spha. Planting stock was always bare rooted seedlings from small Ministry of Forestry nurseries.

In the Isparta region of Turkey where a 2500 ha afforestation program of mixed species has been planned, **1500** local villagers were employed for the planting season! All planting was by hand and all post planting weed and scrub control was by hand! No herbicides, fertilizer or insecticides were used on any sites I visited. I am sure that the application of fertilizer and possibly better scrub control should dramatically increase the growth rate of *P. brutia* on most sites.

**FIGURE T6.** Standard plantation establishment by hand throughout Turkey.

### 1.4.2 BIGA.

The afforestation site visited at Biga had recently had its Oak scrub windrowed by two D7 bulldozers in preparation for planting. Again I was drawn to compare Australian silvicultural practices and I am confident that the use of herbicides such as Velpar™(Hexazinone) or Amitrole/Atrazine to control scrub on such sites could at the very least double stand growth rates in such areas.

As can be seen from Figure T7, the scale of afforestation is large by any standards. Many of the sites I visited had this scale of around 1,000 hectares or greater on a site per planting season.

**FIGURE T7**. Two D7 bulldozers on a recently cleared afforestation site near Biga.

## 1.5 PLANTATIONS

### 1.5.1 ISPARTA

Just outside the city of Isparta I became aware of the difference between what Australians call a plantation and what the Turkish call a plantation. Mixed species plantings are used to create a more diverse and therefore natural stand and are often used on marginal sites as individual species occasionally suffer damage by insects or severe cold events. Figure T8 shows a 30-year-old mixed stand of the species. *P.brutia P.nigra* and *Cedrus Libani*. This was considered a harsh site as it received only 600mm of rain, was at high altitude ~1000 m ASL and received many frosts and some snow during winter.

**FIGURE T8**. Mixed species 30-year-old plantation near Isparta

Even though stand growth rate appeared to be slow (MAI of 1 to 4 $m^3$/ha per annum), it was evident that this plantation near Isparta would eventually provide great benefit in terms of preventing further erosion on steep slopes and eventually produce some wood products from a very harsh site. Even though by Australian standards this stand had a slow growth rate, it was a vast improvement from the rocky barren landscape that was present on an adjacent hill (which was considered by the foresters present to be too rocky and eroded to establish a plantation on).

### 1.5.2 BUCAK

The plantation surrounding the nursery at Bucak was at a lower altitude ~600 m ASL and on a more productive soil type (similar $CaCo_2$ soil but in a valley floor). The stand had an average top height of around 20 m with diameters of up to 40 cm at breast height (Figure T9). The form of the dominant trees in the stand was

very good with small diameter and flat angled branching. Stem form was also very good with virtually no forked trees.

**FIGURE T9**. Nebi Bilir in a *P. brutia* plantation on a more productive site near Bucak.

### 1.5.3 AYDIN.

In the hills around Aydin vast areas (10,000 hectares per hill range) of *P. brutia* plantations have been established over the past 15 years. At the higher altitudes (around >800 m ASL) the *P. brutia* appeared to be under stress. The needles on the stressed trees were further damaged by an insect called *Thaumetopoea pityocampa.* The larvae from this moth can damage (consume) or defoliate many different types of tree species causing damage to 1,000 ha's of forest each year. *Ips errossos* (Ips Bark Beetle) was also a major pest in this area and was responsible for many tree deaths.

I was under the impression that the incorrect provenance seed source had been used in these high altitude plantations and this was the cause of such unhealthy trees and subsequent insect attacks. The major emphasis of the *P. brutia* tree breeding program has been to identify zones to select seed from so as not to mix the different provenances in afforestation.

**FIGURE T10**. *Thaumetopoea pityocampa* damage on *P. brutia* at Aydin.

### 1.5.4 BIGA.

After another all night bus trip, Dr Bilir and I arrived in the City of Biga which is directly south of Istanbul on the south side of the Sea of Marmara. The main difference in the afforestation areas here was the poorer soil, with a dry hard clay base (similar to our duplex soils as the clay was often present at one to two metres). This clay soil appeared to be nutritionally poorer than the common $CaCo_2$ soils.

Afforestation in this area with *P. brutia* didn't appear to be as productive as in other areas possibly due to the clayey soil. The other impediment here was the ever present scrub regeneration after afforestation. Again no herbicides or fertilizer were used in plantation establishment and management. Some plantations were a mass of scrub regeneration yet *P. brutia* still managed to survive and very slowly grow through the scrub.

On similar sites *P. pinaster* appeared to outperform *P. brutia* in this area. I believe this could be due to *P. pinaster's* denser crown and heavy needle fall smothering out the scrub competition.

**FIGURE T11.** Scrub competition in a three year old mixed species plantation near BIGA**.**

### 1.5.5 BIGA *P. pinaster*.

while at Biga I visited a *P. pinaster* plantation which was planted in the mid 1980's. Winter in this area is not as severe as further inland and so *P. pinaster* has been established in some plantations. My impression was that on this site, *P. pinaster* had a better volume increment than any other pine planted. Figure T12 shows myself beside a 14 year old *P. pinaster*. Volume increment of these stems is slow (estimated MAI 4 $m^3$/ha/ann) which is to be expected with so much scrub competition and having received no fertilizer.

**FIGURE T12**. *P. pinaster* plantation near Biga.

The form of the *P. pinaster* was poor with substantial stem sweep (Figure T12). I was to find out later that the origin of the *P. pinaster* seed sources used in Turkey was from one population established in the 1700's by the French. From the form of the trees and their tolerance to cold, I believe the Turkish population to be from the Landes area south of Bordeaux. This would account for the butt sweep and poor form.

The majority of the *P. pinaster* plantations in Turkey are around the Sea of Marmara or along the Black Sea coast (Turkey has approximately 55,000 hectares of *P. pinaster* plantations). The winters in these areas are mild with few frosts. *P. pinaster* (figure T13) in such sites seems to have better vigor than *P. brutia* or *P. radiata*. *P. pinaster* may have also been better suited to the poorer clay soil type in this region or better able to compete with the ever present scrub.

I was informed that due to *P. pinaster* being an exotic species it is no longer used in any afforestation works in Turkey. *P. brutia* is now used on such sites even though there are plenty of examples that other *Pinus* species are more productive.

**FIGURE T13**. Scrub in foreground with *P. pinaster* plantation in background near Biga.

**1.5.6 KESAN**,

The Kesan area in the north-east of Turkey north of Gallipoli adjacent to the Greek border is the region to see afforestation with *P. brutia*. The plantations here cover 10,000 ha's over each hill range with agricultural land in the valleys between (Figure T14). The rainfall in this area is around 550 mm per annum. The climate appears to be similar to the south west of Western Australia (hot and dry) although the area may still occasionally experience light snow falls.

The vigor of stems here appeared to be better than at any other site. Figures T14 and T15 show a stand of *P. brutia* planted in 1964. The growth rates do not compare to *P. radiata* or *P. pinaster* grown in Australia (but I am reminded that this is not Australia). Tree form in plantation stands was very good in places. Not far from this site was a small natural stand of *P. brutia*. This natural stand had very poor form with many forked trees. This was possibly due to negative selection as the site was relatively close to the coast and easily accessed by peasants foraging for wood (see section 1.3.2).

**FIGURE T14**. *P. brutia* plantation near Kesan.

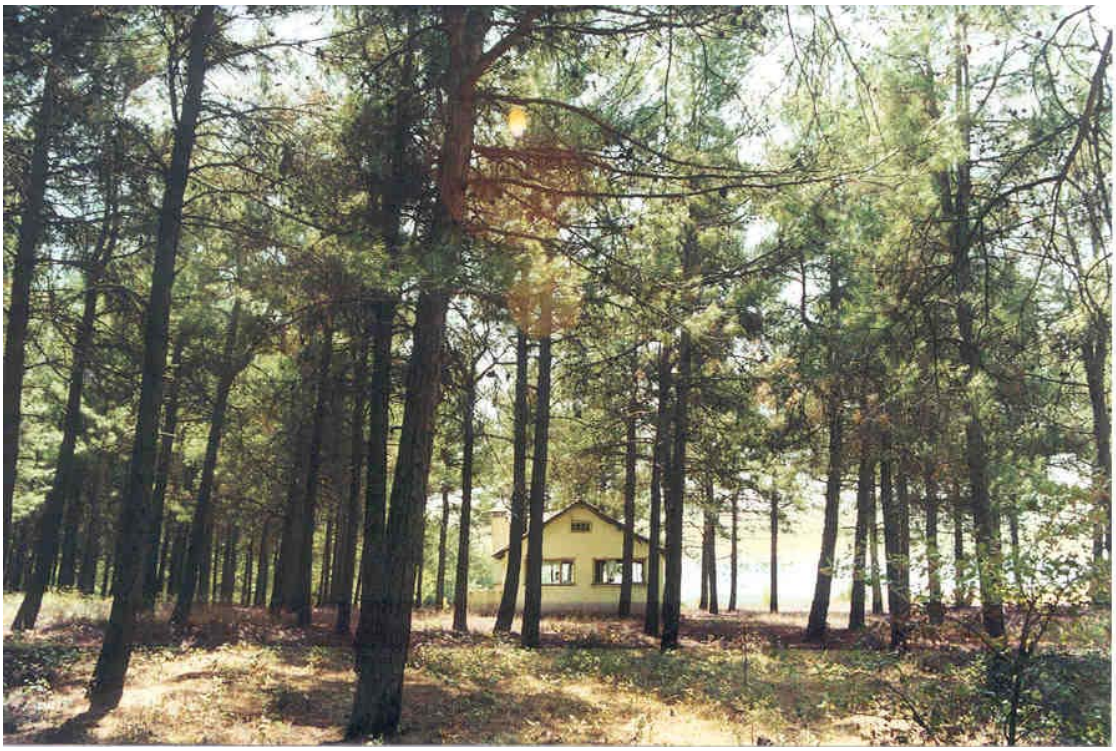

**FIGURE T15**. Forest workers house in a 37 year old *P. brutia* plantation near Kesan.

### 1.5.7 SAKAYA (also known as ADAPAZARI),

We traveled north of this city, which was devastated by an earthquake in the 1990's. The city still has many multi story buildings with cracks from ground to roof top and potholes in footpaths and roads as big as a spa! After a further bus trip we arrived in a small town called Kaynarca then traveled north again to the edge of the Black Sea.

This area was quite different to every other place I had visited in Turkey. The countryside was lush with green rolling hills running for miles. In most of the field's sweet corn and other summer crops were growing without irrigation. I was told the winter here is very mild because of the influence of the Black Sea.

We visited a stand of *P. pinaster* growing on the sand dunes adjacent to the Black Sea where growth and form of the trees was quite good (Figure T16). We then stopped at a stand of *P. pinaster* that was 34 years old with a top height of over 20 m (Figure T17). Vigor was very good but form was poor with considerable stem sweep. I believe this stand was also the French Landes provenance of *P. pinaster*, which is well known for its stem sweep.


**FIGURE T16**. *P. pinaster* plantings near the Black Sea. This plantation was barely 500 m from the edge of the sea on sand dune type country.

What was surprising on such a productive site was that *P. radiata* was growing slower than *P. pinaster*. I was informed insects had repeatedly attacked the *P. radiata* in its earlier years. Due to this insect damage *P. radiata* is not considered a viable species in this area. The *P. radiata* also demonstrated the poorest form I have ever seen in this species. This was apparently due to the insect *Eutria bovelliana* killing the growing tip each year (Figure T18).

**FIGURE T17**. *P. pinaster*. and

**FIGURE T18**. *P. radiata* near the Black Sea.

At this site the Turkish foresters told me that *P. radiata* is considered an inferior species to *P. brutia* due to its slow growth rate and soft timber. Being a sandplain forester I agreed that *P. radiata* was indeed an inferior species when compared with *P. brutia* or *P. pinaster*.

## 1.6 HARVESTING

### 1.6.1 BUCAK.

The most noticeable aspect of a clear fell operation in *P. Brutia* forests was the complete utilization of ALL wood. Figure T19 shows one of numerous stacks of fuel wood collected by nearby villagers on a clear felled site. The only debris left on the site was pine cones and needles.

**FIGURE T19**. Utilization of fuel wood by villagers near Bucak.

The process of harvesting used throughout many of the Turkish forests is interesting though labour intensive. Generally harvesting is by hand with chain saws only used for felling and cross-cutting logs. De-barking and de-limbing is carried out by hand with axes. Extraction to the roadside is with horses, tractors or manually carried. Loading of trucks is also often by hand. This could account for log length often being a relatively short 2 m as the bole of many trees would allow log lengths of up to 6 m.

### 1.6.2 KESAN

After harvesting, logs are transported to large, centrally located stockpiles. Logs are then auctioned off in relatively small lots of 20 m3 to 40 m3 (Figure T20). Near Kesan approximately 3,000 tonnes of *P.brutia* logs were stockpiled awaiting auction day. The foresters present informed me the stockpiles were also created to ensure sufficient material was available for timber mills, when access to the forests was restricted in summer due to the high fire risk. I was also surprised to find blue stain fungus was not present in these dry log stockpiles. The foresters present said blue stain did not occur in *P. brutia* even though the stockpiles were dry and the wood had been down for months. I can only guess that the high resin content of *P. brutia* helps keep the blue stain out of such logs.

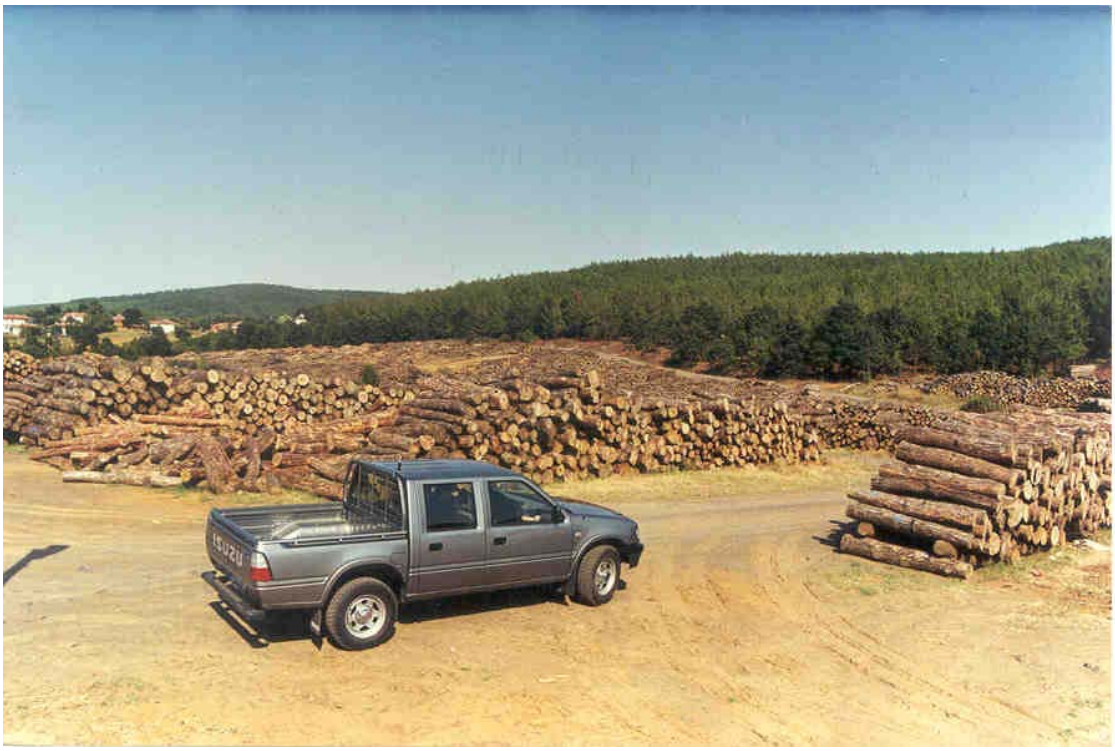


**FIGURE T20**. *P. brutia* log stockpile at Kesan.

## 1.7 RESEARCH/TREE BREEDING

### 1.7.1 REASEARCH ANTALYA.

There is a massive natural forest of *P. brutia* along the entire 120 kilometers of road from Isparta to Antalya. Most of this countryside was quite steep so there was very little agriculture until we reached the flat plains on the edge of Antalya.

In the Antalya area the Ministry of Forestry establishes approximately 1,000 hectares of *P. brutia* annually. Over the past forty years 60,000 ha's of plantation has been established in this area with another 15,000 hectares of establishment for erosion control. I was told that the plantation areas had an average MAI of around 10 to 11 $m^3$/ha/ann. Although these plantations receive up to 1000 mm of rainfall per annum, soils are very porous and the dry period is long and pronounced. This may account for the low MAI's.

First stop was the Ministry of Forestry Office to meet Dr Yusaf Cengiz Director of the Southwest Anatolia Forest Research Institute. He has worked on nursery practices and tree breeding of *P. brutia*. Dr Yusuf Cengiz took us to the Antalya University where we met with Dr Kani Isik who has published six papers on *P. brutia* and is considered an expert on the species. We then drove to the site were Dr Isik has been measuring *P. brutia* growth over the past 15 years.

**FIGURE T21**. Research site near Antalya.

Figure T21 looks over one of Dr Isik's trials which tested the growth rates of *P. brutia* populations from the three altitude zones of seed sources in Turkey. Low altitude 0 - 400 m ASL, middle 400 - 800 m ASL and high 800 - 1200 m ASL. At each altitude 10 parent trees were selected at random. This trial site was established on a low altitude site at around 200 m ASL.

The results indicated that stems established with seed from low altitude trees had good vigor with poor form. Middle altitude seed showed good vigor with good stem form. High altitude seed produced stems with poor vigor and good form (Figure T22).

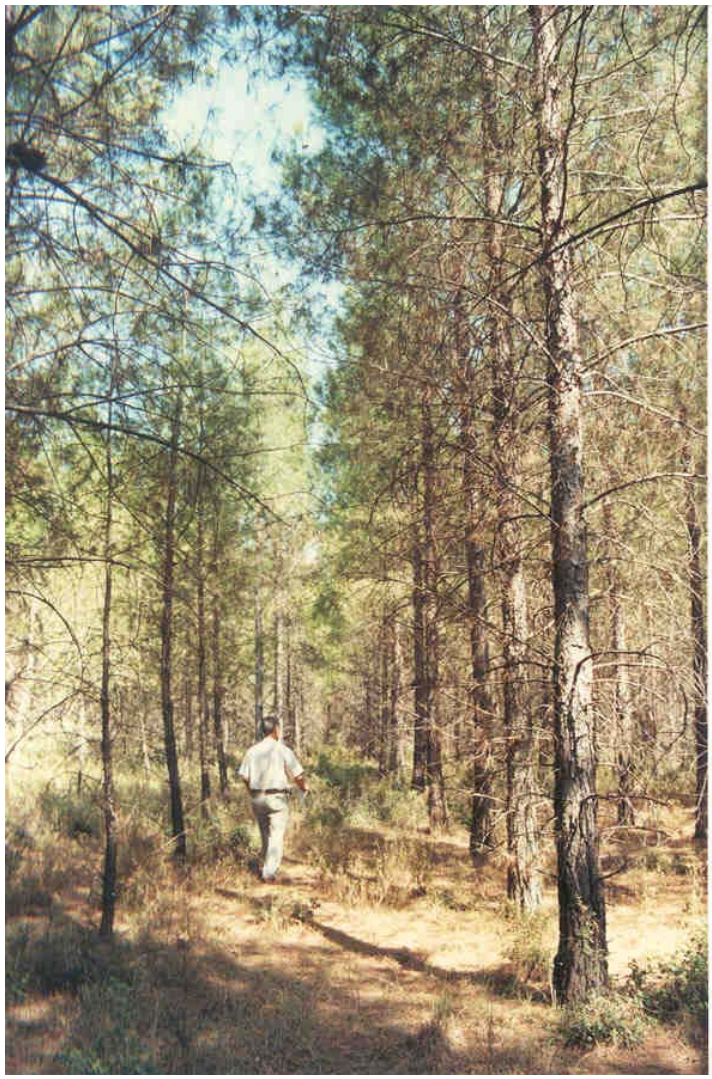

**FIGURE T22**. Dr Isik in the *P. brutia* trial at Antalya (variance in stem size and form is due to seed source being from different altitude zones).

Dr Isik suggested that due to centuries of over cutting, *P. brutia* at low altitude close to the coast could have the influence of negative selection (that is any straight stem would be cut out at a young age thus encouraging the development of crooked stems). After seeing many stands at low altitude with poor form this appeared to be the case.

Another factor influencing *P. brutia* growth seemed to be the soil it was growing in. The variance in annual rainfall from 600 mm to over 1000 mm appeared to have little impact on tree increment. From my observations, it would seem that the $CaCo_2$ soil had little moisture holding capacity on any site apart from valley floors.

**FIGURE T23**. Three year old natural regeneration of *P. brutia* near Antalya.

Figure T23 shows natural regeneration in a stand clear felled after a severe wildfire. As far as I could attain there is a NO BURN policy in all Forests in Turkey. Foresters were very interested to find that in Western Australia we regularly carry out controlled burning under *P. pinaster* and *P. brutia* stands with no adverse affects on stem quality or vigor.

Figure T24 shows a seed stand near Antalya. The seed stand appeared to be a typical stand of *P. brutia* for the area. From my observations there was no deliberate selection in the stand for better formed trees. I was led to believe that even though some seed stands do contain plus trees there is no deliberate selection for vigour or form in such stands.


**FIGURE T24**. *P. brutia* seed stand Antalya.

The Ministry of Forestry has over 50 natural *P. brutia* seed stands, most being larger than 100 ha and thirty seed orchards over 15 years old. Most seed orchards are not collected from because of pollen contamination from nearby plantations. The purpose of a seed stand is to produce large volumes of easily collectable seed of a particular provenance. The Seed orchards were stocked with improved stems although seed quality and quantity was the aim of the orchard not vigor and stem form. Compared to *P. pinaster* or *P .radiata,* the breeding of *P. brutia* is still in its infancy in this country

### 1.7.2 ANKARA (the capital of Turkey).

The tree breeding center for Turkey is based in Ankara in a large complex that also houses the Ministry of Forestry head office. There was an accommodation building on the site for visiting foresters and their families, which was a hotel, some 7 story's high (unfortunately for us it was full when we arrived at 9 pm that night).

The following day we visited the Forests Tree Seeds and Tree Breeding Centre. I met the Director of the center Mr. Sadi Şiklar and the Chief engineer Mr. Hikmet Öztürk. As with every other site we visited the hospitality was tremendous although by this stage my body had reached its limit on tea consumption.

I spent many hours with the Directors discussing why we in Australia were interested in *P. brutia* and the type of material we were interested in obtaining from Turkey. I gave a power point presentation to their staff on the *P. pinaster* program in Western Australia and our landcare problem in the Wheat belt. They were most interested in the gains that have been achieved by the FPC with *P. pinaster* over the past 40 years, in particular the work by Trevor Butcher who has been involved in the program throughout the period.

During discussions on growth rates that we achieve from our improved *P pinaster* on relatively harsh sites, I did my utmost to encourage them to try our improved seed stock which had vastly better form and vigor than the *P. pinaster* I had seen growing in Turkey. Next year they have agreed to trial some improved *P. pinaster.*

The Director informed me that up until quite recently tree breeding had been focused more on conservation of a species than production. They considered the use of the correct provenance to be vital in afforestation to avoid the damage caused by insects on stressed trees. Only recently has vigor or form been a consideration to the breeding program. The center is now putting more resources into finding the most productive provenance to fit a range of sites through a series of trials.

We narrowed down the most promising provenances of *P. brutia* from some recent unpublished data from trials located throughout Turkey. These trials are still young at 4 years of age but are indicating that the Bafra-Camgolu provenance from the Black Sea as the fastest growing (3 m top height at age 3). The next best provenances are from the Antalya and Bucak areas which have lower rainfall and are harsher sites.

Based on information supplied by Mr. Şiklar and Mr. Öztürk, they believe the following provenances of *P. brutia* have the fastest growth combined with acceptable stem form. These provenances perform best in the Mediterranean region of Turkey;

Antakya - Ulucynar
Antakya – Yayladaoy
Anamur - Gokcesu
Silifke – Yepilovacyk
Amasya – Destek.

Below are other provenances that, based on a trial in the Kesan area, have the best vigour although may not have the drought tolerance we require in Australia. The establishment of a large scale provenance trial in Australia is required to fully assess the performance of the best Turkish provenances.

Other provenances worth trialing in Australia due to their fast initial growth:

Black Sea – Alacam
Antalya – Bucak- Merkez
Antalya – Kargi
Antalya – Olimpos
Maramara – Orhanet.

David Spencer from the CSIRO Forestry and Forest Products, Canberra office has arranged the importation of two kilograms from each of 48 seed stands (representing most of the provenances) of *P. brutia*. Mr. Spencer's collection also includes two kilograms from each of the seven *P. brutia* seed orchards. It is possible from this collection to establish a very thorough *P. brutia* trial to assess each provenance and then develop a *P. brutia* breeding program for Australia.

## 1.8 NURSERYS

### 1.8.1 BUCAK.

Figure T25 shows a 5 month old bare rooted *P. brutia* seedling held by Isparta Forest regional manager Necati Cengiz. All pine seedlings used in the area were bare rooted stems grown in the Ministry of Forestry's Bucak nursery. This was in the centre of a 30 year old P. brutia plantation. No chemicals were used in the nursery as all weeding was carried out by hand.

**FIGURE T25**. Necati Cengiz with a 5 month old *P. brutia* seedling.

### 1.8.2 AYDIN.

In the city of Aydin I was shown the Ministry of Forestry nursery (Figure T26). This nursery was surrounded by urban development mainly being flats (every body in Turkey lives in a flat). All *Pinus* species were grown bare rooted. The main commercial species grown here were *P. brutia, P. pinea*, *Cedrus libani* and *Eucalyptus camaldulensis*. I was told again that all weed control was by hand and that no herbicides were used at all in the nursery (the benefits of having cheap labour).

**FIGURE T26**. Ali Osman Aksoy in the forestry nursery at Aydin.

By Australian standards these Ministry of Forestry nurseries were very basic (old style nurseries growing mainly bare rooted stems) Given the low technology used to produce the seedlings I was astounded at the consistent quality of pinus seedlings. At the Aydin nursery I was also impressed at the vigour of seedlings and at how the nursery was kept in such immaculate condition (without the use of herbicides the nurserymen still managed to keep the seedling beds and surrounds weed free).

## 1.9 FIRE CONTROL.

### 1.9.1 FIRE CONTROL AYDIN.

Alongside the Aydin nursery was the Forests Department fire station. This was similar to a four bedroom house but was the accommodation for 14 men who I was told reside here 24 hours a day in readiness for wildfire suppression during summer. Figure T27 shows the team ready for action after Ali Osman Aksoy (Aydin Region Manager) sounded the station fire alarm.

**FIGURE T27**. A team of Forest Firefighters at Aydin

I had a preconceived idea that Turkish fire control would be similar to going back in time 30 years with old Mercedes trucks or worse and old fashioned radio communications. Once again my preconceived stereotype of Turkey was blown away. As I was given a demonstration of a state of the art Renault 4wd Fire truck (Figure T28) which was equal to, or better equipped than similar appliances I have seen in Australia. The main element of effective fire control is good communications, I was surprised to find that the Turkish foresters were using similar Midland™ VHF radio sets that are commonplace in Australia. I was more surprised to find the annual expenditure on fire suppression for the Aydin area was ~$2 million USD. This was to protect forests that produced $1.2 Million USD of wood products per annum! The Ministry of Forestry appeared to be the main, if not the only fire suppression force outside major cities.


**FIGURE T28**. Renault 4wd Fire truck.

Fire control was a major consideration with all *P. brutia* plantations. Major firebreaks were evident in all plantations with a very intensive network of fire towers in each district. At one site I was informed there were seven other fire towers visible on a good day from the 15 metre high tower we were in.

One difference in the Turkish Fire Towers was that at each structure the tower man's family resided in the ground floor? (Figure T28). The towers were also manned 24 hours a day with scheduled calls to the District office every half hour throughout the night.

**FIGURE T29**. A typical Fire Tower near Aydin.

**FIGURE T30**. View from a fire tower looking north over a forest of *P. brutia* and *P. nigra* to the Adriatic Sea west of Aydin.

## 1.10 IN SUMMARY

From the places I visited across western Turkey over 11 days, I have come to the following conclusions.

1. *P. brutia's* natural distribution covers a vast area but appears to be on generally the same soil type ($CaCo_2$ or limestone derived type soils). This soil appears to be generally quite penetrable for tree roots but poor in moisture holding capacity and holds low levels of nutrition. In comparison to the soils that I have seen plantations established on in Australia I would define much of the *P. brutia* country as HARSH. From sites visited in Turkey and the few small plantings that I have seen in Australia, I believe the species can adapt to any soils that *P. radiata* has been established on and most soils *P. pinaster* has been planted on.

2. It is evident from some of the harsh sites *P .brutia* is found growing on that the species is well adapted to dry sites. Other Mediterranean countries that are trialing species for low rainfall sites also believe *P. brutia* has a high tolerance to drought. I believe that we need to establish some large (20 ha +) plantings to really assess the species tolerance of Australian conditions.

3. I was more than surprised to find *P. brutia* is THE main timber producing species in Turkey. It is used in large quantities in the manufacture of structural timber, treated posts, particleboard, MDF and paper production. Local processing centers are **used** to working with the high resin content of *P. brutia* in any product. Unfortunately I couldn't visit any major processing sites in Turkey (I was under the impression I needed to be related to someone important to visit such sites).

4. Possibly due to the species vast natural range, there is a definite variance between populations. I have seen in Western Australia, the improvements that are possible from just the Bucak population. I am confident that, with a plus tree selection from the best performing provenances, we can breed *P. brutia* to the point were it will **outperform** *P. pinaster* and *P. radiata* on medium to low rainfall sites.

5. Based on the improvements in vigor achieved in the *P. pinaster* breeding program in WA, it would be possible to double the wood production per hectare in Turkey's existing plantations of *P. brutia* by using improved silviculture techniques (improved scrub control and the use of fertilizers) linked to a well developed tree breeding program. If this could be put into practice over the next plantation rotation, Turkey could possibly produce an additional **4 million cubic metres** of wood products without increasing its plantation estate area.

# SPAIN

## 2.1 FORESTRY IN SPAIN.

Spain has a vast estate of *P. pinaster* as can be seen from the following natural distribution map.


**FIGURE S1**. *P. pinaster* distribution in Spain.

Like the French Governments' re-afforestation program in the Bordeaux region, the Spanish government has also embarked on a major re-afforestation project with *P. pinaster,* establishing approximately 780,000 hectares up to the mid 1980's. The afforestation was on cleared agricultural land which was often abandoned due to its low fertility and steep slopes. Spain has approximately 1 million hectares of *P. pinaster* in natural stands and plantations. In Spain there are many stands of *P. pinaster* in low rainfall (400 mm) areas. There are also many stands that are protected in National Parks in often rugged and high altitude country.

The Spanish provenances are not included in the Western Australian *P. pinaster* breeding program which concentrated on the Portuguese Leirian strain as this had better form and vigor. The downside of using the Portuguese strain is that it comes from a high rainfall zone where stands do not experience the harsh climate we experience in Western Australia. Now that we are pushing *P. pinaster* plantations out to the 400 mm-rainfall zone, we require more drought tolerant provenances. Another advantage of using Spanish provenances is that they generally occur far from the coast so experience more climatic extremes than the Portuguese or French Strains.

There are other populations of *P. pinaster* in North Africa, Corsica and Italy. My interest in visiting the Spanish populations was to inspect provenance trials established in the 1970's. Spain has the only "dry" populations or plantations that can be visited relatively easily. The Spanish are also very capable and willing to provide seed or vegetative material for the FPC-WA breeding program.

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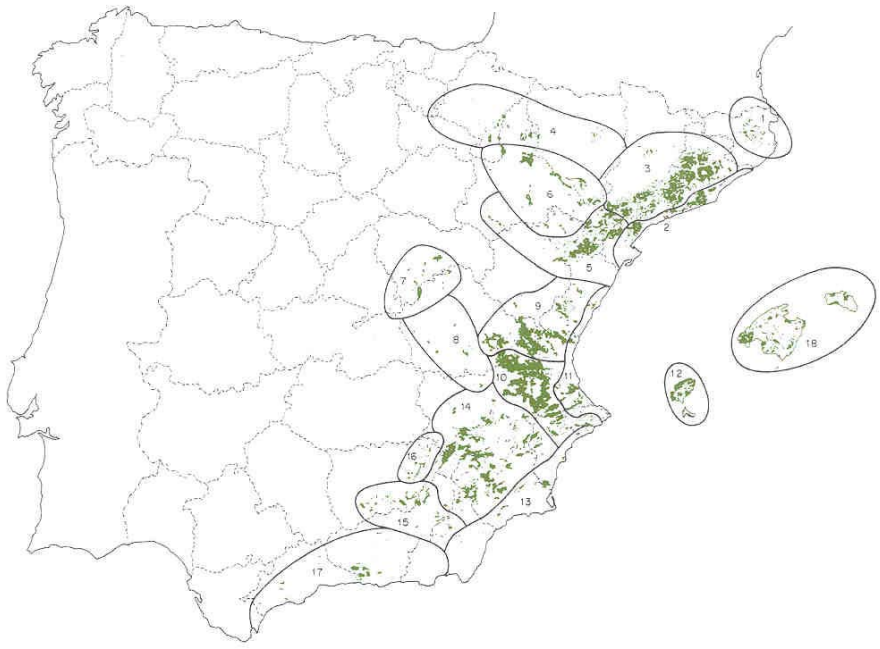


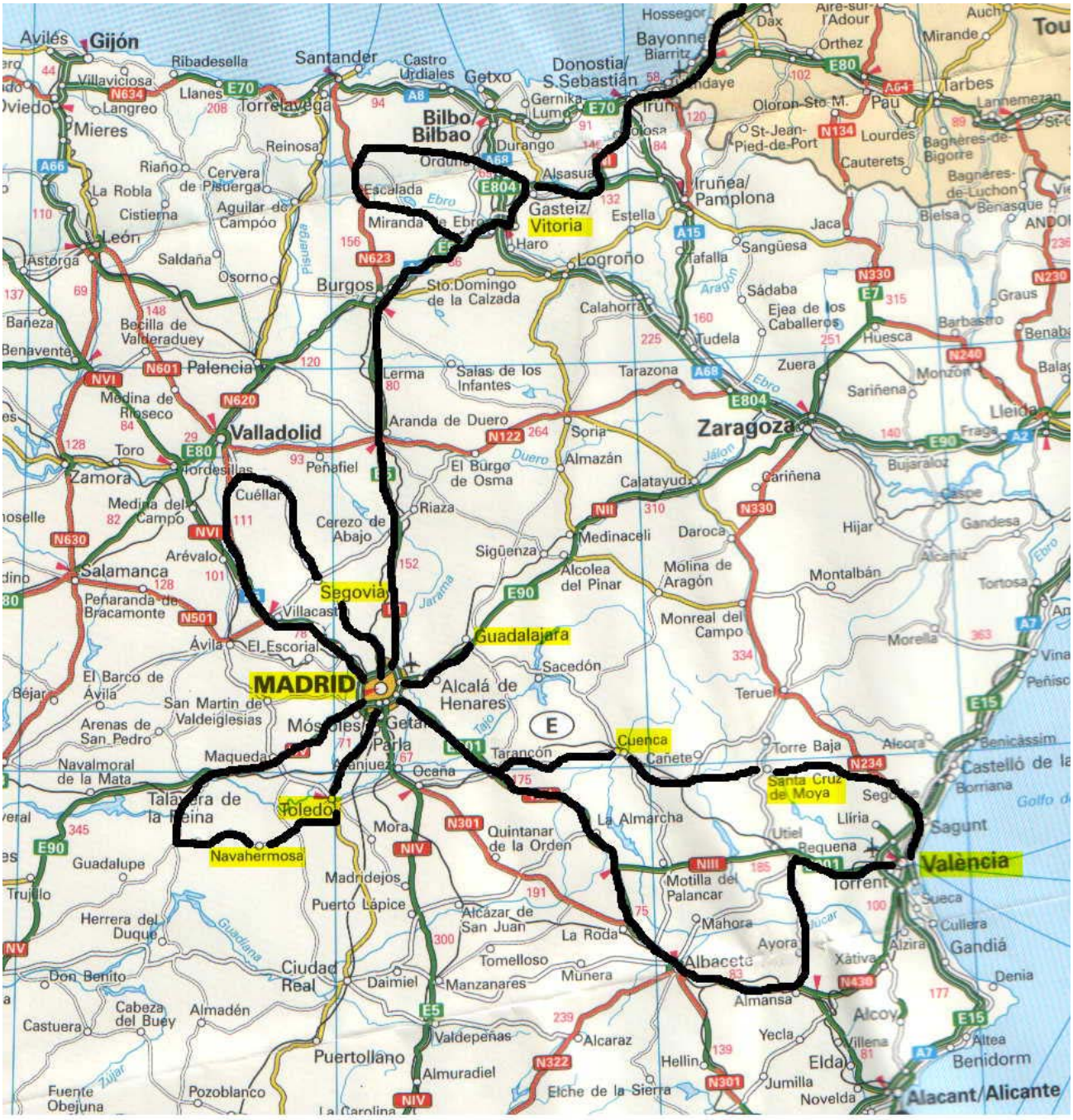
**FIGURE S2**. Distribution of *P. halepensis* natural populations in Spain.

Spain also has vast areas of natural populations of *P. halepensis* along its southern and eastern coast (Figure S2) *P. halepensis* is also found along the Mediterranean coast through to Greece as well as in North Africa where there are populations in Morocco, Tunisia and Algeria.

*P. halepensis* range is generally in low rainfall (400 mm) areas that experience very hot dry summers. The soils I saw *P. halepensis* growing on were almost pure limestone rock and almost always on sites with steep slopes and little or no topsoil. In discussions with Spanish foresters, *P. halepensis* seems to be regarded more as a tool to prevent further erosion rather than a good timber tree. It seems to grow where no other tree species could exist. The main problem with this species is its very poor stem form. Almost every planting that I have seen of this species in Western Australia and in Spain has had excessive stem sweep and heavy branching. The great advantage of this species is its extreme tolerance of drought, possibly more than any other *Pinus* species. There are some stands that demonstrate good stem form although in general this species has poor stem form.

As in Turkey I found that at around 1000 metres ASL there was usually a change in climate that favoured different pinus species. At altitudes of less than a 1000 metres ASL, *P. pinaster* was a dominant forest species in the areas I visited in Spain. Above this altitude *P. nigra* or *P. sylvestris* often became the dominant tree. In Spain and in Western Australia I have not seen these two species perform well at lower altitudes.

The plan on the following page shows the sites I visited in Spain as well as the route I took between sites. One point that can't be shown in detail on the plan is the influence altitude has on the performance of different pinus species.




**MAP 1**. Route traveled through Spain, highlighted cities are mentioned in report.

## 2.2 I.N.I.A. MADRID.

While in Madrid I visited INIA (the National Institute for Agrarian and Food Research and Technology), I met Dr Ricardo Alia from CIFOR (Forest Research Center). CIFOR is the national forestry research centre whose main objective is to “provide society in general and, specifically, administrators with decision taking and managerial responsibilities and also the different production sectors, with scientific knowledge and the services required of them.”

Dr Alia has worked for many years on the *Pinus* species of Spain. More recently he has headed a group mapping the natural immigration of *P. pinaster* through Southern Europe. Dr Alia gave me a tour of the facility and grounds of INIA; I was shown a trial assessing the resistance of Dutch Elms to *Phytopthera cinnamonii* (more commonly know as Dieback Disease). The Spanish were surprised to find out how much damage has been caused by Dieback in Western Australia’s Jarrah forest.

## 2.3 RESIN PRODUCTION.

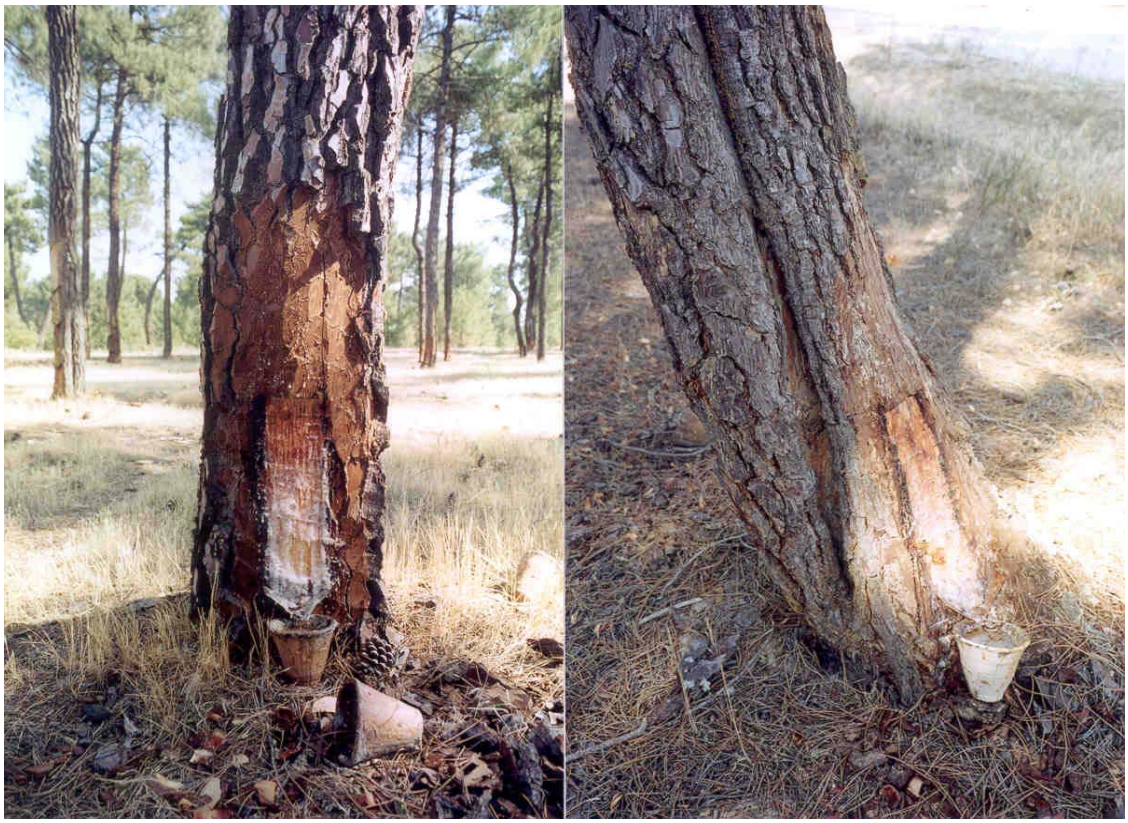
Ricardo Alia, Lolla Agundez and Wubealem Tapesse (an Ethiopian scientist working on *P. pinaster* resin production in Spain) gave me a magnificent tour through the *P. pinaster* plantations near Segovia and Coca which were used solely for resin production.

*P. pinaster* is also called Resinifro in Spain as it is the tree that produces the highest volume of quality resin. Other *Pinus* species, which are more resinous such as *P. halepensis* and *P. brutia* apparently don't produce such a high quantity or quality of resin as *P. pinaster*.

**FIGURE S3**. Wubealem Tapesse alongside a grafted *P. pinaster*.

The *P. pinaster* plantations (natural *P. pinaster* forest that has been managed for resin production for many decades to the point were the forest now resembles a plantation) in the Coca area cover 40,000 hectares and are used solely for the purpose of resin production and have for decades been the main resin producing forest in Spain. The resin is used for the manufacture of paints, lino flooring and pharmaceuticals. The plantation areas are generally located in very broad valley floors several kilometers long and wide. The soils in the plantations are derived from a quartz material and have a moist clay base at 2 to 10 metres below the surface. The sandy soil in the plantation areas is considered to poor for agriculture.

The climate in this area is similar to Perth in summer (hot and dry) with 500 mm rainfall per annum. The winter is cold with many frosts, which may freeze pine needles up to 5 m above the ground (compared to the light frosts we experience in Western Australia which rarely freeze any plant material 10 cm above the ground).



**FIGURES S4 & S5**. Old method of Resin production from *P. pinaster.*

The resin production industry in Spain almost ceased completely in the 1950's to 1960's due to increased labour costs and the importation of cheaper resin from China. Currently there is a renewed interest in the industry as some Spanish companies want to use locally produced resin as it is believed to be of a higher quality than the imported product. INIA have recently completed a breeding program that has seen a 100% increase in resin production from improved selections. Timber is also harvested from the forest but is no more than a by product of resin production.

A *P. pinaster* tree is usually 40 years old (or 35cm in diameter) before it is used for resin production. Cuts are made through the bark to expose the cambium in strips 15 cm wide and 50 cm long. Acid is then applied to make the tree produce a higher volume of resin run (Figure S4 and S5). A small strip of tin is hammered into the trunk at the base of the cut to funnel the resin into a ceramic or plastic cup. As the resin dries up a new cut is made further up the tree. This process is repeated until the cuts reach around 2 to 2.5 metres above ground level.

The tree is then left to heal over this scar and the process is started again on a fresh strip of bark. It is a strange sight to see 1,000s of hectares of trees which have been “vandalized” in this manner. Though the Spanish foresters were used to this sight, to me it appeared to be plain vandalisation of a good stand of timber. A rotation finishes when a stand reaches between 100 to 120 years of age. At this point, the tree trunks are often twisted and disfigured due to decades of damage from resin extraction.

The new method of resin extraction (Figure S6) involves drilling a hole around 10 cm in diameter through to the cambium. Then inserting a plastic cup in to the hole, the cup has a plastic bag affixed to one end to collect the resin. This new more efficient method requires less labour, produces a cleaner product and causes less damage to the tree.

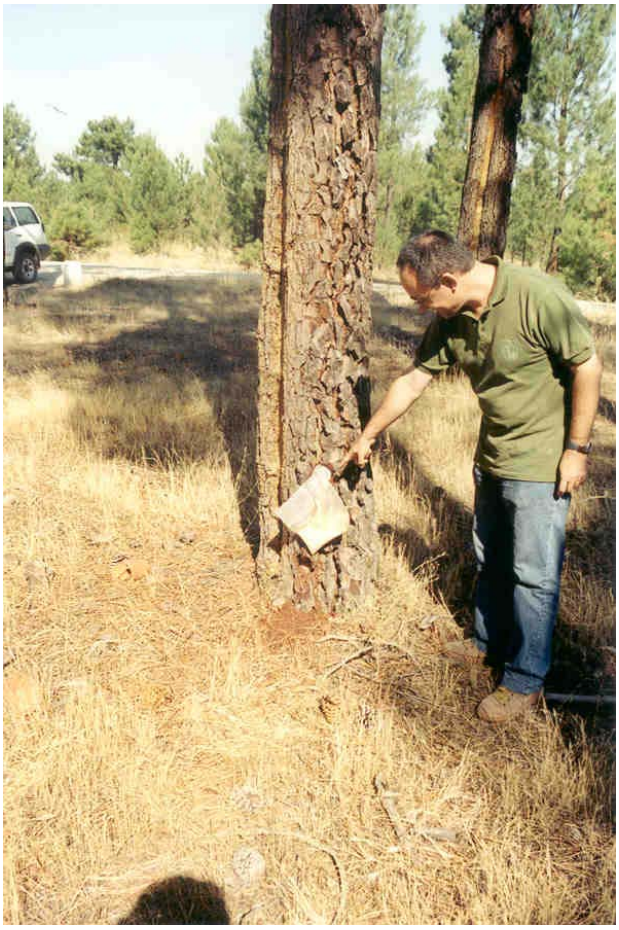


**FIGURE S6**. Ricardo Alia pointing at the new method of Resin extraction.

## 2.4 NATURAL FORESTS.

### 2.4.1 COCA *P. pinea*

**FIGURE S7.** *P. pinea* (Stone Pine) amongst a *P. pinaster* stand.

In the same general area as the resin plantations (COCA) was a mixed stand of *P. pinaster* and *P. pinea* (Stone Pine). Stone Pine is best known for its production of large edible seeds rather than its timber. There are plantations of it in Turkey, Italy and Spain for seed production. This species has a natural distribution very similar to *P. pinaster* (through Spain, Portugal, Italy and some isolated occurrences in Greece and Turkey). The few planted specimens I have seen in Australia are not attractive as a forest species as trees have a tendency to develop a massive crown at ground level. It is interesting to notice that most of the Pine seeds sold in stores are more than likely imported from China from a different species. The *P. pinea* shown in Figure S7 are the only trees of this species I have ever seen that have a straight bole. I believe this species is worth some consideration in future arboretum plantings especially if seed from this provenance is available.

Figure S8 shows an almost pure *P. pinea* stand near Coca. In the foreground you can see some small furrows, which contain 3 year old *P. pinea* seedlings. Tree growth is apparently very slow here due to the hard winter frosts and hot dry summers. It is also apparent in this photo that the weed growth on this sandy soil is very poor.

**FIGURE S8**. 3 year old *P. pinea* stand near Coca.

The *P. pinea* in the Coca area appeared to be in natural stands often scattered through the *P. pinaster* forest, although as can be seen in figure S8 artificial regeneration was required after harvesting. These regeneration operations have created almost plantation stands in the natural forest. It was often difficult to determine if I was in a plantation or *P. pinea* or an area of artificial regeneration in a natural stand.

Since *P. pinea* seed has been used for human consumption for centuries it is quite possible that many of the stands I thought were natural were established as seed production areas many centuries ago. This may account for *P. pinea's* distribution throughout much of the Mediterranean, when to me it appears to be a poor competitor with the *P. pinaster, P. brutia* and *P. halepensis.* From the stands I have seen I believe *P. pinea* has a slower growth rate with a lower final top height.

## 2.4.2 CUENCA.

Fernando Del Cano and Diana Barba, both from I.N.I.A., drove me through Las Torca National park were I saw some magnificent stands of *P. nigra*. In the past *P. nigra* has been trialed in Western Australia, as its natural range is similar to *P. pinaster.* What I found in Spain and Turkey is that *P. nigra* only performs well at altitudes over 1000 metres. To generalise, *P. nigra* really only appeared to become the dominant forest cover where other low altitude pines such as *P. brutia* and *P. pinaster* started to struggle. There was no change in soil type and little change in rainfall where this occurred but the higher altitude certainly had a milder climate.

**FIGURE S9**. Fernando Del Cano and Diana Barba are under the *P. pinaster* in the centre of the photo near Cuenca.

Figure S9 shows how rocky some of the natural *P. pinaster* country is south east of Madrid. The main soil type in this area was $CaCo_2$ (limestone based marl) with many limestone rock outcrops and cliffs.

**FIGURE S10 and S11**. *P. pinaster* stand near Cuenca.

Figures S10 and S11 show the best natural stand of *P. pinaster* I visited in Spain. The form of the stand was good and it was carrying a basal area of 50 $m^2$/ha with an estimated top height of approximately 20 metres. In figure S11 resin extraction scars are visible up to 2.5 metres above the ground.

**FIGURE S12**. Small village amongst pine forests near Bonoiches.

Figure S12 best demonstrates the undulating landscape that much of Spain's natural stands of *P. pinaster* are found on. As can been seen from this figure the natural forests of *P. pinaster* are quite picturesque.

### 2.4.3 BARRACA (near VALENCIA).

The pine forests North and West of Valencia are in supposedly some of the harshest and driest areas of Spain. Rainfall in this area is approximately 600mm per annum. Summer is dry and hot with a dry and cold winter; rainfall is greater in spring and autumn. Figure S13 shows a hillside that has poor *P. halepensis* regeneration after the forest was destroyed by a wildfire in the 1980's.

The foresters present had attempted artificial regeneration on this hillside with very poor results. On several sites near Valencia the foresters present commented on how for the past 20 years the climate had been much harsher and pine regeneration had been very slow and patchy.

**FIGURE S13**. *P. halepensis* natural regeneration near Valencia.

In a forest 50 kilometers north of Valencia, *P. pinaster* regeneration at age 6 years was about 1.5 m tall (Figure S14). All the *P. pinaster* forests in this area have a slow growth rate due to the poor soil and harsh summer climate. The normal rotation length here for *P. pinaster* was 120 years.

**FIGURE S14**. Arancha Prada, Fernando del Cano, unknown forester and Diana Barba amongst 6 year old *P. pinaster* regeneration.

In this region there were many promotional signs which gave information to the public on how much European Union (EU) funds had been spent on afforestation works. EU money appeared to be assisting the local Forests Department in rehabilitating burnt forests and new afforestation on abandoned farmlands. The EU were providing up to 85% of funding for some projects. At this point I asked if Australia could become part of the EU so we could receive some of their assistance money (the Spanish foresters were very grateful that the richer EU countries were providing such assistance).

**FIGURE S15**. Spanish Foresters looking through my Forestry photo album.

The Spanish foresters who were my hosts, were shown the photos I had of *P. pinaster* plantations in Western Australia (Figure S15). They were very impressed with the growth and could not comprehend how improved *P. pinaster* could have such good form and vigor. I carried this album at all times as I found it was the most effective way of communicating what my role in the Forest Products Commission is and the type of plantation work that I am involved in. The one fact that seemed hardest for the Spanish foresters to grasp, was how in Australian *P. pinaster* plantations we have such short rotations (40 years) compared to there rotation lengths of over 100 years.

## 2.5 PLANTATIONS

### 2.5.1 NAVAHERMOSA.

Ricardo Alia, Lola Agundiz and Maria Ribeno from I.N.I.A. took me south of Madrid to a Provenance trial of *P .pinaster* established in 1967.

**FIGURE S16**. *P. pinaster* plantation Navahermosa (near Toledo).

In Turkey the current afforestation works were transforming *Quercus coccifera* scrubland into pine plantations. It was interesting to see a similar project in Spain, where from the 1940's to 1980's, *Quercus ilex* scrubland was transformed into *P. pinaster* plantations. One such plantation of approximately 20,000 hectares was planted near Navahermosa in the 1960's (Figure S16). In this plantation, *P. pinaster* seedlings were planted in rows approximately 2 metres apart with 2 metres between stems giving an initial stocking rate of well over 3000 spha. The high stocking rate suppressed scrub competition and kept branching under control.

**FIGURE S17 and S18**. Trial of 43 provenances of *P. pinaster* at the Espinoso site.

Figure S17 shows a *P. pinaster* provenance trial established in 1967 at the Espinoso site at Navahermosa. The aim of this trial was to test the performance of 43 provenances of *P. pinaster* on five locations through Western Spain. The Leirian provenance from Portugal had the best vigor in the trial with good form although several stems had died from drought. Figure S18 shows myself standing beside a tree from the Leirian provenance.

In the FPC plantations north of Perth we have a trial (established in 1968) with several of the same provenances tested at the Espinoso site. Due to the poor sandy soil in Perth, our FPC trial has much greater variation between provenances than expressed in the Espinoso site, where there is noticeable difference in form between provenances but often very little difference in vigor. This is not the case at the provenance trial in Perth were the Leirian strain has a volume 150% greater than the Corsican strain.

**Figure S19**. Maria Ribeno, Ricardo Alia and Lola Argundiz in a plot of poorly formed Spanish provenance of *P. pinaster*.

Some of the Spanish populations demonstrated extremely poor form at this site with the worst performing plot in the trial shown in Figure S19. Ricardo Alia showed me through the whole 43 different provenances here which included populations from Corsica, Morocco, Italy, France and 37 Spanish stands. Results from across the five trial locations indicated that the following three provenances were the best performers on dry sites:

Morocco, Cazorla (Spain) and Avila/Arenas (Spain).

From earlier trials in Western Australia we have known that the *P. pinaster* from Morocco has good form but the performance of Spanish provenances was generally unknown. It was helpful to confirm that the Spanish provenances show a much higher drought tolerance than the Portuguese provenances which our current breeding program is based on and that a few select Spanish provenances also have acceptable form.

Not far from the Espinoso trial site we drove past plantations of *Eucalyptus camaldulensis*, which were apparently grown for pulp and paper production. There were also some small stands of *Quercus suber* (Cork Oak). Lola Argundiz has previously worked on this species and informed me that cork can be harvested at age 20 or when the tree has a diameter at breast height of 19 cm. Although the first good cork harvest is usually at age 40.

### 2.4.2 VALENCIA *P. halepensis.*

The only plantation of well formed *P. halepensis* I have ever seen was growing on relatively flat productive farmland near Valencia (.Figure S20 and S21). The good vigour of the stand may be a reflection of the better soil however this does not account for the good form. In this area the soil is too poor for *P. pinaster* so *P. halepensis* is used for most afforestation. I was of the opinion that the afforestation in this area was for erosion control on the steep limestone hills and not timber production.

**FIGURE S20 and S21**. *P. halepensis* plantations near Valencia.

Figure S22 shows a *P. halepensis* provenance trial also near Valencia. This species generally has a slow growth rate for its first few years. In this trial provenances which were showing great vigor at age 7 are now marginally in front of poorer provenances at age 14. From several small mixed species plantings of *P. radiata*, *P. halepensis* and *P. pinea* in Western Australia, I have seen individual *P. halepensis* stems progress from a sub dominant trees at age 8 to dominant trees at age 12. This planting confirmed why this species is often referred to as a late developer.

The *P. halepensis* provenance trial was designed to test the adaptability of different provenances from Spain, Italy, France and North Africa. As with much of the research work in Spain, this trial was for conservation and not production purposes so there was no plus tree selection involved with the collection of seed from each provenance.

**FIGURE S22**. *P. halepensis* provenance trial near Valencia.

### 2.4.3 VITORIA (Basque region).

Ricardo Alia from INIA recommended I visit some of the plantation forestry in the Basque region of Spain. After looking through my photo album on *P. pinaster* and understanding what can be grown in Western Australia, then seeing my reaction when shown the slow growing forests of Spain, I believe he thought I should see some productive plantations before leaving Spain.

The Basque area certainly has that with 150,000 hectares of *P. radiata* plantation, which are entirely on ex agricultural sites. The average planting per property over this estate is only 5 hectares! Figure S23 shows a planting of only 1000 square metres; this is the smallest area that will be planted under the forestry lease/share farming arrangements.

**FIGURE S23**. Two year old *P. radiata* near Vitoria.

The Basque area is certainly different to the *P. pinaster* and *P. halepensis* country I visited in other parts of Spain. In the Basque region the soil was a rich sandy clay or shale and the climate was similar to southern Victoria (high rainfall spread throughout the year). It was reassuring to finally see some productive plantation forestry. In this region *P. radiata* plantations have an approximate MAI of 20 $m^3$ / hectare/ annum.

**FIGURE S24**. Santaigo Espinel in a *P. radiata* trial near Liodio.

Mr. Santaigo Espinel (from the Forest Department in Vitoria) is breeding *P. radiata* to improve its vigor and form on these Basque sites. Figure S24 depicts one such trial he has established in the area. It surprised me after traveling through millions of hectares of pine forests in Turkey and Spain to find the only tree breeding for volume improvement was with an exotic species (*P. radiata*).

This Basque Region estate of *P. radiata* produces approximately two million cubic metres of wood products annually. Mr. Espinel has already produced significant gains in his *P. radiata* breeding program for this area. He advised me it was very difficult to obtain more land for plantation purposes so breeding was one way of producing more from the existing estate. My observation was that some second year weed control could also assist with increasing stand vigour at establishment (Figure S25). Only mechanical weed control was used in the young plantations as chemicals were regarded as not acceptable in plantation establishment.

**FIGURE S25**. One year old *P. radiata* near Vitoria.

**FIGURE S26**. Typical Spanish log truck loading short logs for chipping in the Vitoria area.

I was surprised when informed that most log trucks in Spain and France are self loading. The self loading Hiab on the truck is effective but reduces the carrying capacity of the truck (Figure S26). It is also very slow when compared to a typical forwarder with a Hiab.

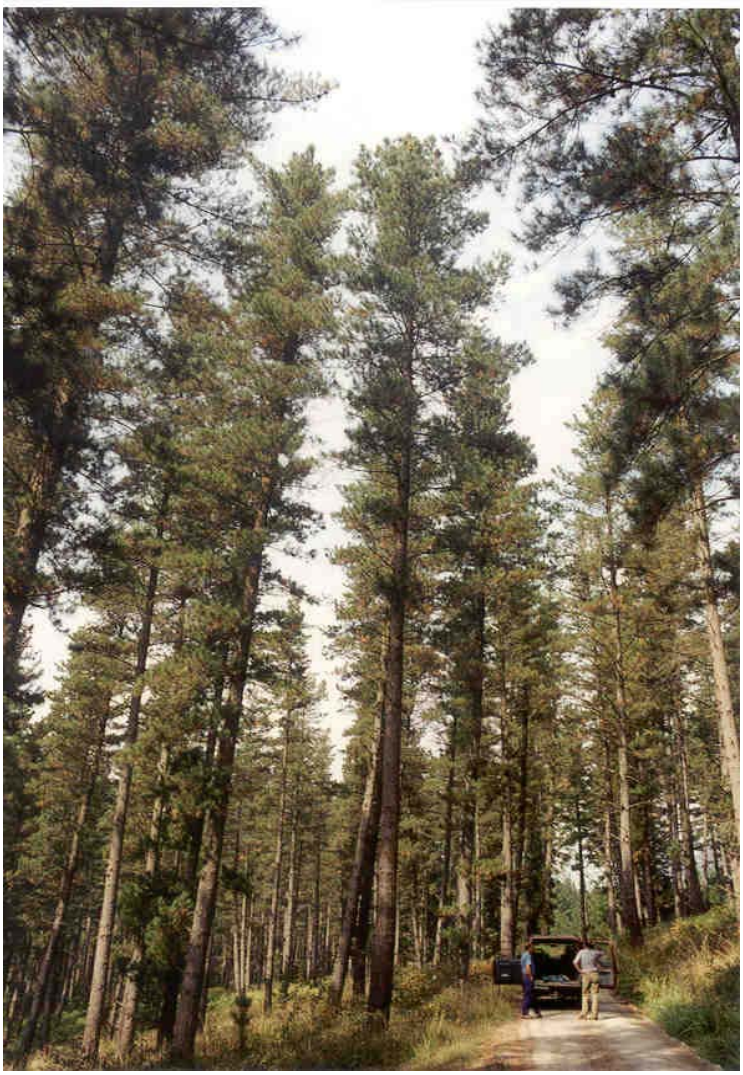


**FIGURE S27**. 40 year old *P. radiata* plantation near Vitoria.

Basque plantations can productive be when managed well (Figure S27). In this area there is virtually no new plantation establishment due to the local community's opposition to exotic species. I was shown some small plantings of *P. pinaster* in the area and was told it is not used extensively due to *P. radiata's* superior growth on these sites. I believe this is due to the lack of improvement in the Spanish *P. pinaster* provenances when compared to *P. radiata*. At one site where *P. radiata* and *P pinaster* had been planted in a mixed plantation, both species appeared to be performing equally. This is unusual to see as each species has a vastly different crown habit and yet on this site, at first glance, it was difficult to tell them apart. In the West Australian plantations this is never the case with each species looking and performing in a vastly different manner.

## 2.6 RESEARCH

### 2.6.1 SEED CENTRE, GAUDALAJARA.

Lolla Agundea from INIA took me to Guadalajara, which in Madrid traffic is about a one hour drive north east of the city. At this town is the Forestry Departments central seed store for all of Spain. The centre also contains a Forest Research nursery.

**FIGURE S28**. *P. halepensis* seed storage at the National seed centre.

The Research nursery's main function was to trial or develop methods to improve the survival and vigor of species used in afforestation. Their work covered *Pinus* as well as *Quercus* and *Fagus* species. It was interesting to see that the researchers were trying to optimize seedling growth by investigating the effects of container shape and size on root development (Figure S29). The foresters present were very adamant that on harsher sites survival was greatly improved with the use of potted stock. The optimum pot size for *P. pinaster* survival was 120 $cm^3$ on most sites. In the Galicia area were rainfall is high and the climate quite mild bare rooted stems are considered acceptable.

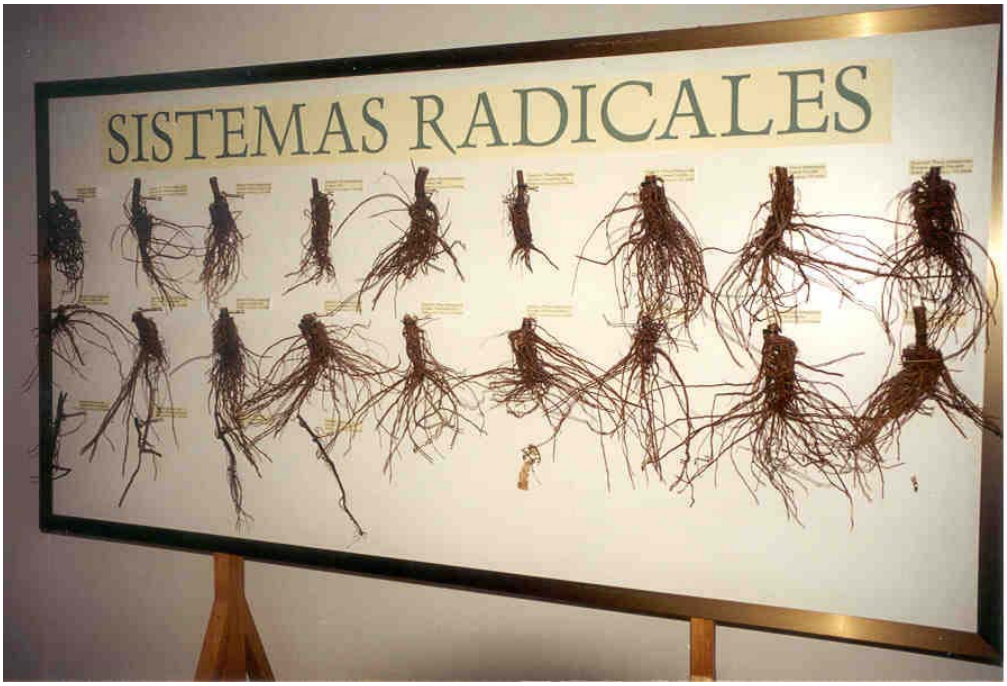



**FIGURE S29**. Root development of *P. halepensis* in various tray types.

After a quick tour of the nursery I was given an overview on the seed center's operations. As the central Forestry seed store for Spain, the center was an impressive set up. The facility had in the past extracted and cleaned up to 15 tonnes of *P. pinaster* seed per season. At present the annual production of *P. pinaster* seed is down to 5 tons per annum. The center also stores large quantities of *P. halepensis* seed (Figure S28). Unlike the Turkish seed center where all seed is kept at a constant temperature, here most species were kept in galvanized drums or silos at room temperature. The main species that were kept in refrigeration were the Oaks. Pinus species were considered to remain viable for long periods when stored at room temperature.

# SUMMARY of SPAIN

I am confident that Western Australia's *P. pinaster* breeding program would benefit greatly with the importation of seed from some select Spanish provenances which show a higher tolerance to drought than our current Portuguese provenances. Such introductions would most likely require a plus tree collection and convincing the Australian Quarantine and Inspection Service (AQIS) to lift the current ban on importing pine seed from Spain. The ban is in place on many countries (USA, South Africa, and Chile to name a few) where Pitch Canker disease has been reported (Pitch Canker is a fungal disease *Fusarium subglutinans f.sp.pini* syn *F. circinatum*) that has severely impacted *P. radiata* stands in its natural range in coastal California). I asked many foresters about Pitch Canker in Spain and none had seen any symptoms in stands of pine in the country, although it has apparently been found in a nursery in the Basque area.

I believe that both *P. pinea* and *P. halepensis* should be re-evaluated in some Australian wide arboretum style plantings with the best material possible from Spain. From previous plantings that I have inspected in Australia, I had considered both species as non-commercial prospects. After seeing a few well formed stands in Spain, I now believe that both species are worthy of some further consideration for low rainfall forestry. ALTRIG would be the most suitable group to coordinate this. While both species show some promise, I am unsure as to the origin of previous trial plantings in Australia. The visit in Spain has made me more aware of the substantial variation in form and vigour amongst the different provenances. Importing the correct provenance is vital if we are to effectively evaluate their performance.

It would be interesting to trial some resin production from the FPC's *P. pinaster* plantations. More detailed information on the costs and markets for *P. pinaster* resin would be needed before undertaking such an investigation. Bark from French *P. pinaster* is used in the manufacture of an anti oxidant product sold around the world. Developing some of these niche or alterative uses of pine trees may help make plantation forestry in Australia's drier areas more profitable. At the worst, they may be a novelty that would increase the general public's interest in *Pinus* species.

From my observations during the visit, I believe that Spain could benefit greatly from some commercial trials of selected Eucalypt species from Australia such as E. cladocalyx and E. maculata. Some of the *P. pinaster* and *P. halepensis* plantation sites visited, planted to select Eucalyptus species, would produce a higher volume of wood per unit area per annum than the current conifer plantations.

# CANARY ISLANDS

## 3.1 FORESTRY IN THE CANARY ISLANDS.

The Canary Islands are a group of seven islands located off the West Coast of Africa near the southern end of Morocco (see figure 1). The Islands were believed to have been discovered by the Romans and later colonized by the Spanish in the 1600's. Today the Islands are part of Spain and a tourist mecca for Europeans especially the English and Germans. The Islands were used by the Spanish as the last "petrol station" on the voyage to the Americas. Due to the Islands being occupied for several hundred years, the forests have been heavily exploited up until possibly the 1960's. About this time tourism started to become the main industry of the larger islands and subsistence farming was greatly reduced as the population moved into the larger towns and cities.

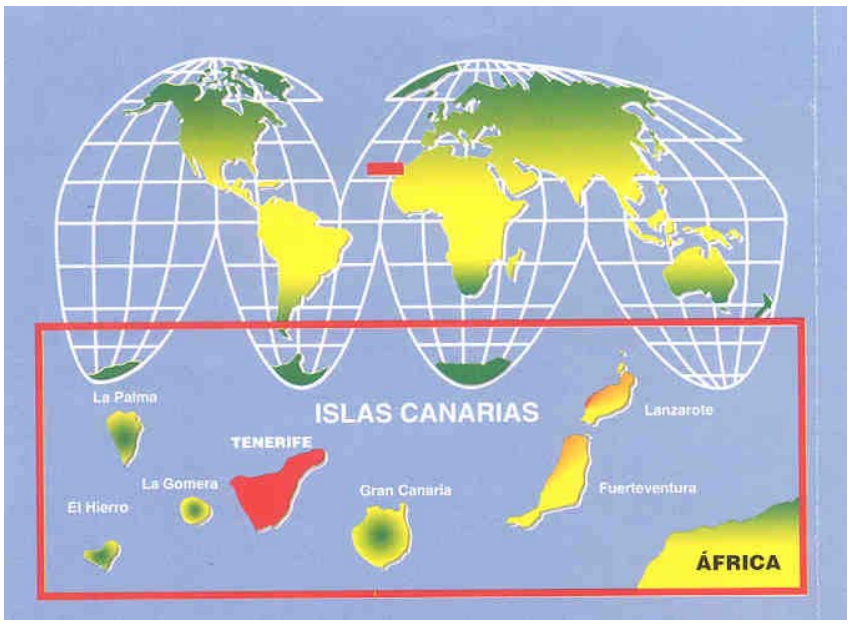



**FIGURE C1**. Location of Canary Islands.

*P. canariensis* occurs naturally only on five of the seven Canary Islands (Figure C2). The two Islands I visited, Tenerife and Gran Canaria, were of volcanic origin with the last lava flow occurring in the 1970's on the Island of Tenerife. Due to the volcanic past, most of the soil on the forested areas is very porous (in places rocks similar to barbeque heat beads occur across the landscape for hundreds of hectares). In some of the valleys there is a rich loam but generally this soil type is utilized for agriculture. Through the volcanic soil are horizontal bands of rock. I can best describe this rock formation as a gentle wave with a surface similar to ceramic coated basalt. I also saw some basalt rock, which often formed cliffs several hundred metres high.

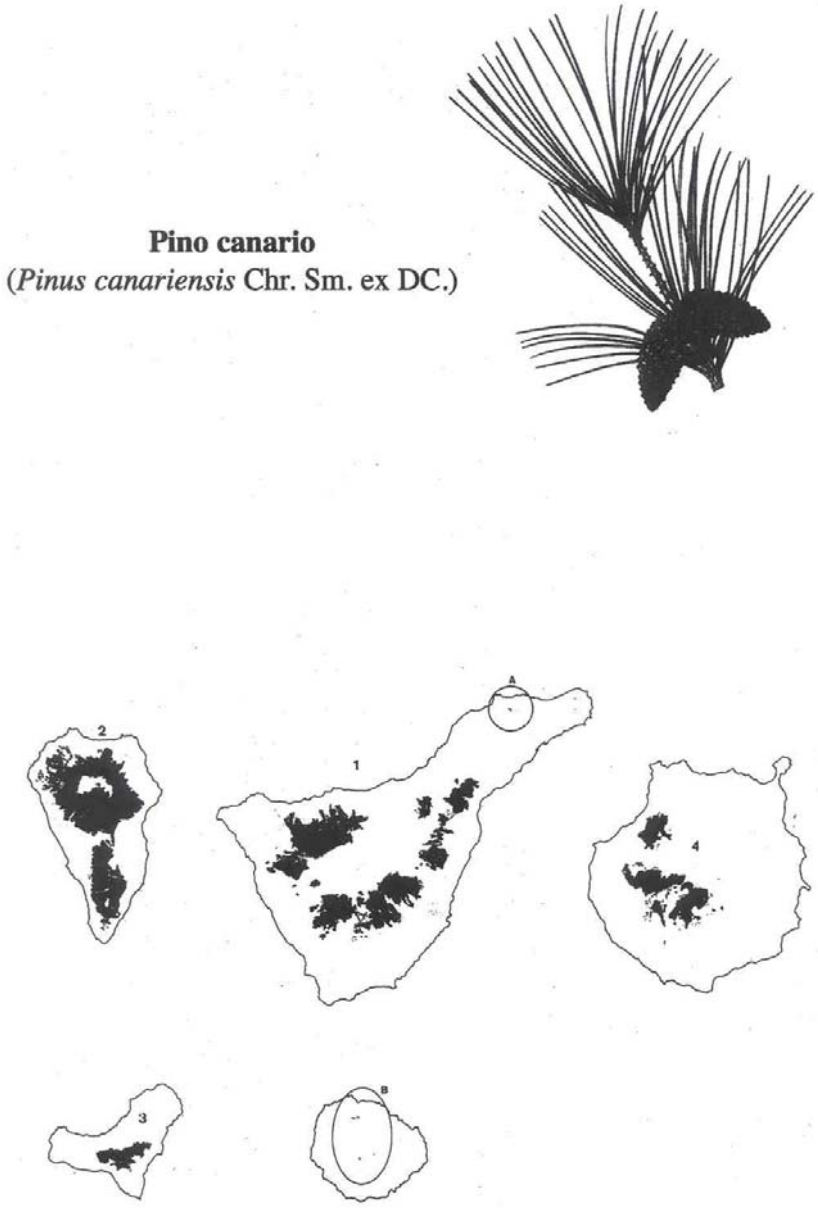



**FIGURE C2.** Map showing the natural distribution of *P. canariensis* on 5 of the Canary Islands.

The climate on the Islands where the pine stands occur is extremely varied. Rainfall in a normal season can vary from less than 400 mm to over 2000 mm. The climate on the islands is highly dependant on altitude and aspect. Horizontal rain (moisture from clouds or mists) can add 1000 mm of rainfall per year. Closer to sea level rainfall is generally much lower with higher daytime temperatures. Unfortunately due to the high population density on the islands there is little or no forest close to the coast.

Canary island pine is easily identified by its long soft needles and very uninodal branching habit. *P. canariensis* also produces almost blue juvenile foliage when germinating from seed or re-sprouting along the stem from damage such as animal grazing or fire. This species has a very strong apical dominance and it is rare to see a stem with any butt sweep or multi leaders. There is one other pine that is similar in appearance to *P. canariensis* and that is *P. roxburghii* from Northern India and Tibet. However, *P. roxburghii* does not produce the bluish foliage when damaged and has not been planted as commonly as *P. canariensis* in Australian arboretums and gardens.

In Australia there are many small plantings of *P. canariensis* in arboretums, on farms, in private gardens and in some botanic gardens. In Western Australia it has occasionally been used for farm plantings throughout the Wheat belt. Plantings are generally for ornamental value as well as stock shelter. In the Mundaring plantations east of Perth, the Forest Products Commission (FPC) has some 10 hectares of this species established between the 1920's to the 1970's. The FPC's interest in this species is due to its high drought tolerance and exceptional stem form. From my observations of the scattered plantings throughout Western Australia, I have not seen *P. canariensis* die from drought or Wildfire.

From publications relating to Australian forestry written over the past 70 years, I found little interest expressed in the commercial use of this species probably because on a good *P. radiata* or *P. pinaster* site, *P. canariensis* is a much slower growing pine. However, on the Canary Islands on harsh sites, *P. canariensis* outperforms *P. radiata, P. halepensis* and *P. pinea*.

From my observations it would appear that in the 1960's to today there has been a significant amount of re afforestation on the Islands, especially on the Island of Tenerife. This re establishment of *P. canariensis* appears to be for commercial and environmental goals. Some plantation sites had reasonable growth rates although many sites were almost sheer cliff faces or steep ravines. At some time in the 1970's, other Pinus species were trialed on the islands. These other pines such as *P. radiata, P. pinea* and *P. halepensis* appeared to have failed on almost every site alongside *P. canariensis*. I can only guess these other Pinus species could not handle the dry and hot conditions combined with the porous volcanic soil.

Figure C3 is of a magnificent solitary *P. canariensis* near the village of Vilaflor on the Island of Tenerife. There is another “King Pine” 100 metres away that measures 60 metres tall with a slightly smaller diameter. The next dominant pine within 500 metres would be at best 25 metres tall. I can only guess that these two “King Pines” were spared from the axe due to their lack of a decent bole as both stems have multiple leaders. This multiple leader form is rarely seen in this species. The site the trees are growing on is also in a drier region of the Island with, in my opinion, a very rocky infertile looking soil.

**FIGURE C3.** *P .canariensis* at Vilaflor village, Tenerife Is. Tree is 56 metres high and 2.7 metres diameter. I am standing to the left side of this tree.

One of the amazing properties of this pine is its ability to withstand fire. From the recently burnt (Figure C4) areas I visited on the Islands, I believe this pine has the fire tolerance we associate with many Eucalypts. It has the ability to re-sprout from the ground when young if defoliated by fire. When branches are defoliated by scorch the tree can recover from epicormic growth from the trunk. Its' bark is quite thick and appears to protect the tree adequately from all but the most severe fire. The older a tree is, the better it withstands fire possibly due to the development of thicker bark. Mature trees can withstand large amounts of scorch with no ill effects on tree health. Another interesting feature is there are several examples of *P. canariensis* trees on the islands that have survived for decades after being completely ring barked.

**FIGURE C4**. *P. canariensis* stand 3 months after being scorched in a wildfire. These stems are around 30m tall with diameters at breast height of up to 50 cm.

## 3.2 The Island of GRAN CANARIA.

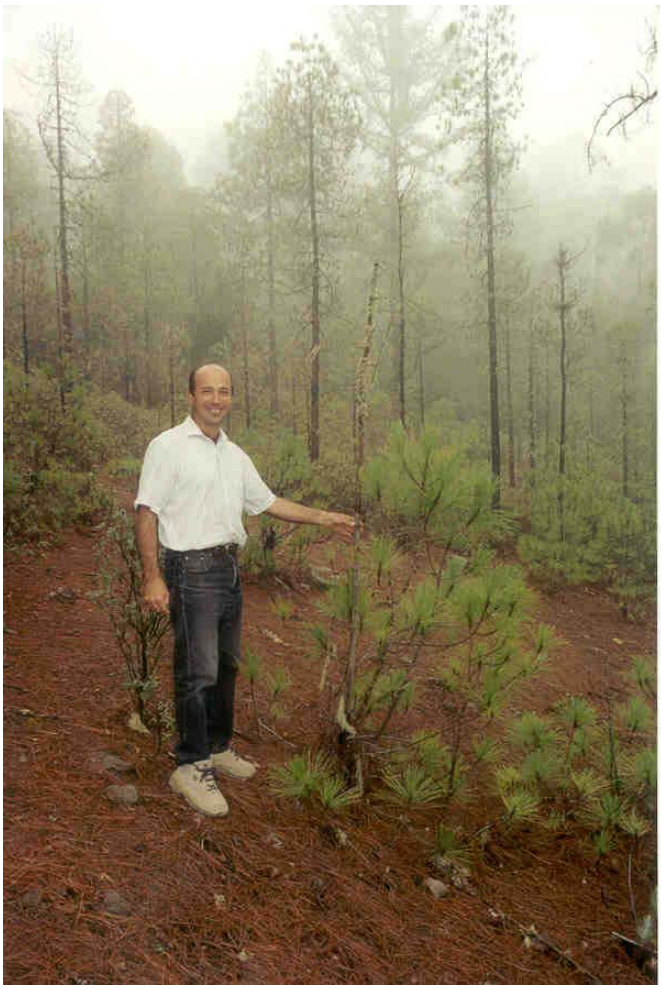


**FIGURE C5**. Carlos Velazquez beside a *P. canariensis* that has re-sprouted from its root system after being damaged by fire.

*P. canariensis* can also produce coppice similar to *E. globulus* from a stump (Figure C5). But its' generally unknown feature is its dark heartwood. The heartwood of this species can start developing at age 30 and is more similar to a Eucalypt hardwood than most softwoods. The heartwood has light brown colouration and is very resinous. It has been used in many of the older buildings on the islands and is reported to have lasted up to 300 years in outside applications (see figure C6). It is also reported to be very durable when in contact with the soil.

Currently the forest service on the Islands is attempting to re-start a local timber industry based around the species. There is an estate of approximately 60,000 hectares of *P. canariensis* on 5 of the Islands. For decades there has been very little timber harvesting due to most mature stands having been reserved. At present, most of the plantation stands are due for a first thinning. Due to the islands remote location and a lack of local processing, the forest service faces a challenge to use the wood locally until the plantations start producing saw log sized material.

**FIGURE C6**. This 100 year old balcony on a house near the village of Terror is constructed with *P. canariensis* heartwood.

Figure C7 shows a site were *P. canariensis* was established one year ago. This site has apparently received only 50 mm of rainfall since planting! The trees have been watered twice by hand since establishment. This barren, rock strewn site is the harshest piece of ground I have ever seen trees established on.

Site preparation was with a small excavator to break the rocky soil. Large rocks were then removed by hand then a hole was dug to plant the *P. canariensis* seedling. Small guards were placed around each tree for protection from grazing and to provide some protection from the sun. All this care appeared to be worthwhile as survival was good and the trees seemed to grow well while the native vegetation had died from drought. Yet to me this seems to be extreme measures to establish trees with reasonable scale afforestation (this planting

covered around 40 hectares) but there were plenty of adjacent sites that hadn't had such care and had barely 5% surviving stems. Some of the adjacent plantings had also been established unsuccessfully up to 3 times.

**FIGURE C7**. Newly established *P. canariensis* plantation in a rock desert.

Nearby above cloud level the climate became extremely dry again with low rainfall (400 mm) and endless sunshine. Another surprise on the islands was how nutrient and moisture poor the volcanic soil was and the large areas of obviously barren, rocky terrain (Figure C8). . There were small areas of rich volcanic soils but these were almost entirely used for horticulture. To realize how water absorbent the soils are is evident in the almost total absence of streams or rivers on most of the steep slopes.

The Islands have no natural lakes or permanent running water. The public drinking supplies on the Islands are supplied from rainwater or horizontal bores that reach the pockets of groundwater hundreds or thousands of meters from ground level. These bores look similar to a mineshaft having a small trolley on rails to remove rock and a large plastic pipe to supply water to the public.

**FIGURE C8**. This photo shows how rocky and barren parts of the Island are (note the two lane bitumen road to the right of the photo).

I must also mention that the roads on this Island are as windy and at times scary as can possibly be built (I am still sure that there are more crash barriers along roads in the Canary Islands than throughout all of Australia). At one point close to the cliff in Figure C8, I am sure we had half a tyre width of dirt track between the Land cruiser we were in and a 1 kilometer fall. As someone who is not fond of great heights, parts of this Island can be a challenge for the senses.

## 3.3 The Island of TENERIFE.

The Island of Tenerife is only 80 km from Gran Canary but had quite different scenery and climate to Gran Canary. In the center of the Island is a mountain (extinct volcano) which is the highest point in Spain (yes the Islands are part of Spain as Tasmania is part of Australia). This mountain (Mount Del Teide) is 3,717 m high and has some magnificent stands of *P. canariensis* on its slopes.

There is a moth endemic to the islands that once every five or ten years descends on an area of forest and defoliates it as in Figure C9. No control of this pest is possible as it damages up to a 1,000 ha's in one season. The foresters consider it a part of the natural cycle of these forests. It only appeared to kill exotic species on the Islands but the defoliation of the natural stands of *P. canariensis* must affect the growth increment of trees.

**FIGURE C9**. Insect damage in a *P. canariensis* plantation.

In Figure C9 it is possible to see the damage caused by this moth in a *P. canariensis* plantation on the Island of Tenerife. A possibility as to why this plantation was damaged is that it may not have been established with the correct provenance of *P. canariensis.*

On Tenerife, I met Dr Jose Climent from the Madrid University, Unit of Anatomy, Physiology and Genetics. Dr Climent has worked on *P. canariensis* for the past decade and has several published papers on the development of heartwood in this species. In 1999 Dr Climent established a provenance trial of *P. canariensis* on the Island of Tenerife. The provenance trial is to test the variability amongst the species. The site was originally a *P. radiata* plantation that was severely damaged by insect attack then clear felled to allow the establishment of *P. canariensis*. Apparently in the 1970's several thousand hectares of *P. radiata* was established on this Island as it was expected it would perform well in the higher rainfall sites. Unfortunately this has not been the case with many stands suffering from attack by numerous insect species and showing poor growth rates and form when compared to *P. canariensis.*

**FIGURE C10**. One year old *P. canariensis* in Dr Climents provenance trial.

At present Dr Climents' trial is too young to obtain any significant results indicating which is the best provenance (Figure C10). One observation I made at the trial site was how rocky and poor the soil was. During site preparation rocks were removed from the soil to create a depression which contained barely enough soil to hand plant a potted seedling. Even in this poor rocky soil the seedlings had apparently good survival and growth.

Figure C11 best demonstrates the horizontal rain influence on some of the forest areas. Apparently this cloud layer is a daily occurrence through much of the year. The effect of the cloud presence in the forest for much of the day permits tropical type vegetation to exist in selected sites on the Islands. In areas where horizontal rain does not occur (high and low altitudes) there is very little understory vegetation. In much of the *P. canariensis* natural forest there is virtually no other species present under the pine canopy. This may be due to centuries of grazing or the fact that locals still gather pine needles for animal bedding.

**FIGURE C11**. Cloud in the forest a daily occurrence.

As I was driven through the forests we would often see great heaps of pine needles (5 metres across and 3 metres high) alongside tracks and roads. Often a pile of needles would have a small piece of paper on a stick placed on the heap to signify its ownership. The pine needle collection seemed to be encouraged by the foresters and in my opinion it was a novel form of fire control. Apparently this is a practice that has been carried out on the Islands for hundreds of years.

**FIGURE C12**. Unusual vegetation on the Island.
**FIGURE C13**. Tagasate also called Tree Lucerne endemic to the Islands.

Being isolated from the mainland for so long, many unusual species of vegetation have evolved and survived such as the large trees in Figure C12. Figure C13 shows myself standing under a Tree Lucerne on the Island of Tenerife. Tree Lucerne has been planted in Western Australia for the past twenty years as a summer stock feed supplement. It is usually grown on duplex sands north of Perth in belt plantings that usually cover one or two hundred hectares. I would estimate North of Perth there are over 40,000 hectares of these belt plantings. It is an interesting species in that it thrives on all but the poorest of sands and has a very high drought tolerance. Yet, on the Canary Islands, there are virtually no sandy soils. So much so that, to create a few ideal sandy beaches for tourists, sand has been imported from Africa's Sahara Desert.

**FIGURE C14.** A fine stand of *P. canariensis*.

Several magnificent natural stands of *P. canariensis* were seen. Figure C14 shows one such stand where trees were around 35 m tall with diameters of approximately 50 cm at breast height. This stand also appeared to have been pruned by fire over the decades. Fire is apparently a major problem on the Islands due to the long dry summer and high numbers of people using the forests. The pines in this valley appeared to be on a rich loamy soil and at a middle altitude with over 1000 mm of rain per annum.

Figure C15 shows a *P. canariensis* forest on a flat plain with the dark area in the centre of the photo being a two hundred year old Lava flow. The Island of Tenerife had several of these lava flows from one to several hundred years old. *P. canariensis* is the first colonizing plant in these fresh lava areas which appear to have rocky and barren soils (Figure C16). These fresh lava soils are Jet black in color and become incredibly hot in the midday sun. To see the natural regeneration of this pine on this black, dry, oven like environment is a testimony to the resilience of the species.

**FIGURE C15**. The black area is a two hundred year old lava flow.

**FIGURE C16**. A forest track through an old Lava flow.

**FIGURE C17**. Young *P. canariensis* with Mount Del Teide 3,717 m in the background.

Figure C17 shows a plantation of *P. canariensis* established in the late 1970's to early 1980's with Mount Del Teide in the background. It is possible from this photo to see how little vegetation exists under this dry forest and how spectacular the scenery is on this Island.

Some of the *P. canariensis* established in this area was laid out in rows three metres apart with two or three metres between stems. Although many areas appeared to have been established on an ad-hoc basis to just get something growing to stabilize the soil and make the area green again. I was interested to notice in much of this area that *P. canariensis* was not just the only tree species but almost the only plant on this harsh rocky soil.

## 3.4 SUMMARY FOR CANARY ISLANDS

Before visiting the Canary Islands I must admit to having doubts as to the commercial viability of this species. After seeing the conditions that this species can survive in, I now believe it can become another viable species for low rainfall forestry in Australia.

After visiting just two of the five Islands and seeing first hand how damn tough this species is, I will endeavor to push for its inclusion in the Forest Products Commission Tree Breeding program and hope it may be included in the Australian Low Rainfall Tree Improvement Group (ALTRIG). The Canary Islands Forest Service is willing to help with plus tree collections from the Islands if funding is available.

From the stands of *P. canariensis* I inspected I saw no great difference in vigour or form between any of the provenances. On all sites the form of trees was exceptional with fine branching, straight stems and virtually no forked trees. I do believe that it is worthwhile trialing several of the provenances of this species as some exist in harsh low rainfall sites. Provenances from the “hard” areas may be better suited to Australian conditions. I would guess that previous seed collections have either been from the better (faster growing and larger stems) high rainfall areas or the easy to collect from, bushy individual stems that can often be seen in open areas near roads and farmland (this could account for the heavy branching that is present on some of the *P. canariensis* grown in Western Australia.

After visiting stands of *P. canariensis* that had been recently affected by wildfire, I am confident that this is the most fire tolerant of all pinus species. It would be interesting to evaluate the fire tolerance and coppicing ability of this species in some of the plantation stands established in Western Australia. If this species regenerates rapidly from a freshly cut stump similar to some Eucalypts, then it may be possible to try shorter 1$^{st}$ rotations to improve the economic returns of this species.

This species has not been considered suitable for plantations in Australia due to its slow growth rates. This has been an economic decision alone. Many block plantings at plantation spacing have been established since the mid 20s (Back Yamma State Forest near Forbes, NSW. 500 mm rainfall) and in places like Wirrabara, SA (580-600 mm) growth rates are acceptable but not economically viable. To date, I am not aware of any selection and breeding occurring with this

species, however attempts have been made to identify the better seed sources through the use of provenance trials both in Australia and overseas.

A possible limitation with this species is its apparent low cold/frost tolerance. This has been given as a reason why the species has not been used on mainland Spain or though out Europe, although frost in European terms can mean temperatures of minus 15˚C for several days in a row, with maximum temperatures of only 5˚C, plus occasional snow falls. I don't believe this is a major limitation for Australia as the areas this species is best suited for, such as the southwest of Western Australia, South Australia, Victoria and west of the Hume highway in New South Wales, generally experience winters with temperatures as low as -8° C and never see snow.

The FPC has approximately 10 hectares of *P. canariensis i*n plantations spread in small plots from Perth to Esperance. Attempts need to be made to have an assessment carried out on the existing stands growth rates, heartwood development and origin of seed source. From this assessment we can then evaluate the commercial viability of the species as a dryland conifer. The existing scattered small plantings of this species in Australia and general lack of information about the genetic origins of most plantings, clearly indicate that to make any improvements in growth for commercial purposes, further seed from an identified broad genetic base should be introduced to Australia as soon as possible before AQUIS Quarantine restrictions preclude any imports.

# FRANCE

## 4.1 THE “LANDES” FOREST.

My visit to France was contained to the Bordeaux region. It was a different experience to Spain and Turkey as France only has *P. pinaster* forests in the Bordeaux area. Frances “Landes” provenance *P. pinaster* forest covers approximately **one million hectares**. The annual production of wood products from this *P. pinaster* forest is approximately eight million cubic metres. This Landes forest is virtually one continuous forest/plantation covering the South West corner of France. To put this into perspective, there are only one million hectares of various Pinus species plantations across all of Australia.

The natural pine forest area was originally much smaller (possibly only 100,000 hectares) before the State undertook a massive program in the nineteenth century to drain the marshlands and fix the coastal dune system in this typically flat landscape in the Landes area using only *P. pinaster* (Maritime Pine) (Figure F1) .

**FIGURE F1**. Agricultural land south of Bordeaux.

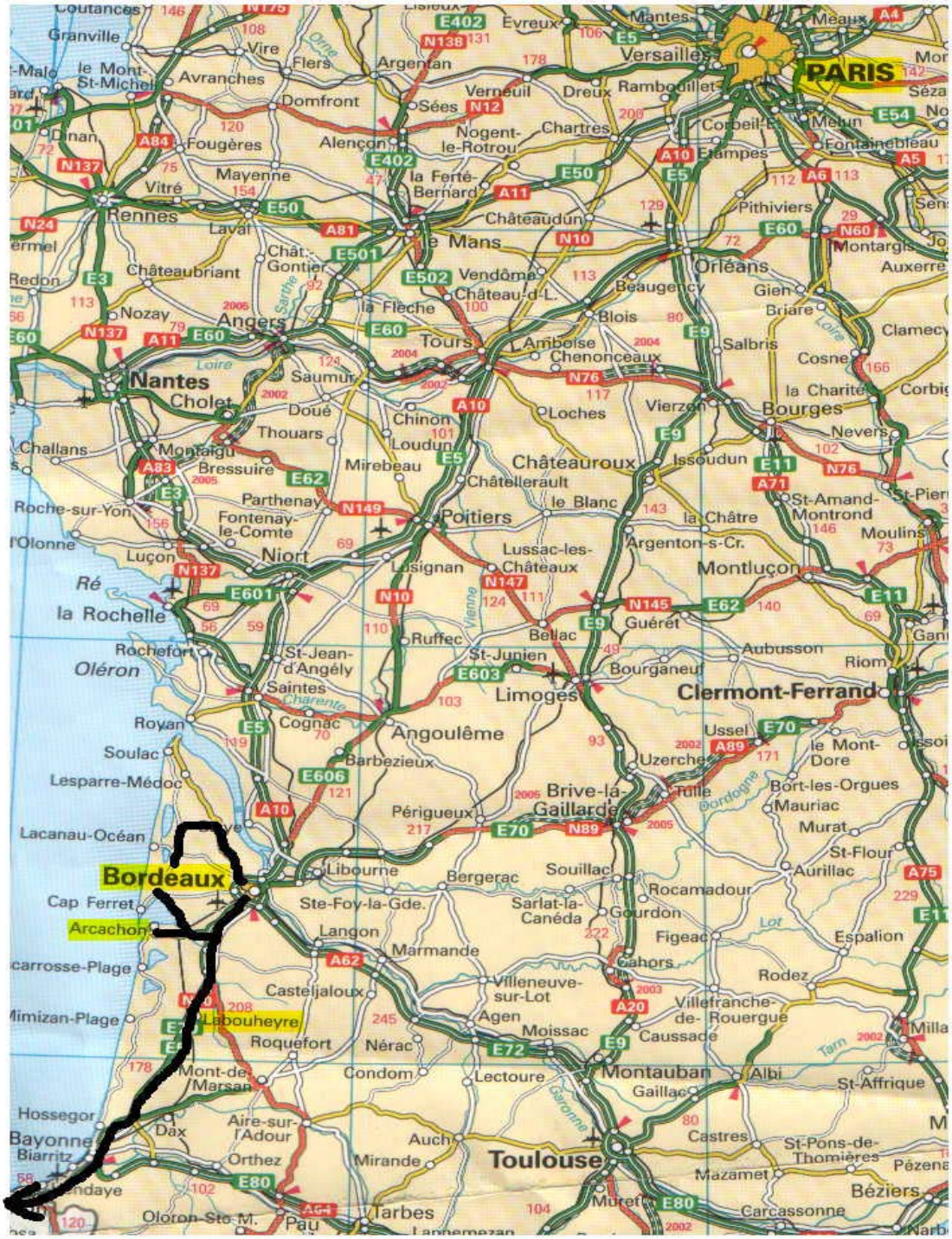
The *P. pinaster* forest was principally used for resin production until the 1950’s when the market for resin declined and timber became the principle product. The State controls only 10% of the forest area, generally along the coastal dune systems. Over 33,000 individual landowners privately own the remaining 90% of the forest.

With such a massive continuous estate of *P. pinaster,* I was interested to see how the foresters manage the 15,000 hectares a year second rotation program. Unfortunately the planting season for the area, which spans from the end of September to the beginning of April: 8 months compared to our West Australian planting season of two months, had not started. Another significant difference in their establishment technique was the use of direct seeding for up to half of all pine establishment.

The climate for the region is somewhat similar to Southern Victoria or Tasmania. Summers are short and mild by Australian standards and rainfall is approximately 1000 mm per annum. Winter can be very cold with frosts of minus 15 Celsius for over a week. One such cold event in the 1985 damaged approximately 100,000 hectares of forest. This was due to a substantial proportion of the plantation being of Portuguese origin which has a low cold tolerance. Since the 1985 frosts, under National legislation, all seed used in the Landes forests must be of Landes origin.

**FIGURE F2**. Typical soil (sand) profile in the Landes forest.

Soils were typically sandy and appeared to be similar on every site I visited (Figure F2) with the water table varying from one to five metres below the surface through much of the forest. Poor soil stability due to seasonal water logging appeared to be the cause of butt sweep in some *P. pinaster* stands. One other common soil type in the Landes forests was coffee rock, often within one metre of the surface. This coffee rock layer was also a cause of poor stability and butt sweep in some stands.




**MAP 2.** Route taken around Bordeaux .

## 4.2 I.N.R.A BORDEAUX.

The French National Institute for Agricultural Research (INRA) just south of Bordeaux was the first stop in France. Here I met many staff including the Director of the centre Mr. Jean Michael Carnus, a Frenchman who had worked in New Zealand *P. radiata* plantations. My host for the day was Mrs. Annie Raffin who has conducted the tree breeding program to improve *P. pinaster* over the past five years.

At first I was taken back by the scale of this research facility. The grounds covered approximately 300 hectares and its buildings housed a staff of possibly a hundred people. I was to find out later that INRA's Department for Forests and the Natural Environment (which has six offices in France) employs 340 research staff with an annual budget of $40 million Australian dollars!

**FIGURE F3**. Behind Mrs. Raffin is routine P. pinaster. On the right side are *P. pinaster* cuttings from improved stock planted in the same season.

Figure F3 shows uniformity in form attained through the use of *P. pinaster* improved stock when compared to routine stock. The stand on the right-hand side of Figure F3 is derived from cuttings whereas the stems behind Mrs. Raffin are routine seedlings. There has been substantial effort committed to the

breeding and improvement *P. pinaster* in the Landes forest. The *P. pinaster* in this region has good vigor (MAI's of between 8 - $12^3$ m per annum) but poor stem form. Branching appears to be acceptable but almost every stand has excessive butt sweep. It would seem that some of the stem sweep is due to the shallow soil and the trees being unstable on water logged sites.

**FIGURE F4**. Mrs. Raffin in a storm damaged research plot (INRA grounds).

After a severe storm in 1999 many *P. pinaster* stands in the region were damaged. It was interesting to see in the trial in Figure F4, that most of the treatments with high amounts of fertiliser and irrigation had resulted in rapid growth and subsequently suffered greatly from wind damage. The control plots that were growing with standard silvicultural techniques received only minor damage. It must have been an expensive option to stabilize each stem with two rope stays, but the researchers had apparently put a lot of resources into this trial and considered it worthwhile saving.

I was also shown a demonstration stand of inbreeding in *P. pinaster*. I found this planting interesting as I hadn't previously considered trees to exhibit deformities from inbreeding in a similar way and extent as livestock. Trees were showing severely poor form and lack of vigour. Unfortunately the weather had turned foul and I was unable to take photos.

## 4.3 AFOCEL BORDEAUX.

Pierre Alazard introduced me to most of the staff at the Association Forest-Cellulose AFOCEL. Mr. Alazard is the principal tree breeder for AFOCEL's Moulis en Medoc office and has worked for many decades on the improvement of form and vigour in *P. pinaster*.

The following is a brief summary of AFOCEL's activities.

AFOCEL was founded by the pulp and paper industry and has 100 staff with an annual budget of $15 million Australian dollars. The office at Bordeaux is involved with mainly *P. pinaster.* Current AFOCEL projects include:

- genetic improvement of *P. pinaster*
- improving the production and quality of resources
- silvicultural research
- Improving the environmental aspect of forestry operations.

AFOCEL is a very interesting research organization in that they are only partly funded by the state (close to half of their funding is from the timber industry). It appeared that all of their projects were commercially based, such as the improvement of logging methods to achieve better utilization or the breeding of *P. pinaster* to improve form and vigor.

In discussions with AFOCEL staff, they advised me that many French foresters do not agree with the monoculture forest regime in the Landes area. They consider the forestry in Landes to be too production based. This is similar to some of the attitudes of Foresters I encountered in Spain and Turkey when discussion turned to monoculture plantations. I found this very different to the plantation forestry culture of Australia that I believe is all about improving the productivity of a species.

### 4.3.1 SMURFIT MILL, LABOURCHEE.

Mr. Jerome Moreau (AFOCEL) and I visited the Smurfit Peeler Plant at Labourchee (Approximately 130 kilometres south of Bordeaux). The Plywood mill has an annual intake of 130,000 cubic metres of *P. pinaster* round wood. Logs are generally 2.6 metres long but many were cut down to 1.3 metres in the mill due to excessive sweep. Both log lengths were then peeled and processed into plywood products (Figure F5).


**FIGURE F5**. Mr. Moreau and myself at the Smurfit plywood plant.

At least one third of all 2.6 m logs that were delivered to the mill needed to be cut into two 1.3 m billets for peeling due to the severity of the butt sweep. The use of logs with severe sweep and many knot holes demonstrated that with improved technology, even low grade logs can be utilized into a high grade product such as plywood or Laminated veneer Lumber.

An interesting point about the *P. pinaster* plywood sheet production was that the mill ran a face sheet table. On this table, staff manually removed knots from sheets and replaced them with clean wood plugs. There appeared to be no desire by the mill to source (possibly due to cost) pruned logs that could produce clear wood sheets, so this plugging method was necessary to produce clean face sheets.

### 4.3.2 HARVESTING

Mr. Said Difle from AFOCEL took me to visit a clearfell logging operation 20 kilometres north of Bordeaux. Figure F6 shows the standard type of tractor forwarder used extensively in France for moving timber to the roadside. There are some more typical forwarders (as mainly seen in Australia) used by some logging crews, but due to the lower capital outlay most contractors choose to purchase the tractor type.

**FIGURE F6**. Tractor Forwarder in a clearfell operation.

At this particular site the contractor was using an eight wheeled mechanical harvester to process logs. I was told that over half of the pine felled in the Landes forest was cut by hand and that most contractors were reluctant to purchase mechanical harvesters due to the high capital outlay. They had always used chainsaws and saw no reason to change to machine harvesting now.

Almost all trucks used for transporting pine logs were of the self loading semi trailer type. I asked why forwarders did not load trucks at the roadside and was informed that it would take the cooperation of individual contractors and that the current system was more flexible for the truck drivers. My observation was that it would require a substantial change in the existing cultural methods used in this circumstance and all the other European forestry operations I had seen. This is not a problem in Australian plantation forestry as foresters are regularly trialing new methods or techniques to improve wood production or utilization. This is more of a reflection of our high cost of labour and the trend to mechanize tasks as much as possible.

### 4.3.3 STORM DAMAGE

In December of 1999, Europe experienced what has been called the storm of the century. The Hurricane of 1999 had wind gusts of up to 200 kilometres per hour and in one night blew down over 190 million cubic metres of wood through Western Europe. In the Landes forest it is estimated that up to 30 million cubic metres of *P. pinaster* timber was blown down or damaged by this storm (Figure F7 & F9) which represents an area estimated at over 100,000 hectares. The area

worst affected was west and north of Bordeaux. Driving through the area one cannot miss the impact of the storm, as there are stacks of logs (Figure F8) on just about every road traveled.

**FIGURE F7**. Mr. Difle alongside a *P. pinaster* blown over by the storm of 1999.

Many of the roadside stacks of timber had degraded to the point where they would be unsuitable for anything but fuel wood. One method used to preserve logs is to create a large stockpile and keep it moist under irrigation. North of Bordeaux I was shown one of three such storm stockpiles (Figures F10 and F11). This stockpile contained approximately 300,000 cubic metres of wood.

**FIGURE F8**. One of the thousands of roadside stockpiles after the storm of 1999.

**FIGURE F9**. Storm damaged *P. pinaster* forest.

**FIGURE F10 and F11**. 300,000 cubic metres of wood stockpiled under irrigation.

Figure F10 shows the height (approximately six metres) of one row of logs in the stockpile. Each row was over 100 metres long and there were dozens upon dozens of rows. In the centre of figure F11 is the soak used to supply water to the hundreds of sprinklers keeping the logs moist. Any excess water running off the stockpile would run back into this central soak. Due to the massive volume of

logs lying in the forest after the storm, this stockpile had only recently been drawn upon by the pulp mill (some two years after the storm).

### 4.3.4 SMURFIT PAPER MILL ARCACHON.

**FIGURE F12**. The Smurfit Kraft Paper Mill at Arcachon.

The Smurfit Kraft Paper Mill at Arcachon (Figure F12) must be the largest single user of *P .pinaster* wood in the world as this plant consumes approximately one million cubic metres of round wood per year. Unfortunately, due to my tight schedule, I could not visit this facility and learn more about the processing techniques and production outputs.

Due to the form of *P. pinaster* in the Landes forest, there is approximately 3 million cubic metres of pulpwood produced per annum. The annual production of timber (sawlog and case wood) is five million cubic metres.

This paper mill is further evidence that in France the technology already exists to utilize *P. pinaster* for any product that *P. radiata* is currently being used for. In the Landes area *P. pinaster* is currently processed into paper, MDF, plywood/LVL and saw products. This proves that the higher resin content of *P. pinaster* (much higher than *P. radiata*) is not a limitation to its use by industry.

### 4.3.5 NURSERY BORDEAUX.

Mr. Jean Yves Fraysse from AFOCEL took me to visit of one of many pine nurseries in the region. The nursery is managed by the pine grower's cooperative (CAFSA). All *P. pinaster* seedlings were grown in potted trays as in Figure F13. At this nursery the potted trays are stacked on a steel rack that supports around 20 trays.

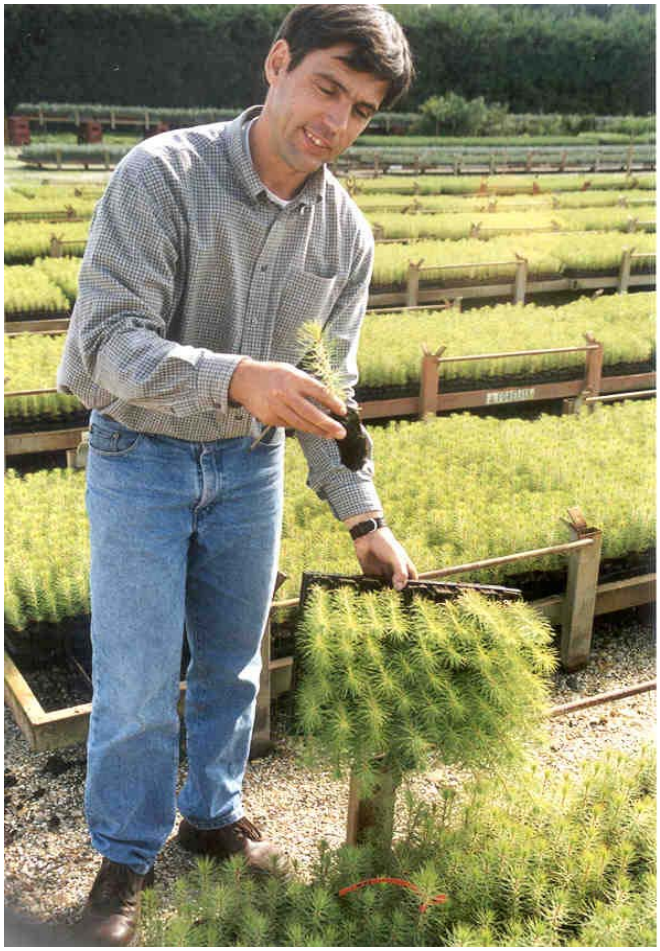


**FIGURE F13**. Standard size *P. pinaster* potted seedling.

The racks (Figures F14 and F15) are moved around the nursery by forklift then stacked five high and placed on a truck for delivery. The truck has a small Hiab that unloads the racks on the planting site. This method of seedling transport and delivery ensured that all seedlings placed in the field were fresh and, if need be, could be stored for some time without affecting seedling quality.

**FIGURE F14 and F15**. Rack transport system and seedling trays.

The nursery grew approximately 5 million seedlings per annum. Due to the climate, the nursery seeded all trays in June and July. Growth was controlled through the fertigation system so that each batch of seedlings would reach the target height at set dates through the eight month planting season. A standard seedling (suitable for planting) is 17 cm high with a dry mass of 1500 milligrams. The seedling growth control system appeared to produce consistently high quality seedlings throughout the long planting season.

### 4.3.6 INSECT DAMAGE.

Insect damage was inspected in a young plantation of *P .pinaster* west of Bordeaux. Apparently all the dry wood lying on the forest floor (due to the 1999 storm) had created ideal conditions for Ips bark beetle to breed up to levels not normally seen in the Landes area. Mr. Jean Yves Fraysse informed me that normally Ips kills only the occasional tree in the forest. Figure F16 shows how even healthy young *P. pinaster* were being attacked and killed by Ips.

**FIGURE F16**. *P. pinaster* killed by Ips bark beetle

Even though young healthy trees were being attacked by Ips, it did not appear that large areas of the plantation would be lost. In many nearby stands there was no damage by Ips yet there was a substantial amount of dead wood on the forest floor. I suggested to the foresters present that the debris on the forest floor should be burnt to reduce the Ips numbers. They told me this was not possible as there is a strict “no burning” policy in any plantations as the fire risk is very high. I tried to convince them that is possible to burn, explaining that in Western Australia we have a much longer and hotter fire season yet, we are still able to carry out controlled burning. I think much of my reasoning was lost in the translation.

In the Landes forest near Bordeaux I was shown the impact of a wood boring insect that occasionally attacks *P. pinaster* after it has been pruned or damaged. The result is the limb or bole becomes damaged to the point where in any strong wind it breaks (Figure F17). This insect has not been identified in *P. pinaster* plantations in Western Australia as yet.

**FIGURE F17**.*P. pinaster* damaged by insects. **FIGURE F18**.*P .taeda* near Bordeaux.

AFOCEL has tested many other species against *P. pinaster* in the area. Figure F18 is of a vigorously growing stand of *P. taeda* which, until recently, had been performing much better than *P. pinaster* on this site. Unfortunately Ips was slowly moving through the stand and killing every *P. taeda* in the plot (the adjacent *P. pinaster* was only slightly affected). *P. radiata* has also been included in trials but cannot withstand the occasional severe winter frosts. Most Eucalyptus species that have been trialed have also been killed in the extreme winter frosts. AFOCEL have used some Eucalypt hybrids bred for greater cold tolerance. I was shown one such hybrid which had not only survived the winter of 1985, but the storm of 1999. The foresters present believed that there was great public resistance in the Landes area to the use of exotics in place of *P. pinaster*.

### 4.3.7 HYBRID *P. pinaster.*

**FIGURE F19**. *P. pinaster* Landes X Corsican hybrid.

Approximately 50 kilometers south of Bordeaux is a *P. pinaster* hybrid trial established in 1991 by AFOCEL to evaluate which *P. pinaster* hybrid will best improve form without compromising vigour. Many provenances of *P. pinaster* were present (Leirian, Corsican and Moroccan etc), all crossed with the most improved material from the Landes provenance, to ensure a high frost tolerance was maintained.

A hybrid between the best of the Landes strain with the best formed of the Corsican strain has resulted in stems with better vigor and equally as good form to either strain (Figure F19). Although this trial is only ten years old, there were vast differences between plots. It is my opinion that this hybrid work will greatly benefit plantation forestry in the Landes area. The use of hybrids will allow improved material from outside the Landes forest to be incorporated into the breeding program.

Using information from this research it is possible that the use of hybrids could fastrack the breeding of *P. pinaster* and other *Pinus* species in Australia. The first such hybrid could be the FPC (WA) 3$^{rd}$ generation *P. pinaster* crossed with a drought tolerant *P. pinaster* strain from Spain or Morocco?

### 4.3.8 ESTABLISHMENT.

**FIGURE F20**. Excavator with stump slicing bucket.

One problem the foresters at AFOCEL are attempting to resolve at present is how to remove stumps, when carrying out second rotation works. Normally the large stumps are not a problem to plant around but trees that were blown down in the storm have had the root system and soil torn out of the ground. One possible solution involves an excavator in (Figure F20) with a modified bucket which has a knife-edge on one side. The excavator bucket slices up the stump and roots into pieces no larger than a mans arm. Which then breakdown or can be worked over when carrying out 2R works.

AFOCEL have also trialed the use of dozers in windrowing the debris but too much land is then lost from the planting area due to the windrows. I suggested they drop a match in the debris rows but they claimed that was not an option because burning is prohibited. I believe that burning the debris would not only make site preparation cheaper but also possibly reduce the severity of Ips attacks due to the removal of dead wood.

**FIGURE F21**. Site preparation south of Bordeaux.

Site preparation on second rotation sites in the Bordeaux region typically involves a tractor (200 horse power) and mould board plough setup (Figure F21). This was interesting to watch in operation as each mould board had a kick back ram to provide some give when hitting stumps. The tractor heaved and lurched through the site with the plough screaming for mercy behind it. It left a very roughly cultivated mound after one pass. Usually a second pass was required with a disc plough for weed control prior to planting.

In the Landes forests, row spacing appeared to vary on every site. Many sites I visited had 4 metre row spacing but often spacing could vary from 3 to 5 metres. When seedlings were used, stocking rates were around 1000 to 1250 spha. Sites that had been established with direct seeding had initial stockings of between 2000 to 4000 spha. Many growers preferred to plant via direct seeding as the initial cost was low. This was unfortunate as improved seed was then unlikely to be used due to its cost and availability, so no real gains were being made in plantation performance.

There was some weed control using chemicals in the Landes forests yet there was local opposition to this. I found this ironic as throughout the forests are vast horticultural farms that would have to use large quantities of chemicals and fertilizers to produce their crops which was quite acceptable to the local community. I believe once again forestry was losing the public perception battle.

**FIGURE F22**. Myself under a mature stand of *P. pinaster*.

I thought it fitting to finish the report with the above photo of a mature stand of *P. pinaster* just south of Bordeaux, even if in the Landes area it means a wobbly looking stem.

In Western Australia *P. pinaster* has been reported as the “perfect pine”. After visiting the home of *P. pinaste*r, I now know that in our FPC plantations contain some of the finest stands of *P. pinaster* in the world.

## 4.4 SUMMARY of FRANCE

After visiting *P pinaster* breeding trials in the Landes forest I am confident that the use of hybrid crossing can greatly improve the tree breeding of *P. pinaster* in Australia. The FPC has already obtained massive increases in vigour from the Leirian provenance. Based on the AFOCEL trial results, a hybrid with the West Australian Leirian provenance, crossed with either the Corsican provenance (for branching habit and stem form) or the Moroccan provenance (for its good form and high drought tolerance) could bring dramatic improvements to the P*. pinaster* breeding program in Australia.

Another point that has been demonstrated to me clearly in the Landes forests and thought all the plantations I visited, is that we must ensure that any material we import to Australia must be free from any contaminants that could damage our pine plantations. I believe we would not face the same devastating affects that I have seen in Europe but some insects and pathogens could at the very least reduce stand increment.

The French method of seedling production through using containerized stock is similar to what I have seen in Australia (but a more refined and exacting process). The method of tacking trays in racks to the field is quite novel and may be worth investigating in Australia were the nursery is in close proximity to establishment operations. It is certainly an efficient method of keeping seedlings fresh while reducing the man handling of trays.

After seeing the aftermath of the 1999 storm through the Landes forests I am convinced that controlled burning under *P. pinaster* pine is beneficial. I am sure the removal of dead wood from the forest through controlled burning would greatly reduce the likelihood of Ips beetle building up to such numbers that it can kill even healthy trees. After visiting only a few sites of second rotation planting, I am quite positive that the selected use of fire to remove debris in the Landes *P. pinaster* plantations would be economically and environmentally beneficial for their forests. I believe the FPC or Department of CALM could provide invaluable assistance or training in the use of under pine burning to the French, Spanish and Turkish foresters. A few demonstration controlled burns would show how relatively simple it is to use fire as a method of fuel and debris reduction in pine plantations.

While I only saw a very small amount of establishment works, I was surprised to see such rough methods of site preparation prior to planting. Given that second rotation sites can rarely be classed as tidy, It seemed odd to use non-disc ploughs to cultivate the soil. I am confident that equipment such as Savanah® disc ploughs would greatly improve site preparation on at least the site I inspected. I also believe that French forestry would benefit from sending staff over to Australia to see our establishment and harvesting operations on difficult sites.

The Landes *P. pinaster* forest will stay in my mind as a clear image of the scale of afforestation that can be achieved when there is commitment to a project. To think nearly one million hectares of afforestation was achieved well over a hundred years ago with limited technology is a credit to the people of France. The visit to this forest has demonstrated to me that anything is possible in Australian Plantation Forestry if we put the negatives aside and just get on and do it.

# 5 AUSTRALIAN MEMORIAL SITES at GALLIPOLI.

While Gallipoli was not a forestry stop on my visit to Turkey, I feel compelled to put a few photos of the ANZAC memorial sites in this report. This National Park is truly a must see for any Australian. I was also interested to find out what species is planted at the Lone Pine memorial (Figure 27), The local Park Ranger was sure it was *P. brutia* although I am convinced now that the lone pine is a *P. pinea* due to its rounded crown and heavy branching. I could not find any cones to confirm this as visiting Australians tend to collect them!

**FIGURE G1**. The Lone Pine Memorial at Gallipoli.

In World War 1 approximately 500,000 Turks, Anzac's, British and French troops were killed or wounded in the Gallipoli area (which is called Gelibolu in Turkey). The one image I am left with after visiting the peninsula is how beautiful the beaches were and how they reminded me of Perth's coastline. Figure 30 contains words from the great Turkish general Ataturk who became Turkeys post WW1 leader. His words bring a tear to the eye of every Australian that reads it at the site (even tough old foresters). To say Gallipoli is a moving place is a gross understatement. I can best sum up the feeling that you get when standing in ANZAC cove (Figure 28) or at the Lone Pine Memorial, is one of making you feel more like an Australian than any other place in the world.

**FIGURE G2**. ANZAC cove cemetery.

**FIGURE G3**. Suvla Bay in the distance with a trench in the foreground.

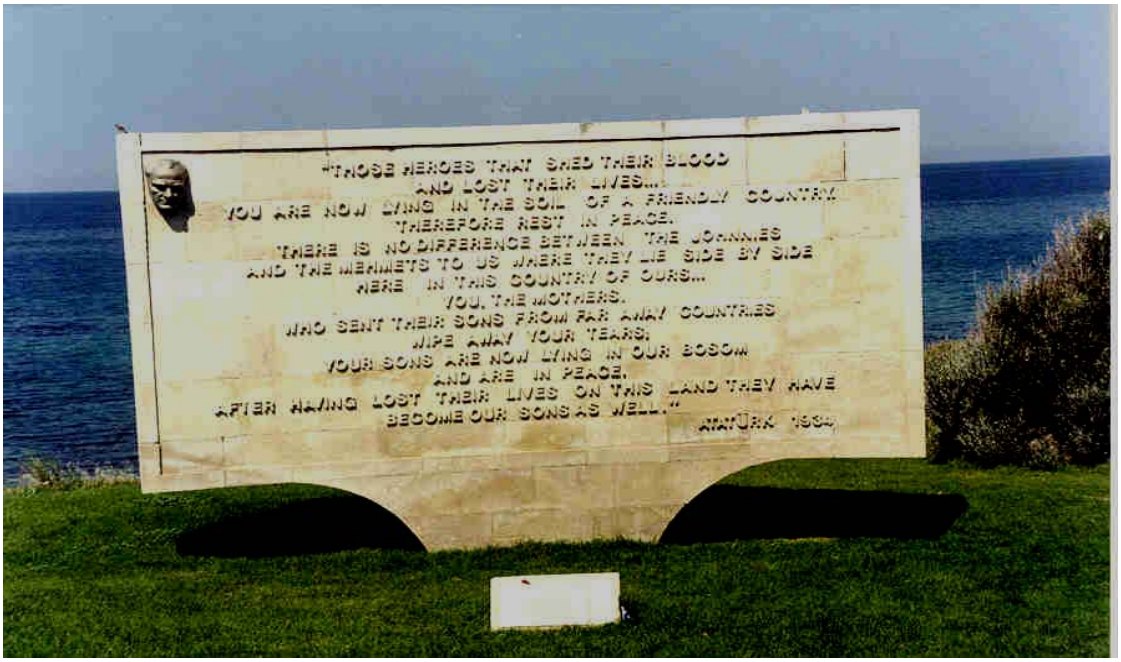



**FIGURE G4**. Words from Ataturk, Turkey's leader after WW1.

The following are the words from this plaque.

**"THOSE HEROS THAT SHED THEIR BLOOD**

**AND LOST THEIR LIVES…**

**YOU ARE NOW LYING IN THE SOIL OF A FRIENDLY COUNTRY.**

**THEREFORE REST IN PEACE.**

**THERE IS NO DIFFERENCE BETWEEN THE JOHNNIES**

**AND THE MEHMETS TO US WHERE THEY LIE SIDE BY SIDE**

**HERE IN THIS COUNTRY OF OURS…**

**YOU. THE MOTHERS.**

**WHO SENT THEIR SONS FROM FAR AWAY COUNTRIES**

**WIPE AWAY YOUR TEARS.**

**YOUR SONS ARE NOW LYING IN OUR BOSOM**

**AND ARE IN PEACE.**

**AFTER HAVING LOST THEIR LIVES ON THIS LAND THEY HAVE**

**BECOME OUR SONS AS WELL."**

**ATATURK 1934**

**FIGURE G5**. In memory of a Forester killed in a wildfire at Gallipoli in 1994.

The above statue (Figure G5) was dedicated to a forester killed in a large wildfire that swept through a significant area of the Gallipoli peninsula in 1994. The vegetation that has re-grown from this fire looks in passing very similar to the low scrub that grows along the coast north of Perth.

In summer this Gallipoli area appears to have dry hot weather very similar to Perth. I was informed that in winter this area can experience occasional snow and many frosts (far colder than Perth's climate).

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# LIST OF FIGURES

## Section 1 Visit to Turkey


1. Forest cover in Turkey.
2. Route taken in Turkey.
3. Clear fell coupe in natural stand of *P. brutia.*
4. Poorly formed *P. brutia.*
5. $CaCo_2$ soil typical of *P. brutia* range.
6. Standard afforestation in Isparta Turkey.
7. Two D7 dozers.
8. Mixed species 30 year old plantation
9. *P. brutia* plantation near Bucak.
10. *Thaumetopoea pityocampa* damage on *P. brutia*.
11. Scrub competition, Biga.
12. *P. pinaster* plantation near Biga.
13. *P. pinaster* 55,000 hectares in Turkey.
14. *P. brutia* plantation at Kesan.
15. 37 year old *P. brutia* plantation near Kesan.
16. *P. pinaster* plantation near Black Sea.
17. *P. pinaster* near the Black Sea.
18. *P. radiata* near the Black Sea.
19. Utilization of fuel wood by villagers.
20. *P. brutia* log stockpile.
21. Research site Antalya.
22. Dr Isik in *P. brutia* plantation trial.
23. Three year old regeneration near Antalya.
24. *P. brutia* seed stand near Antalya.
25. Necati Cengiz with 5 month old seedling.
26. Ali Osman in forestry nursery at Aydin.
27. Renault 4WD fire truck.
28. Typical fire tower at Aydin.
29. A team of Forest Fire fighters at Aydin.
30. View of natural forest of *P. brutia* and *P. nigra*.

**Section 2 Visit to Spain**

S1. *P. pinaster* Map of Spain.
S2. *P. halepensis* Map of Spain.
MAP 1 Sites visited in Spain.
S3. Wubealem Tapesse alongside grafted *P. pinaster.*
S4. Old method of resin production.
S5. Old method of resin production.
S6. Ricardo Alia and new method of resin extraction.
S7. *P. pinea* stand.
S8. Three year old *P. pinea*.
S9. Fernando Del Cano and Diana Barba.
S10. *P. pinaster* stand near Cuenca.
S11. *P. pinaster* stand near Cuenca.
S12. Small village in pine forest.
S13. *P. halepensis* natural regeneration.
S14. Arancha Prada, Fernando Del Cano and Diana Barba .
S15. Spanish Foresters.
S16. *P. pinaster* plantation Navahermosa.
S17. Provenance trial at Espinoso.
S18. Provenance trial at Espinoso.
S19. Maria Ribeno, Ricardo Alia and Lola Argundiz.
S20. *P. halepensis* near Valencia.
S21. *P. halepensis* near Valencia.
S22. *P. halepensis* provenance trial.
S23. Two year old *P. radiata* plantation near Vitoria.
S24. Santiago Espinel in a *P. radiata* trial near Liodio.
S25. One year old *P. radiata* near Vitoria.
S26. Self loading truck in Vitoria area.
S27. 40 year old *P. radiata* plantation near Vitoria.
S28. *P. halepensis* seed store.
S29. Root development of *P. halepensis*.

**3 Visit to the Canary Islands**

C1. Location of Islands
C2. Plan of *P. canariensis* distribution.
C3. *P. canariensis*.
C4. Stand three months after a wildfire.
C5. Carlos Velazquez alongside *P. canariensis* coppice.
C6. *P. canariensis* heartwood in 100 year old balcony.
C7. *P. canariensis* in a rock desert.

C8. Photo of Island.
C9. Insect damage.
C10. One year old *P. canariensis*.
C11. Cloud in the forest.
C12. Unusual vegetation on the Islands.
C13. *Tagasate* also known as Tree Lucerne.
C14. A fine stand of *P. canariensis*.
C15. Two hundred year old lava flow.
C16. A forest track through a lava flow.
C17. Young *P. canariensis* with mountain in background.

**4 Visit to France**

F1. Agricultural land south of Bordeaux.
F2. Typical soil in the Landes forest.
MAP 2 Route taken around Bordeaux.
F3. Mrs. Raffin alongside cuttings and seedlings.
F4. Mrs. Raffin in storm damaged plot of *P. pinaster*.
F5. Mr. Moreau at Smurfit Mill.
F6. Tractor forwarder in clear fell operation.
F7. Mr. Difle alongside *P. pinaster* stump.
F8. Roadside stockpile after storm damage.
F9. Storm damaged *P. pinaster*.
F10. 300,000 cubic metre stockpile.
F11. 300,000 cubic metre stockpile.
F12. Smurfit Kraft Paper Mill.
F13. Standard *P. pinaster* seedling.
F14. Seedling trays and rack transport system.
F15. Seedling trays and rack transport system.
F16. *P. pinaster* killed by Ips Bark beetle.
F17. *P. pinaster* damaged by insects.
F18. *P. taeda* near Bordeaux.
F19. P. pinaster Landes X Corsican Hybrid.
F20. Excavator with stump slicing bucket.
F21. Site preparation south of Bordeaux.
F22. Myself under a mature stand of *P. pinaster.*

**5 AUSTRALIAN MEMORIALS at GALLIPOLI.**

G1 Lone Pine Memorial Gallipoli.
G2 Anzac Cove.
G3 Suvla Bay.
G4 Words from Ataturk.
G5 In memory of forester killed in wildfire.

APPENDIX 1
Purpose for which this fellowship is sought

# A review of Dry land Pinus species in Spain, France, Greece and Turkey

# The implications on productivity and economics of Plantation forestry in the less than 600mm rainfall zone of Australia.

Over the past ten years Western Australia has seen a dramatic increase in plantation forestry on agricultural land. Over ten years ago the Department of Conservation and Land Management (CALM) pioneered the *Eucalyptus globulus* revolution in our southwest. Approximately 140,000 hectares of *Eucalyptus globulus* have been established in the >600mm rainfall zone.

Partly due to this plantation development and the expansion of intensive horticulture, land prices have now reached a level in Western Australia's South West, where tree farming is being priced out of the high rainfall areas. This has prompted CALM to establish *Pinus pinaster* (Maritime Pine) on agricultural land in the 400mm to 600mm rainfall isohyets', on sites that cannot support *Pinus radiata* or *Eucalyptus globulus* through a rotation. CALM is leading Australia in plantation establishment in the medium to low rainfall zone.

The Maritime Pine project started in 1995 with 260ha established under a share farm arrangement with four landowners. The project's aims are to establish a significant resource for industry and to help combat Western Australia's salinity problem. At the close of the 2000 planting season over 11,000ha have been established on agricultural land from Jurien Bay (200kms north of Perth) to Esperance some 700kms south east of Perth.

CALM's goal is to establish 150,000 ha's over the next ten years. To have a significant impact on the State's salinity problem 500,000 ha will need to be established within the next 40 years. A mammoth task to establish plantations in such low rainfall country, yet it has been accomplished before!

In Spain 780,000 ha was afforested between 1940 and 1982 with *Pinus pinaster*. There are over 4 million hectares of *Pinus pinaster* in southern Europe and North Africa. Below is a map of *Pinus pinaster* distribution.

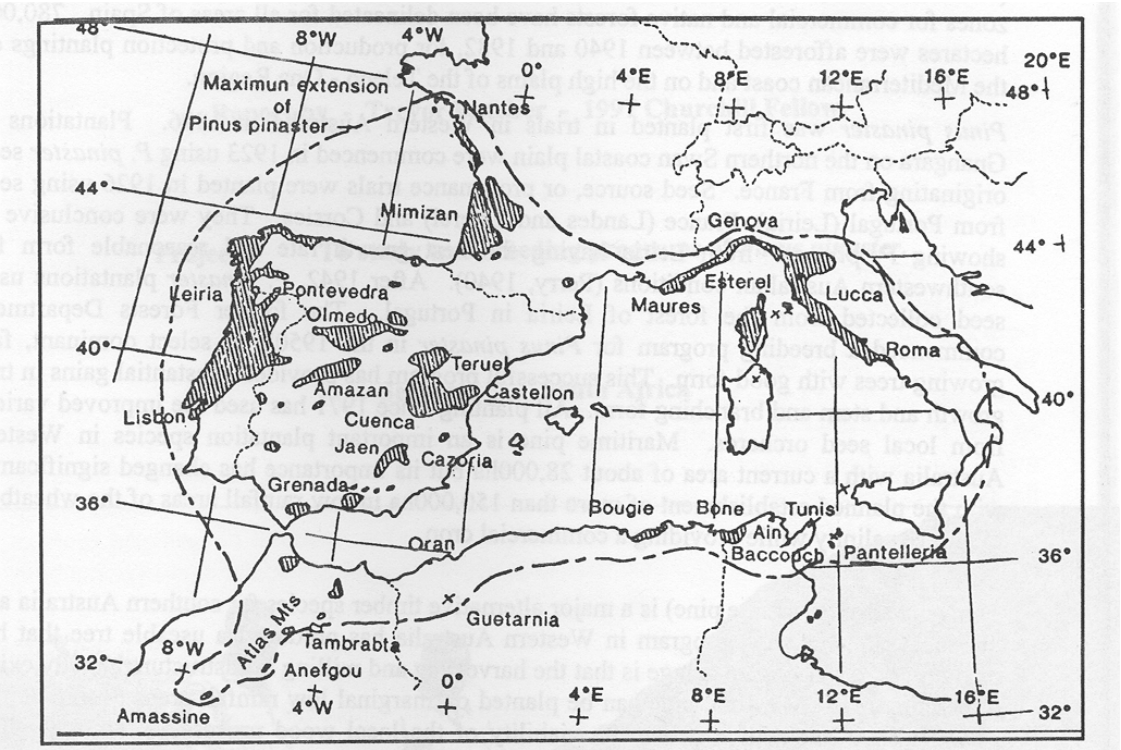


**Figure 1** Natural Distribution of Maritime Pine (Hopkins and Butcher, 1993).

In the 1800's 600,000 ha of *Pinus pinaster* was established in France to ameliorate erosion. Portugal has also carried out significant afforestation projects with *Pinus pinaster* to combat land degradation and create a sustainable timber resource.

I have been employed by CALM as a forester for the past 14 years. In that time I have worked in both hardwood and softwood forests with the majority of my time in plantation management .For the past five years I have carried out the role of a plantation manager with the Maritime Pine project. My key roles are the acquisition of land and the coordination of establishment on sites north of Perth. I have overseen the establishment of over 4,500ha in the past five years. The following page contains a plan detailing the coverage from our Midwest Sharefarm's office based in Perth.

The challenge CALM and I face now is to further develop *Pinus pinaster's* drought tolerance and seek other Pinus species which are suitable for afforestation in the 400mm-600mm rainfall zone .The potential land area available across Australia and its requirement for tree establishment makes this an important and achievable task ,I intend to assist in meeting this challenge by undertaking research through this application to review dryland Pinus species in Spain, France, Greece and Turkey.

The aim of my fellowship is to:

- Further develop the *Pinus pinaster*, breeding program by seeking out more drought tolerant provenances. (There are provenance trials in Spain and Greece established in the late 1960's that CALM has no material from).

- Investigate the performance of provenance trials of other drought tolerant Pinus species such *as P brutia, P halepensis* and *P caneriensis*.

- To study alternative silvicultural regimes. In particular the establishment practices used on the above species on dry land sites.

- Assess other organizations methods of integrating tree crops with agriculture economically, socially and environmentally.

- Observe how European industries utilize these dry land pine species, that generally have much higher resin levels than *Pinus radiata*.

## Proposed Itinerary

Below are a list of confirmed contacts and significant sites in each country. I would require several weeks' notice to compile a final list of sites and contacts. As I don't propose to travel until March 2001 I envisage having sufficient time to compile a much more detailed itinerary

## **Spain** 6 days

Discuss drought tolerance breeding of *P.pinaster* and results from provenance trials at Alebo, Espinoso, and Rifrio. (Ricardo Alia - Provenance studies, INIA)

Inspect provenance trials planted in 1967.

Inspect the best of the 15 provenance's of *P.pinaster* from the less than 600mm rainfall zone.

Investigate with Ricardo Alia provenance trials with *P.brutia* or *P.halepensis*.

Inspect provenance trials of *P.caneriensis* with Jose Climent. (Pine seed orchards and *P. caneriensis* provenance trials, INIA)

Inspect *P.pinaster* plantations to assess M.A.I 's and establishment methods.

**France** 4 days

Inspect the silvicultural techniques used in Landes forest. (Piere Alazard - Tree Breeding Manager, AFOCEL).

Visit processing centres using *P.pinaster* in Landes area.

Performance of *P.pinaster* provenances in regards to economics compared to WA plantations.

**Greece** 2 days

Inspect *P.pinaster* provenance trial and *P.brutia* trials.

Visit *P.brutia* forests to assess their drought tolerance in comparison to Australian sites. (Jerrilderie and Yanchep)

Discuss drought tolerance of *P.pinaster, P.brutia* and *P.halepensis*.

**Turkey** 4 days

Discuss drought tolerance of *P.pinaster, P.brutia* and *P.halepensis* with Dr Fikret Isik.(Southwest Anotolia Forest Research Institute).

Inspect forests of *P.brutia* and *P.halepensis*, to assess form and growth rates.

Visit processing centers that use *P.brutia* or *P.halepensis*.

Inspect silvicultural practices used in Turkish plantations.

## References

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# APPENDIX 2

Aug 22nd Leave Perth

**TURKEY**

| | |
|---|---|
| 23rd to 25th | Istanbul sight seeing |
| 26th | Travel to Isparta (Turkey) meet Nebi Bilir (Forester from Isparta University). |
| 27th | Isparta and Bucak |
| 28th | Isparta. Gave presentation at University |
| 29th | Isparta to Antalaya then Aydin |
| 30th | Aydin |
| 31st | Biga, Maramara Sea |
| Sept 1st | Kesan |
| 2nd | Kesan |
| 3rd | Gallipoli |
| 4th | Adapazari, Black Sea |
| 5th | Ankara |
| 6th | Ankara to Istanbul |
| 7th | Istanbul day off |
| 8th | Istanbul |
| 9th | International Hospital Istanbul |

**SPAIN**

| | |
|---|---|
| Sept 10th | Travel to Madrid |
| **11th** | Madrid INIA |
| 12th | Segovia and Coca |
| 13th | Guadalajara and travel to **Canary Islands** |
| 14th | Gran Canary |
| 15th | Tenerife |
| 16th | Travel back to Madrid |
| 17th | Toledo and Cabeneros |
| 18th | Cuenca and Bonches |
| 19th | Barraca |
| 20th | Valencia to Madrid then Vitoria |
| 21st | Vitoria and Llodio |

**FRANCE**

| | |
|---|---|
| 22nd and 23rd | Travel and day off |
| 24th | Bordeaux INRA |
| 25th | Bordeaux and Labouheyre |
| 26th | Bordeaux AFOCEL and nursery |
| 27th | Bordeaux and Arachon |
| 28th | Personal visit to Wales. |
| Oct 10th | Return to Australia |