GROWTH AND POTENTIAL OF CONIFEROUS SPECIES IN THE SOUTH-WEST OF WESTERN AUSTRALIA

A Report on the Progress of Three Arboreta

by

R.R.A.Fremlin
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FORESTS DEPARTMENT OF WESTERN AUSTRALIA

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INTRODUCTION

Establishment of plantations of exotic coniferous species is a means of rapidly increasing the supply of available timber in Western Australia. In the south-west of the State, two species are favoured for commercial plantations. These are *Pinus radiata* D. Don and *P. pinaster* Ait. *Pinus radiata* prefers fertile soil, and plantations of this species are established mainly on the loamy soils on the western slopes of the Darling range. *P. pinaster* is planted on the less fertile sands of the Swan coastal plain. Generally, *P. radiata* is preferred for its greater productivity, even if repeated applications of fertilizers are required to sustain growth. Other species have been planted to a limited extent. These include *P. canariensis* C. Smith, *P. elliottii* var. *elliottii* Engel. and *P. taeda* Linn. Little was known about the performance of other coniferous species grown under Western Australian conditions.

A programme was initiated in 1967 to establish three arboreta, containing different conifers, on three of the main soil types within the high rainfall zone of the south-west of Western Australia. The main reasons for establishing the arboreta were:

(1) to evaluate and compare the growth of different conifers on soils hitherto considered unfavourable, without the addition of fertilizers, for the growth of *P. radiata*;

(2) to identify particular characteristics and adaptations of conifers that make them suitable for amenity or ornamental purposes;

(3) to record the behaviour of conifers grown on three different soils.

The sites selected for the arboreta were:

(1) a fertile area in Folly plantation near Nannup (Asplin arboretum);

(2) a moderately fertile area in Bussell plantation near Collie (Bussell arboretum);

(3) an infertile site in Meribup block south-east of Manjimup (Meribup arboretum).

General Description of Arboretum Sites

Asplin arboretum

Located approximately two kilometres east of Nannup the arboretum represents a site that is considered near optimum for the growth of *P. radiata*. The soil is red loam derived from basic igneous rock and the high fertility is due, in part, to a history of previously applied superphosphate.

The topography is steep (8-15^{o}) with a southerly aspect and trees were planted across the contour. Soil moisture remains high throughout the year on the lower slopes, but on upper slopes and ridge top sites soil moisture is low during the summer months.

At the time of establishment, the vegetation was comprised of kikuyu grass (*Pennisetum clandistinum*),where moisture levels remained high throughout the year, and annual broad-leaved species and grasses, where summer soil moisture was low.

Bussell arboretum

Located 14 kilometres south-west of Collie, the soils of this arboretum are predominantly lateritic and are marginal for the successful growth of *P. radiata*, without the addition of fertilizer. Some incursion of more fertile igneous-derived soils is present where the laterite cap has eroded. Loam and gravelly loam describe the physical characteristics of the soils throughout the arboretum. Phosphorous pentoxide ($P^2 0^5$) values range from 160 p.p.m. to 640 p.p.m., while gravel percentages range from 6.2 per cent to 50 per cent. A $P^2 0^5$ value of 250 p.p.m., or higher, is recognized as being necessary to sustain the growth of *P. radiata* throughout a rotation, without the addition of fertilizer.

The topography is gentle, with both northerly and southerly aspects. A drainage line runs through the centre of the arboretum.

The original native vegetation was characterized by *Bossiaea aquifolium*, *Eucalyptus calophylla* R. Br., *E. marginata* Sm., *E. patens* Benth., *Pteridium esculentum* and *Trymalium spathulatum*.

Meribup arboretum

Situated 45 kilometres south-east of Manjimup, the soils of this arboretum are unsuited for the growth of *P. radiata*, without additional fertilizers. There is a transition of soil types from yellow sand in the west, through leached grey sand in the centre, to peaty sand on the eastern side. This and the almost flat topography results in the area being subject to water-logging in winter.

The original vegetation on the yellow sand consisted of *Astartea fascicularis, Bossiaea linophylla, B. ornata, Eucalyptus marginata, Hibbertia racemosa, Kunzea recurva, Leucopogon australis, Platytheca viminea, Podocarpus drouyniana* and *Synaphaea favosa*. The grey sand was characterized by *Acacia mooreana, A. saligna, Agonis parviceps, Anigozanthos flavida, Eucalyptus decipiens, Hibbertia cunninghamii, Lepidosperma angustatum, Melaleuca preissiana, Pultenaea reticulata* and *Synaphaea petiolaris*.

Climate

A mediterranean climate is common to each site. Rain falls mainly in June, July and August. Mean summer temperature is likely to be highest at Bussell, the most northerly arboretum, and lowest at Meribup, the most southerly of the three. Winter temperatures are similar at each location, with frost being common. Mean annual rainfall and altitudes are listed (Table 1).

Table 1

	Mean annual rainfall (mm)	Altitude (m) A.S.L.
Asplin arboretum	926	130
Bussell arboretum	968 (nearest recording station Collie)	190
Meribup arboretum	813	180

Establishment Procedure

Asplin arboretum

Where kikuya grass was the dominant species, ploughing one to two months prior to planting was normal. Some further pre-planting grass control using a mixture of amitrole and 2,2-DPA ("Weedazol Total") was necessary on moist sections. However, over the majority of the arboretum, where annual weeds predominated, an overall spray of a mixture of atrazine and amitrole ("Vorox AA") was the only preparation of the site prior to planting.

Subsequent to planting, weed control was confined to slashing bracken (*Pteridium esculentum*) and the poisoning of eucalypt regrowth with 2,4,5-T In sections where there was no ploughing, small circular planting beds approximately 500 mm in diameter were prepared with a mattock.

The arboretum was surrounded by a fence to exclude rabbits and domestic stock. Rabbit warrens inside the fence were fumigated. Cattle gained access and caused minor damage in 1972.

Bussell arboretum

Clearing and burning of the native vegetation over the whole area was completed in 1966, one year before planting commenced. No chemical weed control was necessary before planting.

Plots were ploughed approximately two months before planting, to reduce competition from weeds.

Subsequently, competition attributed to water bush (*Bossiaea aquifolium*) and bracken was reduced by inter-row slashing. Eucalypt regrowth was poisoned with 2,4,5-T

A rabbit-proof fence was erected round the arboretum in 1967. No other animal pests have posed a problem.

Meribup arboretum

Clearing and burning was completed one year later (1967) than at Bussell. All plots were double ploughed two months before planting. Some mounding of the soil by hand was necessary to raise the plant beds above the surface water.

There was no attempt to reduce the competition to trees by scrub until 1981.

Like the other two arboreta, a rabbit-proof fence enclosed the area. There have been no subsequent problems associated with animal pests.

Plot arrangement and Planting Technique

Plot size and shape are generally uniform for all arboreta (see Appendices 1a, 1b and 1c). Plots of two hundred trees were planted where stock availability permitted. Spacing was 2.7 m x 2.1 m throughout,equivalent to 1764 stems per hectare ($s \cdot ha^{-1}$). A 4 m unplanted strip separated plots.

Trees raised in plastic tubes were used almost exclusively,and were planted by hand or with specially designed planting 'spears'. Appendix 4 lists the distribution of species in each arboretum.

Silvicultural Treatment

Asplin arboretum

(i) Fertilizer - no additional fertilizers have been used at Asplin arboretum.

(ii) Pruning and thinning - different pruning and thinning treatments have been used where considered necessary. However, a similar approach to pruning and thinning for all species has been adopted where practicable. Details can be seen in Appendix 5a.

Bussell arboretum

(i) Fertilizer - there has been discriminate use of N, P, Cu and Zn fertilizers where growth and health of some species has been poor. For details see Appendix 5b.

(ii) Pruning and thinning - a similar schedule to that applied at Asplin was adopted at Bussell arboretum. For details see Appendix 5b.

Meribup arboretum

(i) Fertilizer - all species received a surface spot application of fertilizer at the time of planting. Unfortunately, no further fertilizers were applied until 1981, by which time some species had deteriorated to the extent that their potential may not be realised on these soils. An assessment of the silvicultural requirements was undertaken in March 1981 with a view to improving the health of trees in the arboretum. All species received either a P, Zn, Cu mixture or a compound of N and P. Details of fertilizers can be seen in Appendix 5c.

From April 1983 the refertilizing programme will follow closely the prescription applying to plantations in the Donnybrook Sunkland: that is, the soil phosphate levels will be raised by applying 700 kg ha^{-1} of superphosphate over a two year period, followed by maintenance dressings of 200 kg ha^{-1} of superphosphate every three years.

(ii) Pruning and thinning - there was no pruning or thinning in the arboretum until 1980, when a limited amount was completed. An assessment in 1981 revealed that some species were showing symptoms indicative of overstocking. Death of suppressed trees was occurring. A thinning and pruning programme was completed in August 1981. However, the prescriptions differed from those in the Asplin and Bussell arboreta. For details see Appendix 5c.

Problems Encountered

Nomenclature

The names of genera and species in this paper are those used by S.G. Harrison in his revised edition of the "Handbook of Conferae and Ginkgoacae" by Dallimore and Jackson (1966). This has necessitated changes to the records, as follows: *Pinus insularis* End l. was changed to *P. kesiya* Royle ex Gordon and *P. laricio* Poiret was changed to *P. nigra* var. *maritima* Melv.

Incorrect identification

(i) Confusion existed concerning the identity of *P. pseudo-strobus* var. *tenuifolia* (Serial No. 3915). Seed was received identified as *P. tenuifolia* which is the name used by Salisbury to describe *P. strobus* Linn. and is also used by Bentham to describe *P. pseudo-strobus* var. *tenuifolia* Shaw. However, it has been established that *P. pseudo-strobus* var. *tenuifolia* is correct.

(ii) *Pinus nigra* var. *maritima* (Serial Nos. 4018 and 3743) was wrongly identified as *P. nigra* var. *nigra*.

(iii) The seed of *P. pinaster* (Serial Nos. 4238) was received in the nursery labelled as *P. nigra* var. *corsicana*. It is probably the Corsican strain of *P. pinaster* (see Plate 28B), but this has not been confirmed.

(iv) Trees planted in a plot (D2) at Bussell arboretum and identified as *P. thunbergii* are not this species. The correct identification has not been established but is probably *P. densiflora*.

(v) *Pinus pseudo-strobus* var. *tenuifolia* (Serial No. 4291) are mixed with what appears to be *P. leiophylla*.

(vi) *Pinus leiophylla* (Serial No. 4006) are mixed with *P. pseudo-strobus* var. *tenuifolia*.

(vii) *Cupressus lusitanica* cv. *knightiana* was grown from seed collected in the Collie town arboretum where it was identified as *C. knightiana*. According to Dallimore and Jackson (1966) this cultivar has extremely regular and flattened branchlet

systems and the foliage is glaucous. This is not the case with trees at Asplin arboretum where the habit is more consistent with *C. lusitanica* (see Plate 6).

Differences in silvicultural treatments

Meribup arboretum was neglected between 1972 and 1981, reducing the possibility of a direct comparison between the performance of a species on each of the soil types. The health of some species declined to the extent that they appear moribund and are unlikely to respond to thinning or fertilizer.

A different thinning prescription also had to be applied at Meribup because of problems related to the stability of trees growing on soils that were shallow and moist.

Assessment

Each arboretum was assessed in January and February 1980. Species were judged primarily on their potential to produce timber, although their ornamental and amenity value was noted. Where tree size allowed, the diameter at breast height, over bark (D.B.H.O.B.) was measured. Although thinning prescriptions differed within each plot, the equivalent of 250 trees per hectare was measured in each density. The form of each tree was described by the use of the form code (B S T A F), a description of which is attached to Appendix 2a, 2b and 2c. Growth and form data is summarized in Appendices 2a, 2b, 2c, 2d, 2e and 2f.

Comments on Growth and Potential

Abies religiosa Schlechtendal and Chamisso. Sacred Fir.
Planted only on a ridge-top at Asplin, this central American species is not favoured by the Western Australian climate. It may have ornamental application where the climate is mild and the soils are fertile and moist.

Araucaria angustifolia (Bertoloni) O. Kuntze. Candelabra Tree.
A few specimens are surviving at Asplin and Bussell. Fertilizer has been necessary at Bussell to maintain the growth of this frost-sensitive species. The distinctive form and foliage make this tree an interesting ornamental.

Araucaria cunninghamii D. Don. Hoop Pine.
This species has shown moderate growth on the fertile soil at Asplin (see Plate 1). At Bussell the majority of trees were killed by frost; the survivors are unhealthy and growth is slow (Appendix 2B).

Araucaria heterophylla (Salisbury) Franco. Norfolk Island Pine.
The performance of this species is similar to *A. cunninghamii* except that it appears to be less frost tolerant - all trees in the Bussell arboretum died. Norfolk Island pine is popular as an ornamental tree in coastal areas of southern Western Australia and is noted for its tolerance of salt-laden winds.

Callitris endlicheri (Parlatore) F.M. Bailey. Black Cypress Pine.
A native of eastern Australia, this tree is recommended for planting on dry and poor stony ground (Dallimore and Jackson, 1966). The performance of this species in the arboreta, where it is planted on the poorest soil at each site, supports this recommendation. This is confirmed at Meribup where the substrate is coarse lateritic concretions (see Plate 2).

Cedrus deodara (Roxburgh) G. Don in Loudon. The Deodar.
Occurring naturally at high altitudes where rainfall is high and soils are fertile, this species has exhibited slow to moderate growth at each arboretum, and remains healthy on the fertile soils.

Cupressus arizonica Greene. Rough-Barked Arizona Cypress.
A species that is best suited to the fertile loam of Asplin. On the less fertile soils of Bussell and Meribup growth is slow and the colour of the pine has deteriorated (see Plates 3 and 4).

Cupressus lusitanica Miller. Mexican Cypress.
C. lusitanica has the potential to produce high quality timber on fertile sites in the south-west. Growth has been moderate to fast (Appendices 2a, 2b and 2c) and form is generally good, although there is a wide variation of habit amongst individual trees. It needs to be thinned heavily to avoid death by drought. (See plate 5).

Cupressus lusitanica cv. *knightiana* (Endlicher) Carrière.
Trees planted in the arboreta are not exhibiting the characteristics of flattened foliage and regular branching of the *cultivar knightiana*. Growth has been fast at Asplin. (See Appendix 2a and plate 6).

Cupressus macrocarpa Hartweg. Monterey Cypress.
This species is represented at Asplin and Bussell where trees are extremely variable in appearance. Like other members of the genus it has achieved best growth at Asplin. Records omit the source of the seed.

Cupressus sempervirens var. *sempervirens*. Linnaeus. Mediterranean Cypress.
This species has a columnar appearance and has little potential other than for ornamental cultivation.

Pinus ayacahuite Ehrenberg. Mexican White Pine.
This species is represented at Bussell by only two specimens, so little can be said regarding its potential as a timber producer in Western Australia. The species is variable and has wide natural distribution.

Pinus canariensis C. Smith. Canary Island Pine.
Widely, though not extensively,planted in Western Australia, Canary Island pine is known for its straight stems and horizontal branch form. This beneficial characteristic for the production of timber is not, at this stage, being displayed by the majority of trees in the arboreta. It appears to be intolerant of poor soil.

Pinus caribaea Morelet. Caribbean Pine.
Unfortunately the records do not give information identifying the strain of most of the *P. caribaea* planted in the arboreta. Of the three that are known to originate from Honduras, two (Serial Nos. 3279 and 3709) exhibit acceptable form (see Plate 7), the

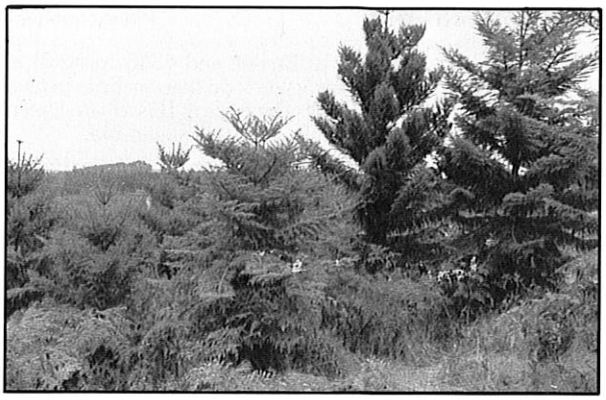


Plate 1 ▲ *Araucaria cunninghamii*

Eleven-year-old hoop pine, planted on a ridge top site at Asplin. Note the variation in phenotype.

Plate 2 ▼ *Callitris endlicheri*

This species appears tolerant to poor, stony and gravelly soils.



▶ **Plate 3**



Plates 3 and 4 ▲ *Cupressus arizonica*

These eleven-year-old trees are growing at Asplin (plate 3) and Bussell (plate 4). Note the poor growth on the gravelly soil at Bussell compared with the growth on rich loam at Asplin.





Plate 5 ▲ *Cupressus lusitanica*

Eleven-year-old trees at Asplin demonstrate the rapid growth and variable habit of this species.

Plate 6 ▼ *Cupressus lusitanica* cv. knightiana

Nine-year-old trees at Asplin. These trees are not displaying the typical characteristics of flattened foliage and very regular branching.





Plate 7 ▶



Plate 9 ▶



Plates 7 and 8 ◀▼ *Pinus caribaea*

Serial Nos. 3709 (plate 7) at Bussell and 4345 (plate 8) at Asplin showing the wide variation in form that can be expected between strains of this species. The trees at Bussell are fifteen years old and the trees at Asplin are twelve years old.



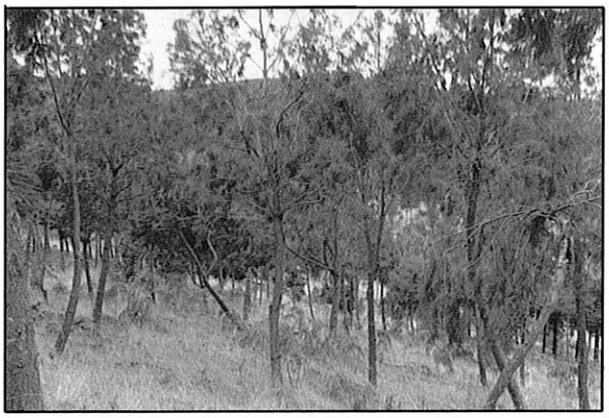


Plate 11 ▲



Plates 11 and 12 ▲ *Pinus clausa*

Nine-year-old trees at Asplin (plate 11) and Bussell (plate 12). This tree is noted for its poor form and displays this characteristic most obviously at Asplin.

Plates 9 and 10 ◀ *Pinus caribaea*

Eleven-year-old trees of serial number 4296 at Meribup (plate 9) and at Bussell (plate 10) show the good form of this unidentified strain. Note the healthy appearance of *P. caribaea* on the poor soils of Meribup.

other (Serial No. 4212) has poor form. A strain from Guatemala (Serial No. 4345) has extremely poor form,and appears to be unthrifty in this climate (see Plate 8). Two unidentified strains (Serial Nos. 4296 and 4092) have grown well at Meribup and Bussell (see Plates 9 and 10), although there is a tendency for *P. caribaea* to develop a 'sweep' in the stem on the moist soils at Meribup.

Pinus clausa Vasey. Sand Pine.

According to Dallimore and Jackson (1966), this is a species of low spreading habit that appears to have no economic value other than as a sand-binder. Its performance in Western Australia appears unspectacular. However, an interesting feature is the marked difference in habit between trees at Asplin and those at Bussell. Form is extremely poor at Asplin, although there is little difference in measurable growth between the two sites (see Plates 11 and 12).

Pinus contorta Douglas. Beach Pine.

The species is not suited to Western Australian conditions. Poor survival, slow growth and nutritional disorders are a feature of this tree's performance at each arboretum. No information is available to identify the variety or the native source (see Plate 13).

Pinus coulteri D. Don. Big-cone Pine.

This tree exhibited moderate growth at Asplin and Bussell. At Meribup some specimens, including dominants, are dying. *P. coulteri* is of little commercial value, being outperformed on all sites by other species. The large cones are popular for decorative purposes.

Pinus densiflora Siebold and Zuccarini. Red Pine of Japan.

This species is planted only at Bussell where its growth is slow and its appearance is unhealthy.

Pinus elliottii Engelmann. Slash Pine.

This species has performed well at each arboretum. This is significant only at Meribup where trees have remained healthy after twelve years, despite receiving fertilizer only at planting. This performance confirms *P. elliottii* as a species suitable for planting on infertile soils in areas such as the Donnybrook Sunkland (see Plate 14).

Pinus elliottii var. *densa* Little and Dorman. South Florida Slash Pine.

Represented at Asplin and Bussell, var. *densa* does not grow as fast as var. *elliottii*, but remains healthy with moderately good form (see Plate 15).

Pinus flexilis James. Limber Pine.
This alpine species failed at both Asplin and Bussell, and was not planted at Meribup.

Pinus glabra Walter. Spruce Pine.
This species is planted at Asplin and Bussell, where it remains healthy, although growth is slow. It is most suited to a sub-tropical climate where the atmosphere is moist (Dallimore and Jackson, 1966).

Pinus greggi Engelmann. Gregg's Pine.
This tree has shown greater tolerance to poor soil than its close relative *P. patula*. Form is good at both Bussell and Meribup (see Plates 16 and 17), whereas on the fertile soils at Asplin form is sacrificed to a considerable extent. Like *P. patula*, *P. greggii* is an attractive tree and has a place in ormamental plantings.

Pinus halepensis Miller. Aleppo Pine.
This species is represented in each of the arboreta. The trees at Asplin and Bussell originate from Tunisia, while the origin of those at Meribup is unknown. The strain at Bussell (Serial No. 3515) from the Chambi region of Tunisia has grown best, remaining healthy and exhibiting good form (see Plate 18). The form of the Qued el Bir strain at Asplin is very poor, although the trees remain healthy. At Meribup the species has declined after good early growth (see Plates 18 and 19).

This strain is generally considered inferior to *P. helepensis* var. *brutia* (Debazac & Tomassone, 1965 - cited by Palmberg, 1975). However, Palmberg found in studies of the *P. helepensis* species complex at Canberra, that some of the Tunisian strains ranked amongst the most vigorous, even when compared with var. *brutia*.

Pinus halepensis var. *brutia* (Tenore) Elwes and Henry.
Calabrian Pine (the name of Calabrian Pine is sometimes applied to *P. nigra* var. *maritima*).
Two distinct strains are recognized and are considered by some botanists to be separate species. *P. brutia* Tenore occurs in the eastern Mediterranean region and forms the western extent of the range, while *P. eldarica* Medwejew is confined to the eastern part of the species range and is found in Iran and Afghanistan. Both strains are represented in the arboreta. A provenance of *P. brutia* from the Bucak district of Turkey (Serial Number 3643), growing at Asplin and Bussell is the most impressive. This



Plate 13 ◀ *Pinus contorta*

Severely deficient and variable twelve-year-old trees at Meribup.



Plate 16 ▶



Plate 14 ▲ *Pinus elliottii* (Serial No. 4215)

This is one of the species that show potential on infertile soils that characterise Meribup.



Plates 16 and 17 ▲ *Pinus greggii*

Twelve-year-old trees at Meribup (plate 16) and Bussell (plate 17). *P. greggii* has out-performed its close relative *P. patula* at all three arboreta.



Plate 15 ◀ *Pinus elliottii* var. densa (Serial No. 3353)

Seen here growing at Bussell, this species is distinguished from *P. elliottii* by remaining as a stemless tussock for a period, and also by the tendency of the leaves to be in pairs (infrequently in threes as is common with *P. elliottii*).



Plate 18 ▶

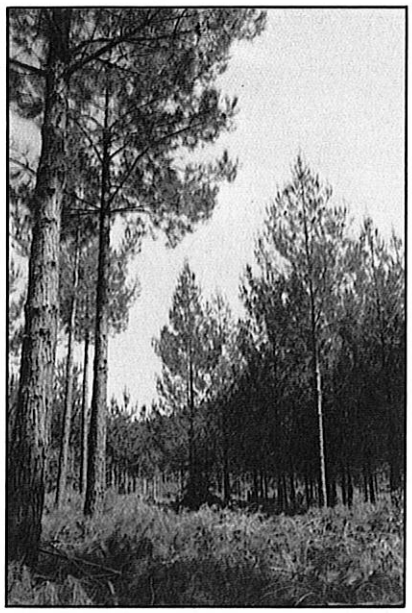


Plate 20 ▶



Plates 18 and 19 ▲ *Pinus halepensis*

The variation between provenances is evident between Serial No. 3515 (plate 18) at Bussell and Serial No. 3511 at Asplin (plate 19).



Plates 20 and 21 ▲ *Pinus halepensis var. brutia*

Trees at Bussell (Serial No. 3643) have exhibited acceptable form (plate 20) while those at Asplin (Serial No. 4343) which originate from the eastern extent of the natural range and are synonymous with *P. eldarica*, are, in this instance, uniformly poor (plate 21).



Plate 22 ▲ *Pinus kesiya* (Serial No. 4011)

This species is characterized in each arboretum by very poor form. This eleven-year-old stand at Bussell is a Vietnamese strain.

provenance is recorded by Arbez (1971) as being relatively superior and this is confirmed by Palmberg (1975) in trials near Canberra, A.C.T. (see Plate 20).

P. eldarica is disappointing at all arboreta. Form is poor and deaths have occurred, particularly where trees remain unthinned. Palmberg (1975) reports that at Canberra certain provenances of *P. elderica* are amongst the best of the *P. helepensis* associated species. Little information is available regarding the origin of the *P. elderica* that is planted in the arboreta, although the seed of Serial No. 4343 is known to have been collected from a plantation near Herat in Afghanistan (see Plate 21).

Pinus jeffreyii A. Murray. Jeffrey's Pine.

This pine appears similar to the Arizona and Colarado provenances of *P. ponderosa*, having the same grey-green foliage. Survival has been poor at Asplin and Bussell indicating that the species may be intolerant to dry conditions in its early growth. The rate of growth appears similar to that of *P. ponderosa*.

Pinus kesiya Royle ex Gordon. Benguet Pine.

This species is characterized at each arboretum by extremely poor form and mostly unhealthy appearance. It is not suited to Western Australian conditions (see Plate 22).

Pinus leiophylla Schlechtendal and Chamisso. Smooth-leaved Pine.

This species prefers fertile soil, indicated by the achievement of its best growth at Asplin (see Plate 23). Growth and health at Meribup are poor, particularly on the grey sands.

Pinus michoacana Martinez. Michoacan Pine.

The taxonomic status of this tree has not been resolved. Shaw (1909) includes it with the *P. montezumae* group while Dallimore and Jackson (1966) list it, with reservation, as a separate species. It is planted only at Bussell where growth is variable and the poor form restricts its potential to ornamental value (see Plate 24).

Pinus montezumae Lambert. Rough-branched Mexican Pine.

The species is represented in each arboretum and is characterized by poor form. However, trees remain healthy at each site and have ornamental value (see Plate 25).

Pinus montezumae var. *rudis* (Endlicher) Shaw.
This variety is distinguished by its shorter bluish leaves and straighter stems. Although branches are extremely heavy, it may have application as an ornamental tree.

Pinus muricata D. Don. Bishop Pine.
P. muricata is planted at all three arboreta. It can be divided into two clearly recognizable entities represented by the "green" strain from south of San Francisco and the "blue" strain from north of San Francisco (Fielding, 1961). Two of the northern provenances, Trinidad Head and Fort Bragg, show the greatest potential as producers of timber. The southern provenances (Santa Barbara, San Luis Obispo, Malin, Cedros Island and Menocino) generally have twisted trunks, large spreading branches and a more sparse appearance (see Plate 26). The northern provenances are often grouped by botanists as *P. muricata* var. *borealis* Duffield (Duffield, 1951), whilst the southern provenances are sometimes grouped as *P. muricata* var. *remorata* (Mason) Duffield. A provenance from the vicinity of San Vicente is atypical of the southern group, being straighter (Fielding, 1961) and more adapted to a dry environment (Duffield, 1951).

Although the exact origin of Serial No. 4220 is not known, the trees are characteristic of the "blue" strain. Growth is moderately fast and trees have remained healthy at all sites (see Plate 27).

Pinus nigra var. *maritima* (Aiton) Melville. Corsican Pine or Black Pine.
Distinguished from *P. nigra* var. *nigra* by its erect habit, the species is more sparsely branched and of less dense appearance (see Plate 29). It appears to be better suited to the Western Australian conditions than var. *nigra* and is more tolerant of infertile soils (see Plate 28A).

Pinus nigra var. *nigra* Arnold. Austrian Pine or Black Pine.
Identified by its shorter stiffer leaves and more dense habit (see Plate 30), this species has been outperformed at each site by *P. nigra* var. *maritima*. Neither variety is likely to be of economic importance in Western Australia due to their slow rate of growth.

Pinus oocarpa Schiede. Ocote Pine.
No information is available that identifies the provenances of the three strains of *P. oocarpa* in the arboreta. There are wide variations of habit between the provenances. (see Plates 31 and 32) This is a variable species which has been the subject of international testing to identify commercial strains. Some results are encouraging (Nikles, 1981).



Plate 23 ▲ *Pinus leiophylla* (Serial No. 4006)

Large branches are a noticeable feature on these thirteen-year-old trees growing at Asplin.



Plate 24 ▲ *Pinus michoacana* (Serial No. 4010)

Represented at Bussell only, this species has little commercial potential, however, it has ornamental merit.



Plate 25 ▲ *Pinus montezumae*

A close-up of the foliage showing the long drooping leaves that characterise many of the Mexican pines.



Plate 26 ▶



Plates 26 and 27 ▲ *Pinus muricata*

The difference between the Southern (green) strains (plate 26) and the Northern (blue) strains (plate 27) is illustrated here. Both these plots are at Bussell.



Plate 28A ▲ *Pinus nigra var. maritima* (Serial No. 3743)

This variety appears to be better suited to Western Australian conditions than *var. nigra*. The foliage is less dense and less persistant, and the branches are more sparse than *var. nigra*. These trees are at Bussell.



Plate 28B ▲ *Pinus pinaster*

Incorrectly identified as *P. nigra var. corsicana* these trees at Meribup are probably the Corsican strain of *P. pinaster*.





Plate 29 ▲ *Pinus nigra* (Serial No. 4290, 4285)

A comparison between *var. nigra* (right) and *var. maritima* (left) at Meribup. Note the yellowing of the foliage associated with *var. nigra*.



Plate 31 ▶



Plates 31 and 32 ▲

Pinus oocarpa (Serial No. 4013) Plate 31 and (Serial No. 4305) Plate 32.

These photographs of trees at Asplin show the wide variation of the species.

Plate 30 ◀ *Pinus nigra var. nigra* (Serial No. 4285)

These trees at Meribup share the typical short coarse foliage and compact appearance of *var. nigra*.

Pinus palustris Miller. Long-leaf Pine.

The species is limited to a few specimens at Asplin and Bussell where growth is slow to moderate. It appears to have little commercial or ornamental potential in Western Australia, preferring a temperate or sub-tropical climate and moist soils (Dallimore and Jackson, 1966).

Pinus patula Schlechtendal and Chamisso. Spreading-leaved Pine.

Growth of this species has been moderately fast and form is good, particularly at Asplin and Bussell. The species has not grown as fast as its close relative *P. greggi*. Because of its preference for fertile soil and a temperate climate, *P. patula* is unlikely to replace any of the species that are currently favoured for plantation silviculture. However, its ornamental character makes it worthy of attention (see Plate 33).

Pinus pinaster Aiton. Maritime Pine.

Pinus pinaster is represented at Bussell by a full sib progeny trial and at Asplin and Meribup by half sib trials. The form and growth of selected progeny is markedly better than routine stock (See Appendix 2d). The species remains healthy at Meribup, indicating a comparatively lower nutritional requirement than other conifers. Its stability is poor on seasonally waterlogged sites.

Plate 28B shows what is probably the Corsican strain of *P. pinaster*, falsely identified as *P. nigra* var.*corsicana* (Serial No. 4238).

Pinus pinea Linnaeus. Stone Pine.

This tree forms a dense umbrella-shaped crown and has application in Western Australia for shelter and wind breaks. It has grown fast at both Asplin and Bussell. Growth at Meribup is extremely poor, indicating a high nutrient requirement. This species is valued in Europe for its edible seeds (see Plates 34 and 35).

Pinus ponderosa Douglas. Western Yellow Pine.

Various provenances are planted at each aboretum. The provenances from low altitudes in the western part of the natural range (south-west U.S.A.) have shown best growth and remain comparatively healthy. Of these, the Californian strains from a mediterranean climate appear to be adapted best to Western Australian conditions (See Appendix 2e). Provenances that occur naturally at high altitudes are unhealthy and in some instances have failed. The gravelly loams of Bussell arboretum suit this species more than the rich loams of Asplin or the infertile sands of Meribup (see Plate 36).

Pinus pseudo -strobus var. *oaxacana* (Mirov) Harrison. False Weymouth Pine. Mexico.

Pinus pseudo -strobus var. *oaxacana* has grown moderately fast on fertile soil, exceeding most other Mexican pines in diameter growth. Trees are uniformly uninodal and acutely tapered,with large branches (see Plate 37).

Pinus pseudo - strobus var. *tenuifolia* (Bentham) Shaw. False Weymouth Pine.

Variety *tenuifolia* is best suited to fertile soil where its growth has been moderate, though form is poor and branches are large. Like var. *oaxacana*, var. *tenuifolia* has more ornamental value than economic potential.

Pinus pungens Lambert ex Michaux, f. Table Mountain Pine.

This species is noted in eastern North America for its quick natural colonization of waste land. Survival was poor at Bussell and Meribup. Although initial survival was better at Asplin, trees are unhealthy and deaths have occurred. Survival and growth of trees decreased when planted on wet grey sand at Meribup.

Pinus radiata D. Don Monterey Pine.

P. radiata is planted on fertile and moderately fertile soils in Western Australia. It was established in the arboreta primarily as a standard for the comparison of species. At Asplin and Bussell the species is also represented in provenance trials. Diameter growth at Meribup is similar to that of *P. elliottii*, *P. greggii*, *P. taeda* and the superior strains of *P. caribaea* (see Plate 38). Unfortunately it is not represented on the wet grey sands where establishment and maintenance of growth poses the greatest problem.

The growth rate of *P. radiata* at Asplin and Bussell exceeds that of all other species (see Appendices 2a and 2b and plate 39). Results of the provenance studies suggest that the Monterey and Cambria provenances are superior. However, as the majority of the seed was collected from open pollinated trees in arboreta, it is probable that the provenances are not true to type (See Appendix 2f). The provenance from the Island of Guadalupe is often referred to as variety *binata*, differing from the other provenances in that its leaves are usually in pairs.



Plate 33 ▲ *Pinus patula* (Serial No. 3907)

P. patula has performed moderately well at Asplin and Bussell, although growth rate does not approach that of *P. radiata*. Its close relative *P. greggii* has also grown faster, especially at Meribup.



Plate 34 ▲



Plates 34 and 35 ▲ *Pinus pinea*

This is a tree that prefers fertile soils, as shown by the stunted appearance at Meribup (plate 34) compared with the moderate growth at Asplin (plate 35).

Pinus radiata (Serial No. 4318) ▶ **Plate 38**

At Meribup *Pinus radiata* shows signs of crown deterioration after eleven years. However, growth compares favourably with the other species on this site.



Plate 36 ▲ *Pinus ponderosa*

Californian strains of *P. ponderosa* flank a South Dakota strain at Meribup. The Californian strains occurring at low altitudes are better suited to Western Australian conditions than strains from high altitudes or from inland California.



Plate 37 ▲ *Pinus pseudo-strobus var. oaxacana* (Serial No. 3978)

This tree prefers fertile soil. At Bussell they show the characteristically tapered stem and uninodal habit.





Plate 39 ▲ *Pinus radiata* (Serial No. 4318)

Eleven-year-old monterey pine at Bussell. Note the good form of these trees at this site.

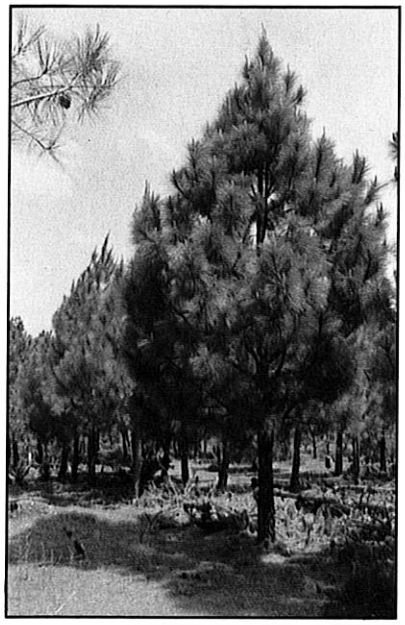


Plate 40 ▲ *Pinus roxburghii* (Serial No. 4236)

This is a species tolerant to a variety of conditions and may be worthy of provenance testing in Western Australia. These trees are at Asplin.

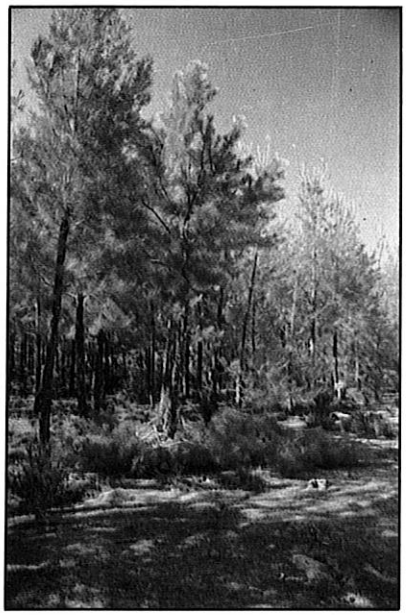


Plate 41 ▲ *Pinus serotina* (Serial No. 4051)

Pond pine has grown moderately fast at Meribup and remains healthy after eleven years. Being a species adapted to wet conditions, the performance of *P. serotina* has significance in relation to the Donnybrook Sunkland project.



Plate 42 ▲ *Pinus taeda* (Serial No. 4214)

The continuing healthy appearance of *P. taeda* at Meribup suggests that its nutrient requirement is less than that of *P. radiata*.

Pinus rigida Miller. Northern Pitch Pine.
This species is not suited to the Western Australian climate, as it is characterized here by poor survival and unhealthy appearance. At Meribup the species grows better on free draining light soils than it does on heavy soils.

Pinus roxburghii Sargent. Long-leaved Indian Pine.
P. roxburghii, like its close ally *P. canariensis*, has exhibited moderate growth. Branches appear to be larger on *P. roxburghii* than *P. canariensis* (see plate 40). At Meribup growth is more variable than at the other arboreta, deficiency symptoms being apparent at the time of assessment.

No record is available identifying the precise origin of the seed. As this species is known for its tolerance to a variety of conditions (Dallimore and Jackson 1966), the provenances from low altitudes in its natural range may be worthy of testing under Western Australian conditions.

Pinus serotina Michaux. Pond Pine.
Considered by some botanists to be a southern variety of *P. rigida* (*P. rigida* var. *serotina* (Michaux) Loudon), pond pine, as the name suggests, has adapted to wet conditions.

This species has grown moderately well at Meribup, where conditions are generally poor for tree growth (see plate 41). A study of selected provenances was initiated in 1980 by Mr. T. B. Butcher at Baudin Plantation south of Busselton, Western Australia, to evaluate the performance of *P. serotina* on moist leached soil and compare it with provenances of *P. taeda*.

Pinus taeda Linnaeus. Loblolly Pine.
Like *P. serotina*, loblolly pine is better adapted to wet conditions than most pines. Its introduction to Western Australia has been confined to trial plots, mainly on infertile wet soils where it appears to have potential for the production of timber. It is less nutrient demanding than *P. radiata*, although the latter grows faster on moist sites under an optimum fertilizer regime. However, *P. radiata* is susceptible to attack by *Phytophthora cinnamomi* (Rands) on some moist sites, whereas *P. taeda* is known to have a degree of resistance to the fungus (Campbell and Copeland, 1954, Batini and Podger 1968).

Provenance studies are located at Asplin and Bussell, where there appears to be little difference between strains. Unfortunately only one strain (which originated from a Queensland seed source) is

planted at Meribup (see Plate 42). Trees remain healthy at each site and form is generally good,although it deteriorates on the more fertile soils of Asplin arboretum, particularly when open grown.

Pinus thunbergii Parlatore. Black Pine.

This species has little potential as either a producer of timber or as a tree for amenity purposes in Western Australia. Health and form are poor at each location.

Pinus torreyana Parry ex Carrière. Soledad Pine.

This species was selected for inclusion in the arboreta because of its natural association with a mediterranean climate. However, its growth in Western Australia is slow to moderate and it appears to have little potential. The species has a limited distribution in the U.S.A.,and is confined to small areas along the San Diego coast and on Santa Rosa Island; consequently,it is unlikely that there is enough natural variation to warrant provenance studies.

Pinus virginiana Miller. Scrub Pine.

Apparently adapted to heavy soils (Dallimore and Jackson 1966), this pine is unspectacular, although it remains healthy. Branches are characteristically twisted and stem irregularities are common.

Pseudotsuga menziesii (Mirbel) Franco. Oregon Douglas Fir.

This species is represented only at Asplin, the trees at Bussell having failed to survive the first summer after planting. At Asplin growth is slow and variable. Its best performance is associated with pockets of deeper soil. While of no economic significance, Douglas fir may do better in more fertile moist situations, where aesthetics are considered.

Sequoia sempervirens (D. Don) Endlicher. Redwood.

This species is planted at Bussell and Asplin. At Asplin it was planted alternately with *P. radiata*, which was to act as a shelter in the establishment phase. However, the pines had to be removed four years later when it became apparent that competition for moisture was affecting the growth of the redwood trees. In spite of favoured positions at both arboreta and regular fertilizer at Bussell, growth has been slow by comparison with most other trees in the arboreta. However, they remained healthy. The species may be better suited to areas in the extreme south of Western Australia where climatic conditions are more moderate and atmospheric moisture is likely to be higher. Redwood would have ornamental value in these conditions.

Sequoiadendron giganteum (Lindley) Buchholz. Big Tree. The species is represented by seven specimens at Asplin. Trees remain healthy, although, like *Sequoia sempervirens*, this species is better suited to climates where atmospheric moisture and rainfall are higher.

General Discussion

The usefulness of arboreta in evaluating and comparing different species is dependent on the appropriate choice of provenance of each species. It is necessary for seed, collected or received for the purpose outlined in this paper, to be accompanied by detailed information relating to the provenance, the climatic, the soil and the topographic conditions under which the species grows in its natural state.

Unfortunately, many of the species and strains represented in the three arboreta are of unknown origin.

A good example is the *P. helepensis* group of species which exhibit a large variation between the strains.

When Arbez (1974) recorded wide variation between natural stands of *P. halepensis* var. *brutia* in Turkey, he accepted that the differences may not be due to genotype alone, but also to environmental factors. However, Palmburg (1975) concluded that the genotype x environmental interaction was low and that the form of the trees was under strong genetic control. The poor performance in the arboreta of *P. halepensis* var. *brutia* (sometimes referred to as *P. eldarica*) from the eastern part of its natural range is in contrast to Palmburg's findings, and emphasizes the importance of careful pre-selection of provenances. Wide growth and phenotypic variation was also recorded in the arboreta between provenances of *P. ponderosa*, *P. caribaea*, *P. muricata* and *P. oocarpa*.

It is unfortunate that Meribup arboretum, which is situated on a site similar to the Donnybrook Sunklands (where the main softwood establishment programme of the Forests Department of Western Australia is concentrated) received little silvicultural attention. Many species may have failed to realize their potential at this arboretum. Despite this, some species have exhibited

potential for producing timber on poor moist sands, provided adequate nutrients are applied. These were: *P. caribaea, P. elliottii, P. greggii, P. halepensis* var. *brutia, P. muricata* (blue strain), *P. radiata, P. serotina and P. taeda.*

These observations should be viewed in perspective, as the majority of the species listed are growing in yellow sand and their performance on the heavily leached grey sand of the Donnybrook Sunkland may differ. Some species have shown little or no tolerance to the soils at Meribup. These were: *Cupressus* sp., *P. canariensis, P. coulteri, P. halepensis, P. kesiya, P. leiophylla, P. oocarpa, P. patula, P. pinea, P. pseudo-strobus and P. thunburgii.*

The demand for trees for amenity purposes in Western Australia is increasing and some conifers have characteristics suitable for this requirement. *Callitris endlicheri* is a species that has shown a marked tolerance of dry, infertile and stony soils and has application where these conditions prevail. Its timber is also of high quality. *P. halepensis* var. *brutia* also appears to have adapated to dry conditions and is suitable for establishment on calcareous soils. Its nutrient requirement, however, appears to be greater than that of *C. endlicheri. Pinus pinea* is a tree of spreading habit with dense foliage and has application on farmland for shelter or as a wind-break. It requires a fertile soil. *Pinus pinaster*, the blue strains of *P. muricata* and the lowland strains of the Californian provenances of *P. ponderosa* are all species that are suitable for planting in intermediate rainfall areas (600-800 mm). *Cupressus arizonica , C. lusitanica* and *P. radiata* are all species that prefer fertile soils and moderate to high rainfall, and are suitable for amenity planting.

While the demand for conifers for ornamental purposes is not great, there are many species and cultivars within the genera of *Araucaria, Callitris, Cedrus, Cupressus, Chamaecyparis, Cryptomeria, Juniperus, Picea, Pinus, Pseudotsuga, Sequoia, Taxodium, Taxus, Thuya*, and *Tsuga* that will grow in Western Australia and have wide ornamental potential.

Within the genus *Pinus* the species originating from Mexico are noted for their aesthetic appeal in particular, *P. michoacana, P. montezumae, P. patula* and *P. pseudo-strobus.* Their long drooping leaves and often pendulous branches make them worthy of horticultural cultivation.

Species of the genus *Araucaria* have been popular in Western Australia. With its tolerance of salt-laden winds *A. heterophylla* is planted widely in coastal areas where frosts are not common.

Other species that are represented in the arboreta and have ornamental application, if growing conditions are suitable,are: *Cupressus* Sp., *P. canariensis, P. coulteri, P. greggii, P. pseudotsuga menziessii, P. roxburghii, Sequoiadendron giganteum* and *Sequoia sempervirens*. Of these, *Cupressus, P. pseudotsuga menziessii, Sequoiadendron giganteum* and *Sequoia sempervirons* have high nutrient requirements.

ACKNOWLEDGEMENTS

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Shaw, G.R. (1909). The Pines of Mexico.

Appendix 1A

ASPLIN ARBORETUM

Planted 1967

A1 *P. pinaster* - Portugal
A2 *P. elliottii,* (S.N. 3710) - S.E. U.S.A.
A3 *P. elliottii,* (S.N. 3563) - S.E. U.S.A.
A4 *P. caribaea,* (S.N. 3279) - Honduras
A5 *P. elliottii var. densa,* (S.N. 3353) - S. Florida U.S.A.
A6 *P. roxburghii,* (S.N. 3370) - Himalaya
A7 *P. palustris,* (S.N. 3712) - E. U.S.A.
A8 *P. caribaea,* (S.N. 3709) - Caribbean (Qld + tree seed)

Planted 1968

B1-6 *P. taeda,* (S.Ns. 3711, 3664, 3667, 3666, 3665, 3663) - S.E. U.S.A.
B7 *P. ponderosa,* (S.N. 3662) - California U.S.A.
B8 *P. kesiya,* (S.N. 3308) - Phillipines
B9 *P. nigra var. maritima,* (S.N. 3743) - Mediterranean
B10 *P. halepensis var. brutia,* (S.N. 3643) - Turkey
B11 *P. nigra var. maritima,* (S.N. 3335) - Corsica
B12 *P. contorta,* (S. N. 4017) - Oregon U.S.A.
B13 *P. thunbergii,* (S.N. 4007) - Japan
B14 *P. montezumae,* (S.N. 4009) - Mexico
B15 *P. oocarpa,* (S.N. 4013) - Central America
B16 *P. leiophylla,* (S.N. 4006) - Mexico
B17 *P. taeda,* (S.N. 3983) - S.E. U.S.A.
B18 *P. halepensis,* (S.N. 3511) - Tunsia
B19 *P. canariensis,* (S.N. 4026) - Canary Islands

Planted 1969

C1 *P. nigra var. maritima,* (S.N. 4018) - Mediterranean
C2 *P. halepensis var. brutia,* (S.N. 4169) - Cyprus
C3 *P. muricata,* (S.N. 4219) - California U.S.A.
C4 *P. pseudo-strobus var. oaxacana,* (S.N. 3978) - Central America
C5 *P. greggii,* (S. N. 4090) - Mexico
C6 *P. kesiya,* (S.N. 4011) - Vietnam
C7 *P. serotina,* (S.N. 4051) - S.E. U.S.A.

Planted 1970 Appendix 1A (cont.)

D1 *Cup. macrocarpa*, (S.N. 4181) - California U.S.A.
D2 *Cup. lusitanica*, (S.N. 3922) - Mexico
D3 *Cup. sempervirens*, (S.N. 3548) - Mediterranean
D4 *Cup. arizonica*, (S.N. 4274) - Arizona U.S.A.
D5 *P. caribaea*, (S.N. 4345) - Guatemala
D6 *P. oocarpa*, (S.N. 4305) - Central America
D7 *P. roxburghii*, (S.N. 4236) - Himalaya
D8 *P. radiata*, (S.N. 4318) - California U.S.A.
D9 *P. caribaea*, (S.N. 4296) - Caribbean
D10 *P. halepensis var. brutia* (Syn. P. eldarica), (S.N. 4343) - Afghanistan
D11 *P. pseudo-strobus var. tenuifolia*, (S.N. 4291) - Mexico
D12 *P. patula*, (S.N. 4293) - Mexico
D13 *P. patula*, (S.N. 3907) - Mexico
D14 *P. torreyana*, (S.N. 4286) - California U.S.A.
D15 *P. pinaster* - Portugal, (progeny trial)
D16 *P. nigra var. nigra*, (S.N. 4285) - Austria
D17 *P. nigra var. maritima*, (S.N. 4290) - Italy
D18 *P. pinaster*, (S.N. 4238) - Corsica
D19 *P. pinea*, (S.N. 4354) - Mediterranean
D20 *P. ponderosa* - S.W. U.S.A., (provenance trial)
D21 *P. coulteri*, (S.N. 3822) - California U.S.A.

Planted 1971

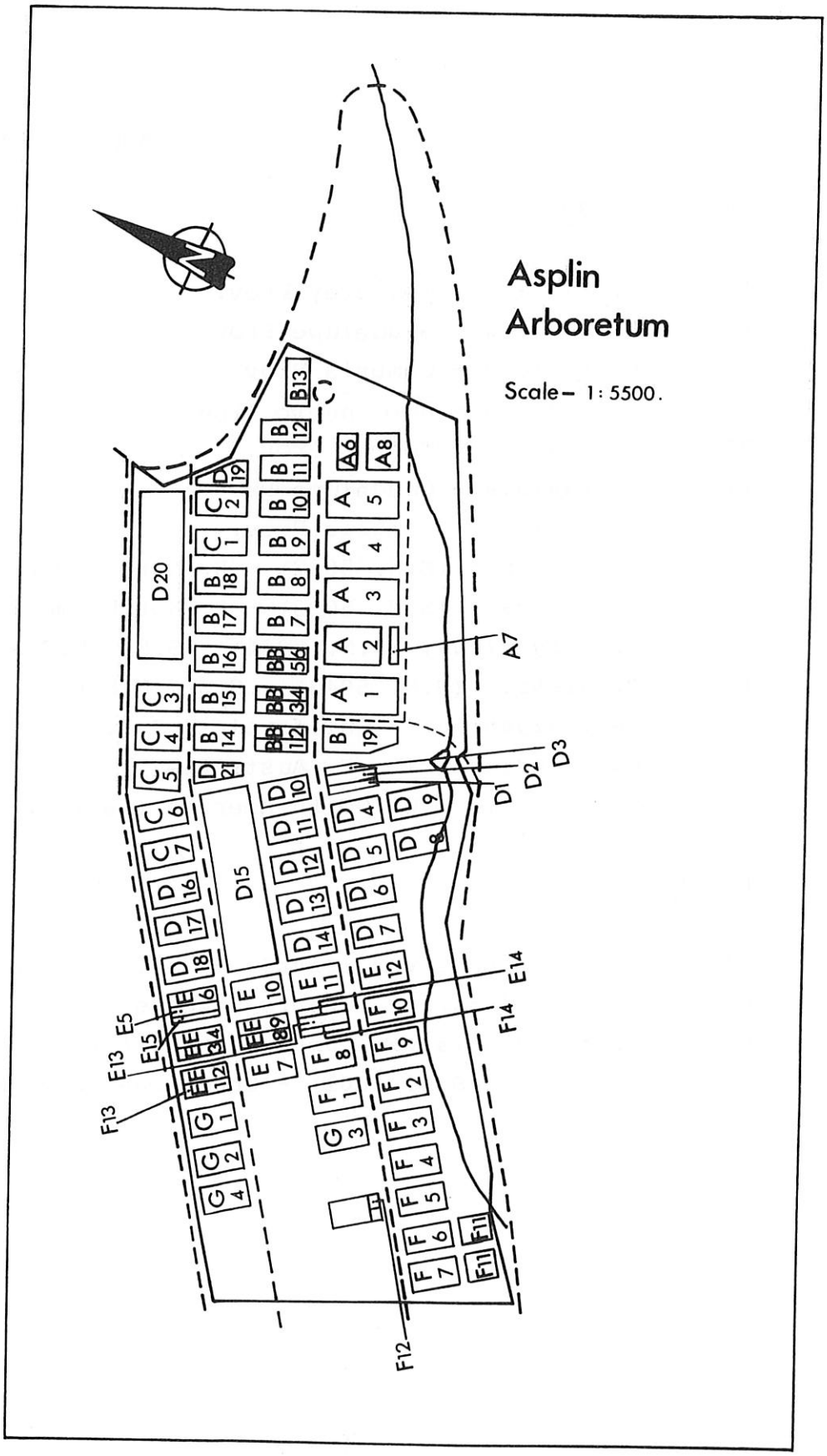
E1 *Abies religiosa*, (S.N. 4338) - Central America
E2 *P. jeffreyii* - Riverside California U.S.A.
E3 *P. jeffreyii* - El Dorado California U.S.A.
E4 *P. jeffreyii* - San Diego California U.S.A.
E5 *Ar. heterophylla* - Norfolk Island
E6 *Ar. cunninghamii* - Queensland Aust.
E7 *Thuya occidentalis* - E. North America (failed)
E8 *P. clausa*, (S.N. 5002) - Ocala, S. Florida U.S.A.
E9 *P. clausa*, (S.N. 5001) - Choctawhatchee, N. Florida U.S.A.
E10 *P. clausa*, (S.N. 5001) - Choctawhatchee, N. Florida U.S.A.
E11 *Ps. menziesii*, (S.N. 4261) - N. America (West Coast)
E12 *Seq. sempervirens*, (S.N. 4159) - S.W. U.S.A.
E13 *Ced. deodara*, (S.N. 4206) - Himalaya
E14 *Cup. lusitanica cv. knightiana* (seed ex Collie arboretum) - Mexico
E15 *Ar. angustifolia*, (S.N. 4282) - Brazil

Planted 1972

F1 *P. radiata* - Monterey Prov.
F2 *P. radiata* - Guadalupe Prov.
F3 *P. radiata* - Cambria Prov.
F4 *P. radiata* - Año nuevo Prov.
F5 *P. radiata* - Cedros Prov.
F6 *P. radiata* - Guadalupe Prov.
F7 *P. radiata* - Cambria Prov.
F8 *P. pungens*, (S.N. 5032) - E. North America
F9 *P. rigida*, (S.N. 5033) - E. North America
F10 *P. virginiana*, (S.N. 5034) - S.E. U.S.A.
F11 *P. glabra*, (S.N. 5043) - S.E. U.S.A.
F12 *Seq. giganteum* - California U.S.A.
F13 *Cal. endlicheri* - E. Australia
F14 *P. flexilis* - W. North America (failed)

Planted 1973

G1 *P. halepensis var. brutia* - Mediterranean
G2 *P. canariensis* - Canary Islands
G3 *P. halepensis var. brutia* - Mediterranean
G4 *P. clausa*, (S.N. 3001) - Choctawhatchee, N. Florida U.S.A.


Asplin
Arboretum
Scale – 1 : 5500.
D20
D15
A7
D1
D2
D3
E14
F14
E5
E13
E15
F13
F12
F11

BUSSELL ARBORETUM

Planted 1967

A1 *P. kesiya,* (S.N. 3308) - Phillipines
A2 *P. roxburghii,* (S.N. 3370) - Himalaya
A3 *P. caribaea,* (S.N. 3709) - Caribbean (Qld + tree seed)
A4 *P. caribaea,* (S.N. 3279) - Honduras
A5 *P. palustris,* (S.N. 3712) - E. U.S.A.
A6 *P. elliottii,* (S.N. 3710) - S.E. U.S.A.
A7 *P. eiliottii,* (S.N. 3563) - S.E. U.S.A.
A8 *P. elliottii var. densa,* (S.N. 3353) - S. Florida U.S.A.

Planted 1968

B1 *P. pinaster* (progeny trial) - Portugal
B2 *P. caribaea,*(S.N. 3899) - Bahamas
B3 *P. caribaea* - Caribbean
B4 *P. caribaea* - Caribbean
B5 *P. michoacana,* (S.N. 4010) - Mexico
B6 *P. ayacahuite,* (S.N. 3977) - Mexico
B7 *P. taeda,* (S.N. 3983) - S.E. U.S.A.
B8 *P. taeda,* (S.N. 3980) - S.E. U.S.A.
B9 *P. elliottii,* (S.N. 3984) - S.E. U.S.A.
B10-15 *P. taeda,* (S.Ns. 3664, 3663, 3665, 3666, 3667, 3711) - S.E. USA
B16 *P. nigra var. maritima,* (S.N. 3335) - Corsica
B17 *P. nigra var. maritima,* (S.N. 3743) - Mediterranean
B18 *P. halepensis var. brutia,* (S.N. 3643) - Turkey
B19 *P. oocarpa,* (S.N. 3902) - Central America
B20 *P. thunbergii,* (S.N. 4007) - Japan
B22 *P. contorta,* (S.N. 3414) - Oregon U.S.A.
B23 *P. ponderosa,* (S.N. 3659) - Arizona U.S.A.
B24 *P. ponderosa,* (S.N. 3660) - Colarado U.S.A.
B25 *P. ponderosa,* (S.N. 3662) - Oregon U.S.A.
B26 *P. ponderosa,* (S.N. 3741) - California U.S.A.
B27 *P. ponderosa,* (S.N. 3661) - New Zealand seed
B28 *P. halepensis,*(S.N. 3515) - Tunsia

Planted 1969

C1 *P. montezumae*, (S.N. 4009) - Mexico
C2 *P. greggii*, (S.N. 4090) - Mexico
C3 *P. pseudo-strobus var. oaxacana*,(S.N. 3978) - Central America
C4 *P. patula*, (S.N. 3907) - Mexico
C5 *P. halepensis var. brutia* (Syn. P. eldarica),(S.N.4343)-
C6 *P. canariensis*, (S.N. 4091) - Canary Islands Afghanistan
C7 *P. pinaster* - Portugal
C8 *P. leiophylla*, (S.N. 4006) - Mexico
C9 *P. serotina*, (S.N. 4051) - S.E. U.S.A.
C10 *P. halepensis var. brutia*, (S.N. 4169) - Cyprus
C11 *P. oocarpa*, (S.N. 4013) - Central America
C12 *P. montezumae var. rudis*, (S.N. 3504) - Mexico
C13 *P. muricata*, (S.N. 4220) - California U.S.A.
C14 *P. nigra var. maritima*, (S.N. 4018) - Mediterranean
C15 *P. pinea*, (S.N. 4245) - Mediterranean
C16 *P. coulteri*, (seed ex Bowelling pltn.) - California U.S.A.

Planted 1970

D1 *P. radiata*, (S.N. 4318) - California U.S.A.
D2 *P. thunbergii*, (S.N. 4007) - Japan
D3 *P. kesiya*, (S.Ns. 3914, 4041) - Burma
D4 *P. pseudo-strobus*, (S.N. 3915) - Mexico
D5 *P. densiflora* - Japan
D6 *Seq. sempervirens*, (S.N. 4159) - S.W. U.S.A.
D7 *P. ponderosa* - S.W. U.S.A. (provenance trial)
D8 *Cup. arizonica*, (S.N. 4274) - Arizona U.S.A.
D9 *Cup. lusitanica*, (S.N. 3922) - Mexico
D10 *Cup. macrocarpa*, (S.N. 4181) - California U.S.A.
D11 *Cup. sempervirens*, (S.N. 3548) - Mediterranean
D12 *P. caribaea*, (S.N. 4296) - Caribbean
D13 *P. nigra var. maritima*, (S.N. 4290) - Italy
D14 *P. pinaster* (S.N. 4238) - Corsica
D15 *P. nigra var. nigra*, (S.N. 4285) - Austria
D16 *P. roxburghii*, (S.N. 4342) - Himalaya
D17 *P. torreyana*, (S.N. 4286) - California U.S.A.
D18 *P. contorta*, (S.N. 4017) - Oregon U.S.A.

Planted 1970 (cont.)

D19 *P. oocarpa*, (S.N. 4305) - Central America

D20 *P. kesiya*, (S.N. 4011) - Vietnam

D21 *P. patula*, (S.N. 4293) - Mexico

D22 *P. pseudo-strobus var. tenuifolia*, (S.N. 4291) - Mexico

D23 *P. caribaea*, (S.N. 4345) - Guatemala

D24 *P. canariensis* - Canary Islands

Planted 1971

E1 *P. muricata/radiata* grafted trees

E2 *P. clausa* (S.N. 5002) - Ocala, S. Florida U.S.A.

E3 *Cedrus deodara*, (S.N. 4206) - Himalaya

E4 *P. clausa*, (S.N. 5001) - Choctawhatchee, Florida U.S.A.

E5 *Ps. menziesii*, (S. N. 4261) - N. America (West Coast)

E6 *Thuya occidentalis* - E. North America (failed)

E7 *P. jeffreyii*, (Riverside) - California U.S.A.

E8 *Abies religiosa*, (S.N. 4338) - Central America

E9 *Cup. lusitanica cv. knightiana* (seed ex Collie arboretum)- Mexico

E10 *Ar. angustifolia*, (S.N. 4282) - Brazil

E11 *Ar. heterophylla* - Norfolk Island (failed)

E12 *Ar. cunninghamii* - Queensland Aust.

E13 *P. jeffreyii* - California U.S.A. (El Dorado and San Diego)

E14 *P. muricata* - California U.S.A.

P. muricata - California U.S.A.

P. radiata var. binata - Guadalupe Island

E15 *P. radiata* - California U.S.A. (Scion orchard)

E16 *Euc. calophylla var. rosea* - S.W. Australia

E17 Mixed Species

Planted 1972

F1 *Cal. endlicheri* - E. Australia

F2 *P. halepensis var. brutia* (Syn. P. eldarica) - Turkey

F3 *P. pungens*, (S.N. 5032) - N. Carolina U.S.A.

F6 *P. radiata var. binata* - Guadalupe Prov.

F7 *P. radiata* - Cambria Prov.

F8 *P. radiata* - Cambria and Año Nuevo Prov.

Planted 1972 (cont.)

F9 *P. radiata* - Monterey Prov.

F10 *P. rigida*, (S.N. 5033) -N. Carolina U.S.A.

F11 *P. virginiana*, (S.N. 5034) - Alabama, U.S.A.

F12 *P. halepensis var. brutia*, (S.N. 5021) - Mediterranean

F13 *P. glabra*, (S.N. 5043) - S.E. U.S.A.

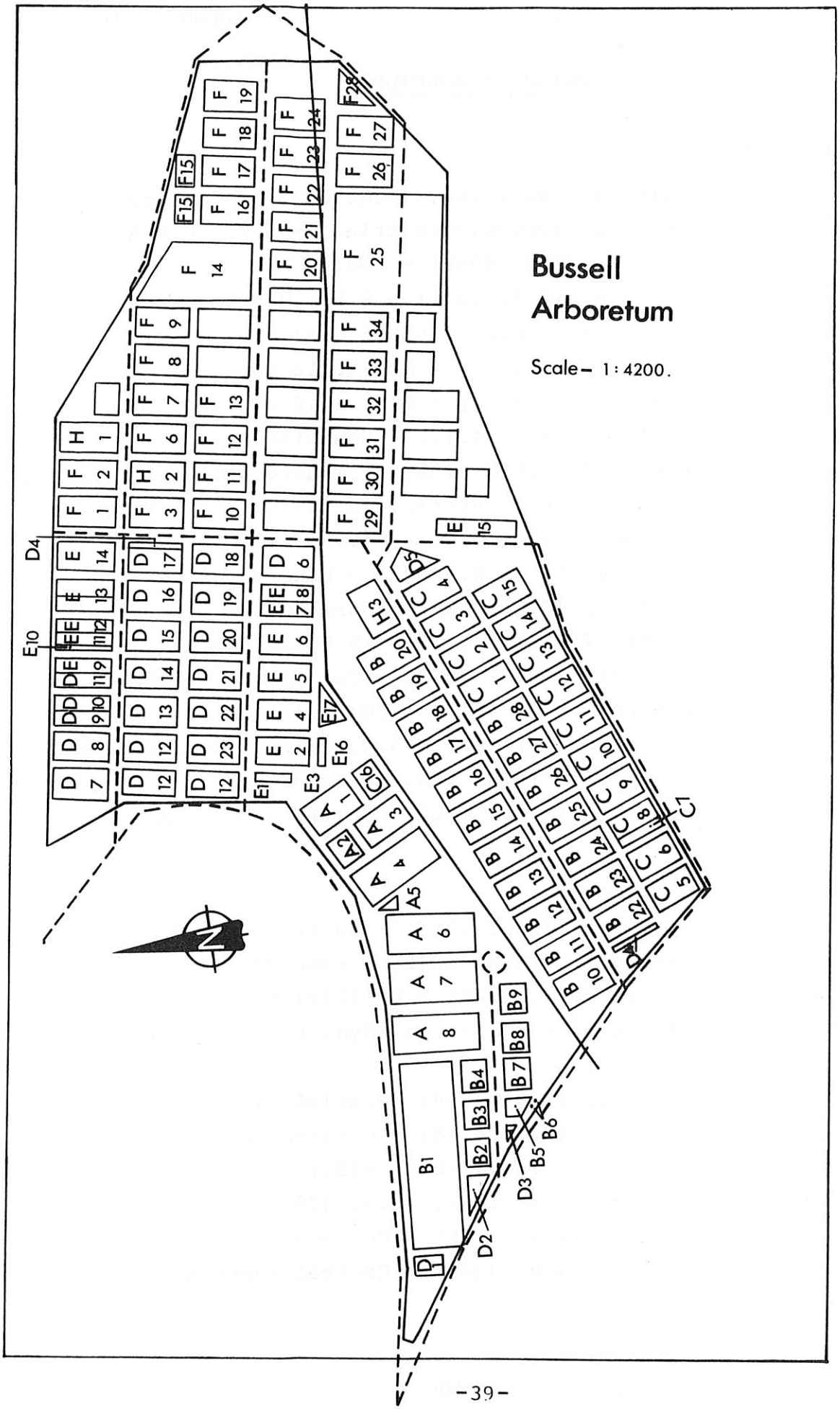
F14 *Eucalyptus spp.* - Goldfields, W.A.

Planted 1980

H1 *P. halepensis var. brutia*, (S.N. 5103) - Turkey

H2 *P. halepensis*, (S.N. 5106) - Turkey

H3 *P. halepensis* (provenance study) - Turkey


Bussell
Arboretum
Scale – 1:4200.
N

Appendix 1C

MERIBUP ARBORETUM

Planted 1969

A1	*P. nigra var. maritima*, (S.N. 3335) - Corsica
A2	*P. ponderosa*, (provenance trial) - S.W. U.S.A.
A3	*P. greggii*, (S.N. 4090) - Mexico
A4	*P. serotina*, (S.N. 4051) - S.E. U.S.A.
A5	*P. montezumae*, (S.N. 4009) - Mexico
A6	*P. pinea*, (S.N. 4245) - Mediterranean
A7	*P. taeda*, (S.N. 4214) - S.E. U.S.A.
A8	*P. caribaea*, (S.N. 4212) - Honduras
A9	*P. helepensis*, (S.N. 4099) - Mediterranean
A10	*P. halepensis var. brutia*, (S.N. 3643) - Turkey
A11	*P. halepensis var. brutia*, (S.N. 4169) - Cyprus
A12	*P. canariensis*, (S.N. 4091) - Canary Islands
A13	*P. caribaea*, (S.N. 4092) - Caribbean
A14	*P. elliottii*, (S.N. 4215) - S.E. U.S.A.
A15	*P. coulteri*, (S.N. 3822) - California U.S.A.
A16	*P. oocarpa*, (S.N. 4013) - Central America
A17	*P. nigra var. maritima*, (S.N. 4018) - Mediterranean
A18	*P. thunbergii*, (S.N. 4007) - Japan
A19	*P. muricata*, (S.N. 4220) - California U.S.A.

Planted 1970

B1	*P. torreyana*, (S.N. 4286) - California U.S.A.
B2	*P. roxburghii*, (S.N. 4342) - Himalaya
B3	*P. kesiya*, (S.N. 3308) - Phillipines
B4	*P. halepensis var. brutia* (Syn. P. eldarica), (S.N. 4343) - Afghanistan
B5	*P. caribaea*, (S.N. 4296) - Caribbean
B6	*P. radiata*, (S.N. 4318) - California U.S.A.
B7	*P. nigra var. nigra*, (S.N. 4285) - Austria
B8	*P. nigra var. maritima*, (S.N. 4290) - Italy
B9	*P. pinaster*, (S.N. 4238) - Corsica
B10	*P. oocarpa*, (S.N. 4305) - Central America

Planted 1970 (cont.)

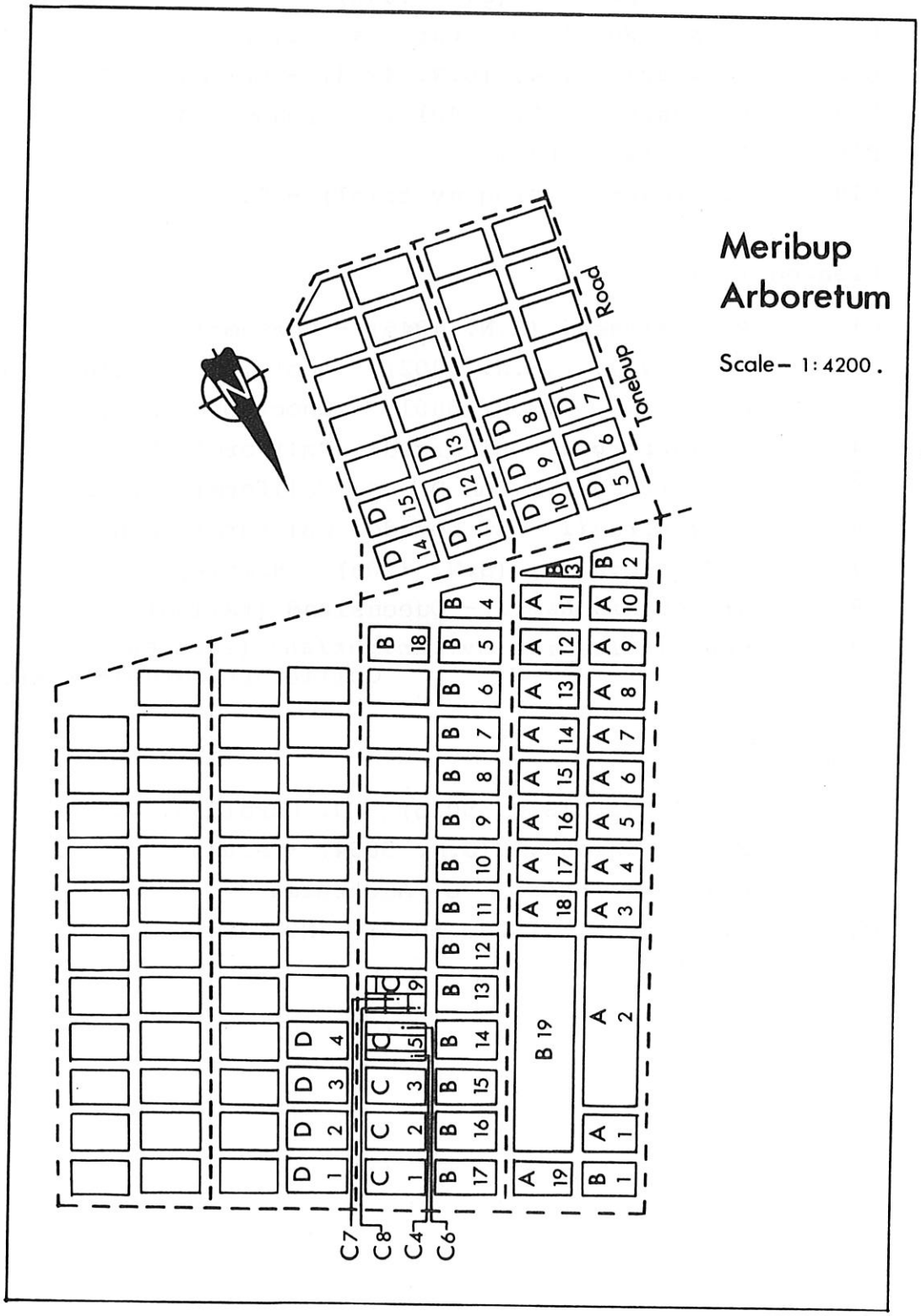
B11 *P. pseudo-strobus var. tenuifolia,* (S.N. 4291) - Mexico
B12 *P. patula,* (S.N. 4293) - Mexico
B13 *P. kesiya,* (S.N. 4011) - Vietnam
B14 *P. leiophylla,* (S.N. 4006) - Mexico
B15 *P. pseudo-strobus var. oaxacana,*(S.N. 3978) - Mexico
B16 *Cup. arizonica,* (S.N. 4274) - Arizona U.S.A.
B17 *P. contorta,* S.N. 4017) - Oregon U.S.A.
B18 *P. kesiya* - Burma
B19 *P. pinaster* (progeny trial) - Portugal

Planted 1971

C1 *P. caribaea,* (S.N. 4345) - Guatemala
C2 *P. clausa,* (S.N. 5002) - Ocala, S. Florida U.S.A.
C3 *P. clausa,* (S.N. 5001) - Choctawhatchee, Florida U.S.A.
C4 *P. jeffreyii* - Riverside, California U.S.A.
C5 *P. jeffreyii* - San Diego, California U.S.A.
C6 *P. jeffreyii* - El Dorado, California U.S.A.
C7 *Ced. deodara* , (S.N. 4206) - Himalaya
C8 *Ar. cunninghamii* - Queensland (failed)
C9 *Cup. lusitanica cv. knightiana* (seed ex Collie arboretum)- Mexico

Planted 1972

D1 *P. rigida,* (S.N. 5033) - N. Carolina, U.S.A.
D2 *P. virginiana,* (S.N. 5034) - Alabama
D3 *Cal. endlicheri* - E. Australia
D4 *P. pungens,* (S.N. 5032) - N. Carolina


Meribup
Arboretum
Scale – 1:4200.
N
Tonebup Road
D 15
D 14
D 13
D 12
D 11
D 10
D 9
D 8
D 7
D 6
D 5
B 18
B 17
B 16
B 15
B 14
B 13
B 12
B 11
B 10
B 9
B 8
B 7
B 6
B 5
B 4
B 3
B 2
B 1
A 19
A 18
A 17
A 16
A 15
A 14
A 13
A 12
A 11
A 10
A 9
A 8
A 7
A 6
A 5
A 4
A 3
A 2
A 1
B 19
D 1
D 2
D 3
D 4
C 1
C 2
C 3
C7
C8
C4
C6

ASPLIN ARBORETUM - GROWTH AND FORM DATA AT JANUARY 1981

Species	Plot No.	Year Planted	DBHOB (cm)	Top Ht. (m)*	B		S		T		A		F			
					Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	No. single stem	No. of ramicorms	No. forked or multi-leader	Total
Abies religiosa (4338)	E1	1971	5.2	3.4	2.5	-	2.5	-	3.5	-	3.5	-	1	0	1	2
Araucaria angustifolia (4282)	E15	1971	1.8	2.1	1.2	-	1.2	-	1.6	-	3.0	-	5	0	0	5
Araucaria cunninghamii	E6	1971	5.0	4.0	1.7	0.6	1.3	0.6	2.4	0.7	2.6	0.7	20	0	0	20
Araucaria heterophylla	E15	1971	4.6	3.1	1.4	0.5	1.4	0.5	1.6	0.6	1.8	0.6	12	0	3	15
Callitris endlicheri	F13	1972	10.5	5.9	1.9	1.0	2.1	0.8	3.9	0.8	3.6	0.6	19	1	1	21
Cedrus deodara (4206)	E13	1971	3.3	3.8	2.3	0.7	1.8	0.9	1.2	0.6	1.8	0.4	9	0	1	10
Cupressus arizonica (4274)	D4	1970	16.5	8.3	2.0	0.6	2.0	0.3	4.0	0.9	2.3	0.7	30	0	0	30
Cupressus lusitanica (3922)	D2	1970	20.7	12.6	1.7	0.6	1.6	0.8	4.2	1.1	2.9	0.6	21	0	0	21
Cupressus lusitanica cv. knightiana	E14	1971	13.9	8.8	1.9	0.8	1.4	0.5	3.4	1.0	1.8	0.4	14	0	0	14
Cupressus macrocarpa (4181)	D1	1970	15.3	9.6	2.0	0.8	2.1	0.7	3.5	1.5	2.7	0.7	15	0	0	15
Cupressus sempervirens (3548)	D3	1970	3.1	4.5	3.6	0.7	3.2	1.0	1.2	0.6	4.5	1.0	2	0	9	11
Pinus canariensis (4026)	B19	1968	20.8	10.3	2.7	0.9	3.3	0.9	4.6	0.6	1.8	0.6	23	1	6	30
Pinus canariensis	G2	1973	12.0	5.7	2.3	0.7	2.1	0.7	3.6	0.6	1.9	0.6	13	6	11	30
Pinus caribaea (3279)	A4	1967	21.9	11.7	2.8	0.8	3.6	1.0	4.1	1.1	2.5	0.6	23	3	4	30
Pinus caribaea (3709)	A8	1967	23.9	12.0	2.3	0.6	2.6	0.6	4.2	0.7	2.7	0.9	12	3	0	15
Pinus caribaea (4345)	D5	1970	16.4	9.0	3.7	1.1	3.5	0.9	4.2	0.8	2.7	0.8	19	7	4	30
Pinus caribaea (4296)	D9	1970	17.8	9.0	2.4	0.6	3.0	0.8	4.6	0.7	3.1	0.7	20	2	8	30
Pinus clausa (5002)	E8	1971	9.5	6.4	3.2	0.8	3.5	0.5	3.4	0.9	2.9	0.6	8	2	5	15
Pinus clausa (5001)	E9	1971	10.2	6.8	2.5	0.6	2.5	0.5	3.9	1.2	3.3	0.7	8	3	4	15
Pinus clausa (5001)	E10	1971	10.1	7.1	2.4	0.9	2.4	0.6	3.3	0.6	3.1	0.6	14	7	9	30
Pinus clausa (5001)	G4	1973	7.9	5.2	3.4	1.2	3.3	0.7	3.8	0.9	3.5	0.8	15	10	5	30
Pinus contorta (4017)	B12	1968	5.0	3.4	2.5	-	3.0	-	3.5	-	2.8	-	2	0	2	4
Pinus coulteri (3822)	D21	1970	18.8	6.2	2.3	0.5	2.2	0.8	4.9	0.3	2.9	0.3	6	0	4	10
Pinus elliottii (3710)	A2	1967	24.4	12.5	1.6	0.8	2.1	0.8	4.6	0.7	2.7	0.8	24	6	0	30
Pinus elliottii (3563)	A3	1967	20.6	11.8	1.9	0.9	2.3	0.6	4.2	1.0	2.5	0.6	23	3	4	30
Pinus elliottii var. densa (3353)	A5	1967	21.2	11.2	1.5	0.6	3.0	0.9	4.3	0.9	3.0	0.4	12	7	11	30
Pinus glabra (5043)	F11	1972	8.4	5.9	3.1	0.6	3.1	0.8	3.2	0.8	2.8	0.7	22	6	2	30
Pinus greggii (4090)	C5	1969	21.9	12.9	3.4	0.9	2.5	0.6	4.6	0.6	2.4	0.6	23	5	2	30
Pinus halepensis (3511)	B18	1968	15.5	10.8	3.9	0.9	3.2	0.8	4.8	0.4	3.0	0.7	12	4	14	30
Pinus halepensis var. brutia (3643)	B10	1968	18.7	10.0	2.0	0.7	2.2	0.5	3.6	0.7	2.3	0.5	29	0	0	29
Pinus halepensis var. brutia (4169)	C2	1969	18.2	10.1	3.3	0.9	2.7	0.8	4.7	0.8	2.5	0.7	26	1	3	30
Pinus halepensis var. brutia (4343)	D10	1970	13.9	7.5	3.2	0.8	2.9	0.7	3.5	0.8	2.1	0.5	13	3	14	30
Pinus halepensis var. brutia	G1	1973	8.7	5.2	3.2	0.9	3.2	0.7	3.8	0.8	2.4	0.7	2	6	22	30
Pinus halepensis var. brutia	G3	1973	8.8	5.2	2.4	0.6	2.6	0.7	2.6	0.7	1.9	0.4	24	2	4	30
Pinus jeffreyii (Riverside)	E2	1971	3.1	2.3	2.3	0.7	2.0	0.7	2.9	1.7	2.0	0.5	9	0	0	9
Pinus jeffreyii (El Dorado)	E3	1971	7.1	3.4	1.9	0.7	1.8	1.0	4.0	1.2	2.4	0.5	5	2	3	10
Pinus jeffreyii (San Diego)	E4	1971	9.5	4.6	1.6	0.7	1.6	0.9	4.5	0.6	2.4	0.8	14	1	2	17
Pinus kesiya (3308)	B8	1968	18.1	9.4	3.3	1.1	3.8	0.8	4.8	0.5	2.8	0.5	11	4	15	30
Pinus kesiya (4011)	C6	1969	20.8	10.2	3.5	1.4	3.9	1.0	4.9	0.4	2.6	0.6	16	1	13	30
Pinus leiophylla (4006)	B16	1968	20.2	11.8	3.5	1.0	3.0	0.7	4.5	0.8	2.7	0.6	12	5	13	30
Pinus montezumae (4009)	B14	1968	23.9	11.0	3.5	0.9	3.2	1.0	5.0	0.0	2.2	0.4	6	10	14	30
Pinus muricata (4219)	G3	1969	18.9	10.1	2.0	0.8	2.1	0.6	4.5	0.7	3.3	0.7	20	7	3	30
Pinus nigra var. maritima (3743)	B9	1968	13.7	7.4	1.8	0.5	2.0	0.4	3.8	0.6	2.4	0.5	25	4	1	30

Species	Plot No.	Year Planted	DBHOB (cm)	Top Ht. (m)*	B		S		T		A		F			
					Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	No. single stem	No. of ramicorms	No. forked or multi-leader	Total
Pinus nigra var. maritima (4018)	C1	1969	10.3	5.8	1.6	0.6	1.6	0.7	3.8	1.1	2.4	0.6	6	7	5	18
Pinus nigra var. maritima (3335)	B11	1968	12.1	6.6	1.3	0.5	2.0	0.6	3.6	0.6	2.7	0.6	18	5	6	29
Pinus nigra var. maritima (4290)	D17	1970	9.0	5.1	1.8	0.5	1.6	0.7	3.3	0.7	2.5	0.5	23	4	3	30
Pinus nigra var. nigra (4285)	D16	1970	6.6	4.2	1.9	0.6	2.2	0.9	3.3	0.8	2.4	0.6	13	8	9	30
Pinus oocarpa (4013)	B15	1968	21.1	12.1	2.8	1.3	3.5	0.9	4.2	1.0	2.2	0.4	10	3	17	30
Pinus oocarpa (4305)	D6	1970	13.2	7.3	4.1	0.8	4.5	0.6	3.3	1.0	2.1	0.6	9	4	17	30
Pinus palustris (3712)	A7	1967	14.9	9.1	2.7	0.8	2.4	0.8	4.0	1.0	2.6	1.0	9	3	2	14
Pinus patula (4293)	D12	1970	17.2	11.2	2.7	0.9	2.4	0.6	4.0	1.1	2.6	0.6	26	1	3	30
Pinus patula (3907)	D13	1970	19.5	12.6	2.2	0.7	2.3	0.8	3.4	1.1	2.4	0.6	23	2	5	30
Pinus pinaster (progeny study)	D15	1970			see Appendix 2d											
Pinus pinaster	A1	1967	23.6	12.5	2.7	1.0	3.3	1.0	4.6	0.6	3.2	0.6	14	6	10	30
Pinus pinaster (4238)	D18	1970	15.6	7.7	2.1	0.7	2.2	0.7	4.0	0.9	2.5	0.5	20	7	3	30
Pinus pinea (4354)	D19	1970	20.5	7.6	3.2	1.2	3.2	0.6	5.0	0.0	4.4	0.6	3	2	16	21
Pinus ponderosa (3662)	B7	1968	16.1	7.8	2.0	0.5	2.4	0.6	4.8	0.4	3.1	0.9	21	7	2	30
Pinus ponderosa (provenance trial)	D20	1970			see Appendix 2e											
Pinus pseudo-strobus var. oaxacana (3978)	C4	1969	22.4	11.6	3.3	0.6	2.7	0.8	4.9	0.4	3.1	0.7	21	5	4	30
Pinus pseudo-strobus var. tenuifolia (4291)	D11	1970	18.2	9.0	3.6	0.8	2.9	1.0	4.8	0.4	3.1	0.9	11	2	1	14
Pinus pungens (5032)	F8	1972	7.2	4.9	2.2	0.6	3.0	0.7	2.9	0.8	3.0	0.6	24	4	2	30
Pinus radiata (4318)	D8	1970	23.4	14.0	2.3	0.9	3.5	0.7	4.8	0.5	3.3	0.6	24	6	0	30
Pinus radiata (provenance study)	F1-6	1972			see Appendix 2f											
Pinus rigida (5033)	F9	1972	8.6	5.6	2.1	0.6	2.6	0.7	3.3	0.7	3.4	0.9	25	2	3	30
Pinus roxburghii (3370)	A6	1967	19.5	9.2	2.1	0.6	2.1	1.0	4.3	0.6	2.1	0.9	14	1	0	15
Pinus roxburghii (4236)	D7	1970	17.2	7.6	3.3	0.9	2.7	0.7	4.9	0.3	1.7	0.8	29	0	1	30
Pinus serotina (4051)	C7	1969	16.4	9.3	2.4	1.1	3.7	0.8	3.9	0.8	2.8	0.4	25	4	1	30
Pinus taeda (3711)	B1	1968	22.0	11.6	2.3	0.7	2.3	0.5	4.9	0.4	3.1	1.0	9	6	0	15
Pinus taeda (3664)	B2	1968	19.6	11.0	3.0	0.4	2.1	0.4	4.7	0.6	2.5	0.6	14	1	0	15
Pinus taeda (3667)	B3	1968	21.3	11.3	2.7	0.6	2.4	0.6	4.9	0.4	3.1	0.7	9	3	3	15
Pinus taeda (3666)	B4	1968	21.6	11.6	2.7	0.6	2.3	0.6	4.8	0.4	3.1	0.5	12	3	0	15
Pinus taeda (3665)	B5	1968	20.7	11.1	2.1	0.6	1.9	0.5	4.7	0.5	2.7	1.0	9	4	2	15
Pinus taeda (3663)	B6	1968	21.2	11.4	2.3	0.8	1.9	0.5	5.0	0.3	2.7	0.7	12	2	1	15
Pinus taeda (3983)	B17	1968	21.8	11.9	2.4	0.7	2.3	0.6	4.8	0.4	3.2	0.5	19	8	3	30
Pinus thunbergii (4007)	B13	1968	20.6	9.8	3.8	1.0	3.9	0.9	4.8	0.5	2.6	1.0	8	8	13	29
Pinus torreyana (4286)	D14	1970	18.4	9.8	2.3	0.8	2.7	0.6	5.0	0.2	2.5	0.6	28	2	0	30
Pinus virginiana (5034)	F10	1972	8.7	6.0	3.0	0.3	2.9	0.7	3.1	0.7	3.0	0.7	28	2	0	30
Pseudotsuga menziesii (4261)	E11	1971	2.9	3.8	2.1	0.6	2.0	0.5	1.8	0.7	3.2	0.8	28	0	2	30
Sequoiadendron giganteum	F12	1972	7.4	8.2	1.4	0.5	1.1	0.4	1.9	0.4	1.7	0.8	7	0	0	7
Sequoia sempervirens (4159)	E12	1971	5.0	4.3	3.8	0.8	2.9	0.9	1.8	0.5	1.7	0.8	23	0	7	30

* Top height: based on the tallest 100 s.p.h.

\+ Total: No. of trees assessed, in most cases the equivalent of 250 crop trees per hectare.

Form: B - butt sweep. Visual assessment on a 1-5 scale where 1 = no butt sweep, 5 = severe butt sweep

S - stem sweep. Assessment the same as for butt sweep.

T - branch thickness. A scale of 1-5 where: 1 = < 20 mm
2 = 20 mm - 30 mm
3 = 30 mm - 40 mm
4 = 40 mm - 50 mm
5 = > 50 mm

Form A - branch angle. A scale of 1-5 where: 1 = horizontal branch (90^{o})
2 = 90^{o} - 112.5^{o}
3 = 112.5^{o} - 135^{o}
4 = 135^{o} - 157.5^{o}
5 = 157.5^{o} - 180^{o}

F - leader status.

Appendix 2B

BUSSELL ARBORETUM - GROWTH AND FORM DATA AT FEBRUARY 1980

Species	Plot No.	Year Planted	DBHOB (cm)	Top Ht. (m)*	B		S		T		A		F			
					Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	No. single stems	No. of ramicorms	No. forked or multi-leader	Total
Abies religiosa (4338)	E8	1971	3.4	3.1	2.2	-	2.3	-	3.0	-	3.4	-	2	0	0	2
Araucaria angustifolia (4282)	E10	1971	-	2.3	1.3	0.5	1.2	0.4	1.8	0.4	3.8	0.4	10	0	0	10
Araucaria cunninghamii	E12	1971	-	0.2	-	-	-	-	-	-	-	-	4	0	0	4
Callitris endlicheri	F1	1972	6.1	4.8	1.7	0.7	1.5	0.8	1.1	0.3	3.0	0.5	30	0	0	30
Cedrus deodara (4206)	E3	1971	2.9	3.2	1.1	0.3	1.9	1.1	1.0	0.0	2.1	0.6	5	0	5	10
Cupressus arizonica (4274)	D8	1970	8.0	3.6	1.0	0.2	1.0	0.2	1.4	0.6	2.7	0.5	30	0		30
Cupressus lusitanica (3922)	D9	1970	8.8	6.1	1.3	0.5	1.1	0.3	1.4	0.6	2.7	0.6	15	0	0	15
Cupressus lusitanica cv. knightiana	E9	1971	3.7	3.4	1.7	0.8	1.5	0.6	1.7	0.5	1.8	0.4	15	0	0	15
Cupressus macrocarpa (4181)	D10	1970	8.1	6.3	1.1	0.4	1.1	0.4	1.8	0.4	2.6	0.6	15	0	0	15
Cupressus sempervirens (3548)	D11	1970	3.9	4.1	2.87	0.7	1.87	0.5	1.00	0.0	5.0	0.0	11	0	4	15
Pinus ayacahuite (3977)	B6	1968	16.2	8.2	1.0	-	1.0	-	4.5	-	2.5	-	2	0	0	2
Pinus canariensis (4091)	C6	1969	18.0	11.1	2.1	0.8	2.0	0.7	3.0	0.5	1.6	0.8	18	0	12	30
Pinus canariensis	D24	1970	16.8	7.0	1.8	0.8	1.9	0.6	3.3	0.8	1.2	0.4	7	2	1	10
Pinus caribaea (3709)	A3	1967	20.8	11.9	2.3	1.2	2.8	1.0	2.0	0.9	2.2	0.8	27	2	1	30
Pinus caribaea (3279)	A4	1967	20.1	13.0	2.9	0.9	3.2	0.8	2.4	0.8	2.4	0.8	24	3	3	30
Pinus caribaea (3899)	B2	1968	19.7	11.8	2.4	1.0	2.3	1.1	1.8	0.8	2.4	1.0	10	0	0	10
Pinus caribaea	B3	1968	19.5	11.8	1.9	0.7	1.7	0.8	2.0	0.9	2.1	0.7	8	0	2	10
Pinus caribaea	B4	1968	18.9	11.4	2.3	1.1	1.9	0.8	2.2	1.0	2.0	1.1	2	2	6	10
Pinus caribaea (4296)	D12	1970	16.2	9.6	2.3	0.9	2.3	0.6	3.0	0.4	2.5	0.7	30	0	0	30
Pinus caribaea (4345)	D23	1970	16.5	10.4	3.8	0.9	3.7	1.1	2.8	0.7	2.7	0.8	25	2	3	30
Pinus clausa (5002)	E2	1971	9.6	5.6	2.7	0.8	2.7	0.7	2.8	0.6	3.0	0.6	22	0	8	30
Pinus clausa (5001)	E4	1971	10.8	6.3	3.3	1.1	3.3	0.9	2.9	0.6	3.1	0.7	20	1	9	30
Pinus contorta (3414)	B22	1968	-	1.2	-	-	-	-	-	-	-	-	4	0	1	5
Pinus contorta (4017)	D18	1970	-	3.9	4.0	1.1	4.2	1.0	2.6	1.1	3.3	0.8	11	0	19	30
Pinus coulteri	C16	1969	18.2	8.4	1.8	0.4	1.7	1.3	4.2	0.7	2.9	0.6	9	0	0	9
Pinus densiflora	D5	1970	6.8	5.7	2.1	0.6	2.1	0.6	3.0	0.5	2.8	0.8	7	0	3	10
Pinus elliottii (3710)	A6	1967	23.0	13.6	1.5	0.7	2.0	0.6	3.0	1.0	2.5	0.6	28	2	0	30
Pinus elliottii (3563)	A7	1967	20.7	13.2	1.7	0.6	2.2	0.5	3.4	1.0	2.4	0.8	26	4	0	30
Pinus elliottii (3984)	B9	1968	21.7	10.9	2.1	0.9	1.8	0.6	1.8	0.8	2.6	0.8	6	1	3	10
Pinus elliottii var. densa (3353)	A8	1967	19.8	12.1	1.8	0.6	2.3	0.6	3.0	0.9	2.3	0.7	30	0	0	30
Pinus glabra (5043)	F13	1972	6.9	4.9	3.6	1.0	2.8	0.8	1.7	0.8	2.7	0.5	27	0	3	30
Pinus greggii (4090)	C2	1969	17.2	11.6	2.2	0.6	2.2	0.7	2.8	0.9	2.4	0.7	30	0	0	30
Pinus halepensis (3515)	B28	1968	17.5	11.2	2.7	0.6	2.0	0.4	3.7	1.0	2.5	0.7	29	1	0	30
Pinus halenpensis (5106)	H2	1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinus halenpensis vars. (provenance study)	H3	1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pinus halepensis var. brutia (3643)	B18	1968	18.7	11.4	2.0	0.6	1.3	0.5	2.6	0.8	2.0	0.4	30	0	0	30
Pinus halepensis var. brutia (4343)	C5	1969	16.6	10.0	2.0	0.8	2.1	0.8	2.6	0.6	2.4	0.6	26	0	4	30
Pinus halepensis var. brutia (4169)	C10	1969	18.4	11.2	2.7	1.3	2.4	0.8	3.3	0.6	2.3	0.5	30	0	0	30
Pinus halepensis var. brutia	F2	1972	6.7	4.9	2.6	1.0	2.7	1.0	1.6	0.6	2.2	0.7	26	0	4	30
Pinus halepensis var. brutia (5021)	F12	1972	5.5	4.0	2.4	0.9	2.4	0.8	1.2	0.4	2.8	0.5	30	0	0	30
Pinus halenpensis var. brutia (5103)	H1	1980	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix 2B (cont.)

Species	Plot No.	Year Planted	DBHOB (cm)	Top Ht. (m)*	B Mean	B Std. Dev.	S Mean	S Std. Dev.	T Mean	T Std. Dev.	A Mean	A Std. Dev.	F No. single stems	F No. of ramicorms	F No. forked or multi-leader	Total
Pinus jeffreyii (Riverside)	E7	1971	-	3.0	1.6	0.7	1.8	0.8	2.9	0.8	2.4	0.5	10	0	0	10
Pinus jeffreyii (El Dorado) (San Diego)	E13	1971	-	2.9	1.4	0.5	1.3	0.5	3.0	0.0	2.3	0.5	10	0	0	10
Pinus kesiya (3308)	A1	1967	18.2	12.2	3.6	1.1	3.0	0.9	3.5	1.0	2.3	0.7	20	4	6	30
Pinus kesiya (3914, 4041)	D3	1970	7.9	5.7	1.9	0.7	2.3	1.9	2.4	0.8	2.5	0.9	3	2	5	10
Pinus kesiya (4011)	D20	1970	13.2	5.9	4.4	0.9	4.4	0.7	4.3	0.8	2.8	0.8	11	1	18	30
Pinus leiophylla (4006)	C8	1969	19.4	12.0	3.5	0.9	3.1	0.7	3.7	0.8	2.8	0.6	21	2	1	24
Pinus michoacana (4010)	B5	1968	18.4	9.9	2.2	1.0	2.5	1.3	2.2	1.2	2.4	1.2	4	1	5	10
Pinus montezumae (4009)	C1	1969	16.4	8.6	3.7	1.1	3.5	0.8	4.3	0.5	2.3	0.9	25	4	1	30
Pinus montezumae var. rudis (3504)	C12	1969	18.1	7.5	3.2	0.9	2.8	0.8	4.4	0.6	3.3	0.8	26	2	2	30
Pinus muricata (4220)	C13	1969	18.2	12.0	1.2	0.4	1.4	0.6	3.6	0.7	2.7	0.8	28	0	2	30
Pinus muricata (San Vicente)	E14	1971	7.7	6.1	1.5	-	2.5	-	4.0	-	3.5	-	1	0	1	2
Pinus muricata (Santa Cruz)	E4	1971	12.7	7.4	4.7	-	4.3	-	4.0	-	2.3	-	2	0	1	3
Pinus muricata (Santa Barbara prov.)	E14	1971	12.1	6.6	3.8	1.2	3.8	0.9	3.9	0.9	3.2	0.4	6	0	4	10
Pinus muricata (San Luis obispo prov.)	E14	1971	7.6	6.5	4.9	0.4	3.9	1.4	2.4	0.5	3.3	1.1	5	0	2	7
Pinus muricata (Trinindad Head prov.)	E14	1971	7.7	5.0	4.0	-	3.0	-	2.3	-	3.3	-	2	0	1	3
Pinus muricata (Malin prov.)	E14	1971	9.6	5.9	2.4	-	2.4	-	3.2	-	3.0	-	4	1	0	5
Pinus muricata (Cedros Island prov.)	E14	1971	4.0	4.1	3.5	-	2.5	-	2.5	-	2.5	-	2	0	1	3
Pinus muricata (Mendocino prov.)	E14	1971	13.6	7.9	2.3	1.3	2.7	1.1	3.6	1.1	3.4	0.5	4	1	2	7
Pinus muricata (Monterey prov.)	E14	1971	16.1	8.7	2.9	1.5	3.3	1.2	3.5	0.5	2.9	0.6	5	0	3	8
Pinus nigra var. maritima (3743)	B17	1968	14.1	8.2	1.2	0.4	1.1	0.3	2.4	0.9	2.1	0.6	24	2	4	30
Pinus nigra var. maritima (4018)	C14	1969	9.2	6.0	1.3	0.5	1.2	0.4	1.8	0.7	2.2	0.7	28	0	2	30
Pinus nigra var. maritima (3335)	B16	1968	10.4	6.8	1.2	0.4	1.3	0.5	2.2	1.1	2.2	0.6	29	0	1	30
Pinus nigra var. maritima (4290)	D13	1970	7.7	4.5	1.6	0.7	1.8	0.8	2.1	0.7	2.9	0.6	21	2	7	30
Pinus nigra var. nigra (4285)	D15	1970	-	3.3	1.8	0.6	2.2	0.8	2.7	0.7	2.2	0.9	8	1	1	10
Pinus oocarpa (3902)	B19	1968	17.7	12.5	2.3	0.6	2.4	0.7	3.1	1.0	2.3	0.6	18	6	6	30
Pinus oocarpa (4013)	C11	1969	17.0	10.8	3.2	0.9	2.9	0.8	3.4	1.0	2.2	0.8	28	1	1	30
Pinus palustris (3712)	A5	1967	14.6	11.6	2.3	1.3	2.1	0.7	3.1	0.9	2.9	0.3	8	1	1	10
Pinus patula (3907)	C4	1969	16.8	11.2	1.9	0.6	1.4	0.5	3.2	0.8	2.3	0.6	29	0	1	30
Pinus patula (4293)	D21	1970	14.2	8.2	3.3	0.9	2.2	0.9	2.7	0.7	2.5	0.6	26	0	4	30
Pinus pinaster (progeny study)	B1				see Appendix 2d											
Pinus pinaster (4238)	D14	1970	17.4	7.6	2.9	1.0	2.9	0.8	3.2	0.6	2.9	0.8	28	0	2	30
Pinus pinaster	C7	1969	22.1	12.6	2.0	0.8	2.6	0.5	3.1	0.6	3.0	0.8	7	1	2	10
Pinus pinea (4245)	C15	1969	18.9	8.5	3.0	1.0	2.8	0.8	4.6	0.6	4.5	0.7	15	2	13	30
Pinus ponderosa (3659)	B23	1968	11.6	6.0	1.6	0.9	1.4	0.6	3.0	0.3	2.8	0.4	30	0	0	30
Pinus ponderosa (3660)	B24	1968	7.8	4.7	1.9	0.8	1.8	0.7	2.6	0.6	2.8	0.6	29	0	1	30
Pinus ponderosa (3662)	B25	1968	18.0	8.5	2.4	0.8	1.8	0.8	3.5	0.6	2.9	0.4	30	0	0	30
Pinus ponderosa (3741)	B26	1968	16.4	8.9	2.1	0.8	1.8	0.6	3.3	0.5	2.7	0.6	30	0	0	30
Pinus ponderosa (3661)	B27	1968	10.5	5.7	1.7	0.7	1.8	0.7	3.2	0.6	2.6	0.7	30	0	0	30
Pinus ponderosa	D7	1970			Mixed Provenances											
Pinus pseudo-strobus var. oaxacana (3978)	C3	1969	18.4	9.9	3.1	0.9	2.6	0.8	4.0	0.7	2.9	0.8	28	1	1	30
Pinus pseudo-strobus var. tenuifolia (4291)	D22	1970	14.5	7.7	3.7	1.2	3.1	1.0	3.9	0.7	3.0	0.7	22	0	3	25
Pinus pseudo-strobus var. tenuifolia (3915)	D4	1970	16.9	7.8	4.0	1.2	3.8	1.2	4.6	0.7	2.6	0.5	5	0	3	8

Appendix 2B (cont.)

Species	Plot No.	Year Planted	DBHOB (cm)	Top Ht. (m)*	B Mean	B Std. Dev.	S Mean	S Std. Dev.	T Mean	T Std. Dev.	A Mean	A Std. Dev.	F No. single stems	F No. of ramicorms	F No. forked or multi-leader	Total
Pinus pungens (5032)	F3	1972	-	3.1	-	-	-	-	-	-	-	-	3	0	0	3
Pinus radiata var. binata	E14	1971	9.5	6.3	3.8	-	3.5	-	2.5	-	3.0	-	3	0	1	4
Pinus radiata (4318)	D1	1970	21.1	14.1	1.2	0.4	1.2	0.4	3.0	0.4	2.7	0.7	10	0	0	10
Pinus radiata (provenance study)	F6-9	1972			See Appendix 2f											
Pinus rigida (5033)	F10	1972	-	3.9	-	-	-	-	-	-	-	-	4	0	0	4
Pinus roxburghii (4342)	D16	1970	16.0	7.8	3.3	0.9	2.6	0.7	3.8	0.7	2.3	0.9	30	0	0	30
Pinus roxburghii (3370)	A2	1967	20.6	9.4	2.7	0.8	2.3	0.7	3.9	0.6	2.2	0.6	9	0	1	10
Pinus serotina (4051)	C9	1969	15.3	9.0	2.3	1.1	3.1	0.9	2.6	0.7	2.4	0.6	30	0	0	30
Pinus taeda (3983)	B7	1968	22.0	13.2	2.1	1.4	2.2	0.9	1.9	0.7	2.1	1.2	7	1	2	10
Pinus taeda (3980)	B8	1968	21.6	12.5	1.9	0.9	2.1	1.0	1.9	0.9	2.0	1.0	5	1	4	10
Pinus taeda (3664)	B10	1968	19.9	11.5	2.1	0.6	2.1	0.7	3.8	0.7	2.9	0.7	30	0	0	30
Pinus taeda (3663)	B11	1968	17.9	11.2	1.8	0.7	2.3	0.6	3.1	1.1	2.7	0.5	29	1	0	30
Pinus taeda (3665)	B12	1968	17.1	10.8	1.7	0.6	2.1	0.5	3.3	0.8	2.8	0.6	28	1	1	30
Pinus taeda (3666)	B13	1968	17.1	11.1	2.1	0.6	2.1	0.6	2.8	0.9	2.7	0.5	29	1	0	30
Pinus taeda (3667)	B14	1968	17.1	10.8	1.9	0.6	2.1	0.5	3.2	0.9	2.9	0.5	29	1	0	30
Pinus taeda (3711)	B15	1968	18.2	11.6	1.5	0.6	2.1	0.6	3.2	1.0	2.9	0.6	28	2	0	30
Pinus thunburgii (4007)	B20	1968	17.0	12.0	3.2	0.5	3.0	0.7	3.4	0.8	2.5	0.6	26	1	3	30
Pinus thunburgii (4007)	D2	1970	3.4	4.5	2.0	-	3.0	-	1.5	-	2.0	-	1	1	0	2
Pinus torreyana (4286)	D17	1970	11.5	7.1	2.9	1.1	3.4	1.0	2.9	0.9	2.2	0.6	26	1	3	30
Pinus virginiana (5034)	F11	1972	7.7	4.6	3.0	0.9	3.1	0.8	2.5	0.8	2.7	0.6	27	0	3	30
Sequoia sempervirens (4159)	D6	1970	8.7	6.0	2.1	0.9	1.7	0.7	1.4	0.5	1.9	0.8	20	0	10	30

* Top height: based on the tallest 100 s.p.h.

\+ Total: No. of trees assessed, in most cases the equivalent of 250 crop trees per hectare.

Form: B - butt sweep. Visual assessment on a 1-5 scale where 1 = no butt sweep, 5 = severe butt sweep.

S - stem sweep. Assessment the same as for butt sweep.

T - branch thickness. A scale of 1-5 where: 1 = < 20 mm
2 = 20 mm - 30 mm
3 = 30 mm - 40 mm
4 = 40 mm - 50 mm
5 = > 50 mm

A - branch angle. A scale of 1-5 where: 1 = horizontal branch (90^{o})
2 = 90^{o} - 112.5^{o}
3 = 112.5^{o} - 135^{o}
4 = 135^{o} - 157.5^{o}
5 = 157.5^{o} - 180^{o}

F - leader status.

MERIBUP ARBORETUM - GROWTH AND FORM DATA AT FEBRUARY 1980

Species	Plot No.	Year Planted	DBHOB (cm)	Top Ht. (m)*	B		S		T		A		F			
					Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	No. single stem	No. of ramicorms	No. forked or multi-leader	Total
Callitris endlicheri	D3	1972	6.2	4.6	1.3	0.6	1.3	0.5	1.1	0.3	3.7	0.7	30	0	0	30
Cedrus deodara (4206)	C7	1971	2.2	2.1	1.3	0.7	1.2	0.4	1.0	0.0	1.6	0.7	9	0	3	12
Cupressus arizonica (4274)	B16	1970	5.9	5.4	1.2	0.4	1.0	0.2	1.0	0.2	1.8	0.4	30	0	0	30
Cupressus lusitanica cv. knightiana	C9	1971	4.6	4.7	1.2	0.4	1.6	0.7	1.2	0.4	1.7	0.5	22	1	2	25
Pinus canariensis (4091)	A12	1969	14.8	8.9	1.8	0.7	1.3	0.5	2.8	1.0	1.7	0.5	29	1	0	30
Pinus caribaea (4212)	A8	1969	19.2	12.2	2.2	0.9	2.4	0.9	2.4	1.0	2.2	0.5	22	2	6	30
Pinus caribaea (4092)	A13	1969	17.1	11.4	2.4	1.1	1.9	0.9	2.2	0.7	2.4	0.5	30	0	0	30
Pinus caribaea (4296)	B5	1970	18.7	11.0	2.0	0.8	2.0	0.8	3.2	1.0	2.7	0.6	29	0	1	30
Pinus caribaea (4345)	C1	1971	13.2	7.7	3.6	1.0	2.7	1.0	2.6	1.0	2.6	0.8	21	4	5	30
Pinus clausa (5001)	C3	1971	8.6	7.7	2.9	0.9	2.3	0.9	2.5	1.0	2.9	0.8	26	0	4	30
Pinus clausa (5002)	C2	1971	8.7	7.1	3.0	1.0	2.1	0.9	2.2	0.9	2.8	0.8	22	0	8	30
Pinus contorta (4017)	B17	1970	5.8	4.2	1.7	0.8	1.6	0.7	2.1	0.8	2.5	0.6	19	1	10	30
Pinus coulteri (3822)	A15	1969	11.4	6.7	1.3	0.5	1.1	0.4	2.4	0.8	2.1	0.4	30	0	0	30
Pinus elliottii (4215)	A14	1969	20.4	12.5	1.7	0.6	1.5	0.8	2.8	1.0	2.2	0.5	26	3	1	30
Pinus greggii (4090)	A3	1969	17.1	11.7	2.0	0.6	1.2	0.5	1.9	0.7	2.3	0.5	28	1	1	30
Pinus halepensis (4099)	A9	1969	15.5	10.6	1.8	0.5	1.4	0.5	2.9	0.9	2.3	0.5	27	0	3	30
Pinus halepensis var. brutia (4169)	A11	1969	15.2	10.4	2.0	0.9	1.4	0.6	2.8	0.9	2.2	0.5	29	0	1	30
Pinus halepensis var. brutia (4343)	B4	1970	14.8	9.0	2.2	0.7	1.8	0.9	2.1	1.0	2.2	0.7	19	6	5	30
Pinus halepensis var. brutia (3643)	A10	1969	14.5	10.1	1.4	0.5	1.3	0.5	2.5	0.8	2.2	0.4	28	1	1	30
Pinus jeffreyii (Riverside)	C4	1971	5.4	3.3	1.6	0.6	1.2	0.4	1.8	0.7	2.0	0.4	10	0	0	10
Pinus jeffreyii (San Diego)	C5	1971	5.5	3.3	2.0	0.7	1.3	0.5	2.1	0.7	2.2	0.5	10	0	0	10
Pinus jeffreyii (El Dorado)	C6	1971	4.0	2.8	2.0	0.7	1.4	0.5	1.9	1.0	1.5	0.5	10	0	0	10
Pinus kesiya (3308)	B3	1970	10.4	8.7	3.5	0.8	2.4	1.0	2.6	1.4	2.9	0.6	8	1	4	13
Pinus kesiya (4011)	B13	1970	12.1	7.6	2.9	1.4	1.7	0.8	2.8	0.9	2.3	0.6	21	0	9	30
Pinus kesiya	B18	1970	9.1	6.0	3.4	0.6	3.4	0.5	2.7	0.5	2.2	0.4	18	2	10	30
Pinus leiophylla (4006)	B14	1970	9.9	6.3	3.6	1.0	2.1	1.0	2.1	0.9	2.1	0.6	30	0	0	30
Pinus montezumae (4009)	A5	1969	16.4	9.1	4.3	1.0	3.9	0.9	4.2	0.8	1.6	0.7	22	2	6	30
Pinus muricata (4220)	A19	1969	16.8	11.2	1.6	0.7	1.2	0.4	3.2	0.8	2.3	0.5	22	3	5	30
Pinus nigra var. maritima (4018)	A17	1969	11.0	7.5	1.2	0.4	1.0	0.2	2.2	0.7	2.1	0.4	28	1	1	30
Pinus nigra var. maritima (3335)	A1	1969	12.8	7.4	1.4	0.5	1.1	0.3	2.6	0.6	2.1	0.5	28	0	2	30
Pinus nigra var. maritima (4290)	B8	1970	9.4	6.1	1.5	0.6	1.4	0.6	2.4	0.8	2.9	0.7	30	0	0	30
Pinus nigra var. nigra (4285)	B7	1970	7.3	4.6	1.9	0.8	1.5	0.7	2.4	0.6	2.4	0.5	23	2	5	30
Pinus oocarpa (4013)	A16	1969	15.9	10.7	3.4	1.1	2.5	1.1	2.6	1.1	1.8	0.6	24	1	5	30
Pinus oocarpa (4305)	B10	1970	11.9	7.6	3.5	1.0	2.8	0.8	1.9	0.8	1.8	0.4	26	4	0	30
Pinus patula (4293)	B12	1970	13.9	9.1	2.2	1.0	1.3	0.5	2.5	0.8	2.4	0.5	25	2	3	30
Pinus pinaster (4238)	B9	1970	17.2	8.5	2.2	0.9	1.8	0.8	3.1	0.5	2.3	0.5	29	0	1	30
Pinus pinaster (progeny study)	B19	1970	see Appendix 2d													
Pinus pinea (4245)	A6	1969	13.3	4.8	1.6	0.7	1.7	0.8	4.1	0.7	2.9	0.7	8	0	22	30
Pinus ponderosa (provenance study)	A2	1969	see Appendix 2e													
Pinus pseudo-strobus var. oaxacana (3978)	B15	1970	11.8	7.6	3.1	1.2	2.1	0.9	3.3	0.9	2.6	0.8	24	2	4	30
Pinus pseudo-strobus var. tenuifolia (4291)	B11	1970	11.3	7.0	4.1	1.1	2.4	1.0	2.4	0.7	2.1	0.5	29	1	0	30

Appendix 2C (cont.)

Species	Plot No.	Year Planted	DBHOB (cm)	Top Ht. (m)*	B		S		T		A		F			
					Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	No. single stem	No. of ramicorms	No. forked or multi-leader	Total
Pinus pungens (5032)	D4	1972	3.9	4.0	2.4	0.8	2.9	0.9	1.9	1.0	3.0	0.6	28	0	2	30
Pinus radiata (4318)	B6	1970	18.9	14.3	2.0	0.6	1.6	0.8	3.0	1.0	2.9	0.7	26	3	1	30
Pinus rigida (5033)	D1	1972	7.7	4.2	1.6	0.9	1.8	0.9	2.9	0.7	3.6	0.6	21	1	8	30
Pinus roxburghii (4342)	B2	1970	11.7	5.8	1.6	0.5	1.3	0.5	3.5	0.9	2.0	0.6	29	0	1	30
Pinus serotina (4051)	A4	1969	16.3	9.5	2.0	0.7	1.8	0.9	2.7	0.7	1.9	0.4	28	0	2	30
Pinus taeda (4214)	A7	1969	21.4	12.5	1.7	0.5	1.7	0.6	2.9	0.9	2.6	0.5	27	1	2	30
Pinus thunbergii (4007)	A18	1969	13.1	8.7	2.6	0.9	1.9	0.7	2.5	1.3	1.9	0.7	18	1	11	30
Pinus torreyana (4286)	B1	1970	9.8	9.1	1.7	0.6	1.8	0.5	1.9	0.7	1.9	0.3	28	0	2	30
Pinus virginiana (5034)	D2	1972	5.3	4.3	2.4	0.9	1.6	0.8	1.8	0.9	3.0	0.8	25	1	4	30

* Top height : based on the tallest 100 s.p.h.

\+ Total : No. of trees assessed, in most cases the equivalent of 250 crop trees per hectare.

Form B - butt sweep. Visual assessment on a 1-5 scale where 1 = no butt sweep, 5 = severe butt sweep

S - stem sweep. Assessment the same as for butt sweep.

T - branch thickness. A scale of 1-5 where: 1 = < 20 mm
2 = 20 mm - 30 mm
3 = 30 mm - 40 mm
4 = 40 mm - 50 mm
5 = > 50 mm

A - branch angle. A scale of 1-5 where: 1 = horizontal branch (90^{o})
2 = 90^{o} - 112.5^{o}
3 = 112.5^{o} - 135^{o}
4 = 135^{o} - 157.5^{o}
5 = 157.5^{o} - 180^{o}

F - leader status

Appendix 2D

PINUS PINASTER PROGENY STUDY

GROWTH AND FORM DATA

Arboretum	Age at Assessment	Pedigree				Routine			
		D.B.H.O.B. (cm)	Height (m)	% of trees with average stem straightness	% of trees with little or slight butt sweep	D.B.H.O.B. (cm)	Height (m)	% of trees with average stem straightness	% of trees with little or slight butt sweep
Asplin (half sib.)	11.1	21.5	12.1	76	84	17.6	10.7	61	61
Bussell (full sib.)	8	12.5	8.7	62	43	11.8	8.0	24	21
Meribup (half sib.)	10.1	15.3	11.6	58	91	15.1	11.4	24	70

Assessment carried out prior to culling

P. PONDEROSA PROVENANCE STUDY

Growth and Form Data at February 1981

Serial No.	Origin	Altitude (m)	D.B.H.O.B. (cm)			Height (m)			% trees of acceptable form		
			Asplin	Bussell	Meribup	Asplin	Bussell	Meribup	Asplin	Bussell	Meribup
3659	Arizona, U.S.A.	?	-	11.6*	-	-	6.0*	-		100*	
3660	Colarado, U.S.A.	2134	-	7.8*	-	-	4.7*	-		97*	
3661	Oregon, U.S.A.	1372	-	10.5*	-	-	5.7*	-		100*	
3662	California, U.S.A.	571	16.1*	18.0*	-	7.8	8.5*	-	87*	97*	
3741	New Zealand	381	-	16.4*	-	-	8.9*	-		100*	
4041	S. Dakota, U.S.A.	?	1.6	-	0.9	1.9	-	1.7	48	-	48
4042	Idaho, U.S.A.	1585	3.8	-	3.6	2.5	-	2.5	36	-	48
4043	Oregon, U.S.A.	1372	2.6	-	-	2.0	-	-	48	-	-
4044	Washington, U.S.A.	1219	1.9	-	2.0	1.6	-	1.7	13	-	40
4045	Oregon, U.S.A.	610	9.3	-	9.6	4.3	-	4.4	48	-	50
4046	California, U.S.A.	?	13.2	-	-	4.8	-	-	48	-	-
4047	Colarado, U.S.A.	2134	3.6	-	1.8	2.4	-	1.8	38	-	15
4069	California, U.S.A.	762	14.0	-	12.5	5.4	-	5.4	61	-	65
4237	Oregon, U.S.A.	914	9.9	-	8.3	4.3	-	4.2	67	-	50
4238	Washington, U.S.A.	762	5.6	-	5.2	3.1	-	3.2	52	-	48
4239	Washington, U.S.A.	1219	3.1	-	2.7	2.2	-	2.1	39	-	52
4240	Oregon, U.S.A.	1524	2.8+	-	2.9	2.1	-	2.1	75+	-	48

* Based only on crop trees (250 s.p.h.). + Based only on 4 trees.

Appendix 2F

PINUS RADIATA PROVENANCE STUDY

Provenance	Plot No.	% showing little or no butt sweep	% showing little or no stem sweep	% having acceptable branch thickness	% of single stemmed trees	D.B.H.O.B.	Top Height	Remarks
1. Asplin								
Monterey	F1	77	87	48	87	19.8	13.3	Pedigree seed.
Guadalupe Is.	F2	68	81	58	81	20.0	16.0	Seed from A.C.T. & New Zealand arboreta.
Cambria	F3	90	79	21	79	19.0	14.3	Seed mainly from natural stands.
Año Nuevo	F4	59	62	52	72	18.4	12.8	Seed from natural stands.
Cedros Is.	F5	79	71	36	71	21.5	15.6	Seed from A.C.T. & New Zealand arboreta.
Guadalupe Is.	F6	70	65	48	74	21.8	14.6	Seed from A.C.T. & New Zealand arboreta.
Cambria	F7	88	66	34	78	23.7	15.7	Seed from A.C.T. & New Zealand arboreta.
2. Bussell								
Guadalupe Is.	F6	97	97	66	85	15.5	12.1	Seed from A.C.T. & New Zealand arboreta.
Cambria	F7	97	100	53	91	17.9	12.6	Seed from natural stands.
Cambria	F8	87	91	41	94	18.4	12.5	Seed from A.C.T. & New Zealand arboreta.
Año Nuevo	F8	100	75	42	83	19.5	13.3	Seed from natural stands.
Monterey	F9	99	88	52	94	18.8	14.1	Pedigree seed.

Appendix 3

List of Common Names

Abies religiosa	-	Sacred Fir
Araucaria augustifolia	-	Candelabra Tree
" *cunninghamii*	-	Hoop Pine
" *heterophylla*	-	Norfolk Island Pine
Callitris endlicheri	-	Black Cypress Pine
Cedrus deodara	-	The Deodar
Cupressus arizonica	-	Rough-Barked Arizona Cypress
" *lusitanica*	-	Mexican Cypress
" *macrocarpa*	-	Monterey Cypress
" *sempervirens*	-	Mediterranean Cypress
Pinus ayacahuite	-	Mexican White Pine
" *canariensis*	-	Canary Island Pine
" *caribaea*	-	Caribbean Pine
" *clausa*	-	Sand Pine
" *contorta*	-	Beach Pine or Lodgepole Pine
" *coulteri*	-	Big-cone Pine or Coulter Pine
" *densiflora*	-	Red Pine of Japan
" *elliottii*	-	Slash Pine
" *flexilis*	-	Limber Pine
" *glabra*	-	Spruce Pine
" *greggii*	-	Gregg Pine
" *halepensis*	-	Aleppo Pine
" *halepensis var. brutia*	-	Calabrian Pine *
" *jeffreyii*	-	Jeffrey Pine
" *kesiya*	-	Benguet Pine
" *leiophylla*	-	Smooth-leaved Pine
" *michoacana*	-	Michoacan Pine

Pinus montezumae	-	Rough-branched Mexican Pine
" *muricata*	-	Bishop Pine
" *Nigra var. maritima*	-	Corsican Pine. Black Pine
" *Nigra var. nigra*	-	Black Pine. Austrian Pine
" *oocarpa*	-	Ocote pine
" *palustris*	-	Long-leaf Pine
" *patula*	-	Spreading-leaved Pine
" *pinaster*	-	Maritime Pine
" *pinea*	-	Stone Pine
" *ponderosa*	-	Western Yellow Pine
" *pseudo-strobus*	-	False Weymouth Pine
" *pungens*	-	Table Mountain Pine
" *radiata*	-	Monterey Pine
" *rigida*	-	Northern Pitch Pine
" *roxburghii*	-	Long-leaved Indian Pine
" *serotina*	-	Pond Pine
" *strobus*	-	Weymouth Pine
" *taeda*	-	Loblolly Pine
" *thunbergii*	-	Black Pine
" *torreyana*	-	Soledad Pine
" *virginiana*	-	Scrub Pine
Pseudotsuga menziesii	-	Oregon Douglas Fir
Sequoia sempervirens	-	Sequoia or Redwood
Sequoiadendron giganteum	-	Big Tree
Thuya occidentalis	-	White cedar

* The name of Calabrian pine is sometimes applied to *P. Nigra var. maritima.*

SPECIES DISTRIBUTION LIST

Species	Bussell Arboretum		Asplin Arboretum		Meribup Arboretum	
	Rep.	Year Planted	Rep.	Year Planted	Rep.	Year Planted
Abies religiosa (4338)	Yes	1971	Yes	1971	-	-
Araucaria angustifolia (4282)	Yes	1971	Yes	1971	-	-
" *cunninghamii*	Yes	1971	Yes	1971	failed	1971
" *heterophylla*	failed	1971	Yes	1971	-	-
Callitris endlicheri	Yes	1971	Yes	1972	Yes	1972
Cedrus deodata (4206)	Yes	1971	Yes	1971	Yes	1971
Cupressus arizonica (4274)	Yes	1970	Yes	1970	Yes	1970
" *lusitanica* (3922)	Yes	1970	Yes	1970	-	-
" *lusitanica* *cv. knightiana*	Yes	1971	Yes	1971	Yes	1971
" *macrocarpa* (4181)	Yes	1970	Yes	1970	-	-
" *sempervirens* (3548)	Yes	1970	Yes	1970	-	-
Pinus ayacahuite (3977)	Yes	1968	-	-	-	-
Pinus canariensis (4091)	Yes	1969	-	-	Yes	1969
" *canariensis* (4026)	-	-	Yes	1968	-	-
" *canariensis*	Yes	1970	-	-	-	-
" *canariensis*	-	-	Yes	1973	-	-
Pinus caribaea (3279)	Yes	1967	Yes	1967	-	-
" *caribaea* (3709)	Yes	1967	Yes	1967	-	-
" *caribaea* (3899)	Yes	1968	-	-	-	-
" *caribaea*	Yes	1968	-	-	-	-
" *caribaea*	Yes	1968	-	-	-	-
" *caribaea* (4296)	Yes	1970	Yes	1970	Yes	1970
" *caribaea* (4345)	Yes	1970	Yes	1970	Yes	1971
" *caribaea* (4212)	-	-	-	-	Yes	1969
" *caribaea* (4092)	-	-	-	-	Yes	1969
Pinus clausa (5002)	Yes	1971	Yes	1971	Yes	1971
" *clausa* (5001)	Yes	1971	Yes	1971	Yes	1971
" *clausa* (5001)	-	-	Yes	1973	-	-
Pinus contorta (4017)	Yes	1970	Yes	1968	Yes	1970
" *contorta* (3414)	Yes	1968				
Pinus coulteri	Yes	1969	-	-	-	-
" *coulteri* (3822)	-	-	Yes	1970	Yes	1969
Pinus densiflora	Yes	1970	-	-	-	-
Pinus elliottii (3710)	Yes	1967	Yes	1967	-	-
" *elliottii* (3563)	Yes	1967	Yes	1967	-	-
" *elliottii* (3984)	Yes	1968	-	-	-	-
" *elliottii* (4215)	-	-	-	-	Yes	1969
" *elliottii var. densa* (3353)	Yes	1967	Yes	1967	-	-
Pinus flexilis	-	-	failed	1972	-	-
Pinus glabra (5043)	Yes	1972	Yes	1972	-	-
Pinus greggii (4090)	Yes	1969	Yes	1969	Yes	1969
Pinus halepensis (3515)	Yes	1968	-	-	-	-
" *halepensis* (3511)	-	-	Yes	1968	-	-
" *halepensis* (4099)	-	-	-	-	Yes	1969
" *halepensis* (5106)	Yes	1980	-	-	-	-
" *halepensis var. brutia* (3643)	Yes	1968	Yes	1968	Yes	1969
" *halepensis var. brutia* (4343)	Yes	1969	Yes	1970	Yes	1970
" *halepensis var. brytia* (4169)	Yes	1969	Yes	1969	Yes	1969
" *halepensis var. brutia*	Yes	1972	-	-	-	-
" *halepensis var. brutia* (5021)	Yes	1972	-	-	-	-

Species	Bussell Arboretum		Asplin Arboretum		Meribup Arboretum	
	Rep.	Year Planted	Rep.	Year Planted	Rep.	Year Planted
Pinus halepensis var. brutia (5103)	Yes	1980	-	-	-	-
" *halepensis var. brutia*	-	-	Yes	1973	-	-
" *halepensis var. brutia* (5106)	Yes	1980	-	-	-	-
" *halepensis var. brutia*	-	-	Yes	1973	-	-
" *halepensis* (provenance study)	Yes	1980	-	-	-	-
Pinus jeffreyii (Riverside)	Yes	1971	Yes	1971	Yes	1971
" *jeffreyii* (El Dorado)	Yes	1971	Yes	1971	Yes	1971
" *jeffreyii* (San Diego)	Yes	1971	Yes	1971	Yes	1971
Pinus kesiya (3308)	Yes	1967	Yes	1968	Yes	1970
" *kesiya* (3914 + 4041)	Yes	1970	-	-	-	-
" *kesiya* (4011)	Yes	1970	Yes	1969	Yes	1970
" *kesiya*	-	-	-	-	Yes	1970
Pinus leiophylla (4006)	Yes	1969	Yes	1968	Yes	1970
Pinus michoacana (4010)	Yes	1968	-	-	-	-
Pinus montezumae (4009)	Yes	1969	Yes	1968	Yes	1969
" *montezumae var. rudis* (3504)	Yes	1969	-	-	-	-
Pinus muricata (4220) (blue strain)	Yes	1969	-	-	Yes	1969
" *muricata* (4219) (blue strain)	-	-	Yes	1969	-	-
" *muricata* (green strain various provenances	Yes	1971	-	-	-	-
Pinus nigra var. maritima (3743)	Yes	1968	Yes	1968		
" *nigra var. maritima* (4018)	Yes	1969	Yes	1969	Yes	1969
" *nigra var. maritima* (3335)	Yes	1968	Yes	1968	Yes	1969
" *nigra var. maritima* (4290)	Yes	1970	Yes	1970	Yes	1970
" *nigra var. nigra* (4285)	Yes	1970	Yes	1970	Yes	1970
Pinus oocarpa (3902)	Yes	1968	-	-	-	-
" *oocarpa* (4013)	Yes	1969	Yes	1968	Yes	1969
" *oocarpa* (4305)	Yes	1970	Yes	1970	yes	1970
Pinus palustris (3712)	Yes	1967	Yes	1967	-	-
Pinus patula (3907)	Yes	1969	Yes	1970	-	-
" *patula* (4293)	Yes	1970	Yes	1970	Yes	1970
Pinus pinaster (4238)	Yes	1970	Yes	1970	Yes	1970
" *pinaster* (progeny trial)	Yes	1968	Yes	1970	Yes	1970
" *pinaster*	Yes	1969	-	-	-	-
" *pinaster*	-	-	Yes	1967	-	-
Pinus pinea (4245)	Yes	1969	-	-	Yes	1969
" *pinea* (4354)	-	-	Yes	1970	-	-
Pinus ponderosa (3659)	Yes	1968				
" *ponderosa* (3660)	Yes	1968				
" *ponderosa* (3662)	Yes	1968	Yes	1968		
" *ponderosa* (3661)	Yes	1968				
" *ponderosa* (3741)	Yes	1968				
" *ponderosa* (mixed provenances)	Yes	1970				
" *ponderosa* (provenance trial)			Yes	1970	Yes	1969
Pinus pseudo-strobus var. oaxacana (3978)	Yes	1969	Yes	1969	Yes	1970
" *pseudo-strobus var. tenuifolia* (4291)	Yes	1970	Yes	1970	Yes	1970
" *pseudo-strobus* (*var. tenuifolia?*) (3915)	Yes	1970	-	-	-	-
Pinus pungens (5032)	Yes	1972	Yes	1972	Yes	1972
Pinus radiata var. binata	Yes	1971	-	-	-	-
Pinus radiata (4318)	Yes	1970	Yes	1970	Yes	1970

Species	Bussell Arboretum		Asplin Arboretum		Meribup Arboretum	
	Rep.	Year Planted	Rep.	Year Planted	Rep.	Year Planted
Pinus radiata (scion orchard)	Yes	1971				
" *radiata* (Monterey)	Yes	1972	Yes	1972	-	-
" *radiata var. binata* (Guadalupe)	Yes	1972	Yes	1972	-	-
" *radiata* (Cambria)	Yes	1972	Yes	1972	-	-
" *radiata* (Año nuevo)	Yes	1972	Yes	1972	-	-
" *radiata* (Cedros)	-	-	Yes	1972	-	-
Pinus rigida (5033)	Yes	1972	Yes	1972	Yes	1972
Pinus roxburghii (4342)	Yes	1970	-	-	Yes	1970
" *roxburghii* (3370)	Yes	1967	Yes	1967	-	-
" *roxburghii* (4236)	-	-	Yes	1970	-	-
Pinus serotina (4051)	Yes	1969	Yes	1969	Yes	1969
Pinus taeda (3983)	Yes	1968	Yes	1968	-	-
" *taeda* (3980)	Yes	1968	-	-		
" *taeda* (3664)	Yes	1968	Yes	1968		
" *taeda* (3663)	Yes	1968	Yes	1968		
" *taeda* (3665)	Yes	1968	Yes	1968		
" *taeda* (3666)	Yes	1968	Yes	1968		
" *taeda* (3667)	Yes	1968	Yes	1968		
" *taeda* (3711)	Yes	1968	Yes	1968		
" *taeda* (4214)	-	-	-	-	Yes	1969
Pinus thunbergii (4007)	Yes	1968	Yes	1968	Yes	1969
Pinus torreyana (4286)	Yes	1970	Yes	1970	Yes	1970
Pinus virginiana (5034)	Yes	1972	Yes	1972	Yes	1972
Pseudotsuga menziesii (4261)	failed	1971	Yes	1971	-	-
Sequoia sempervirens (4159)	Yes	1970	Yes	1971	-	-
Sequoiadendron giganteum	-	-	Yes	1972	-	-
Thuya occidentalis	failed	1971	failed	1971	-	-

ASPLIN ARBORETUM - SILVICULTURAL HISTORY TO JUNE 1981

Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Abies religiosa (4338)	E1	1971	Nil	A	Two surviving from the original 200, one healthy.
Araucaria angustifolia (4282)	E15	1971	Nil	A	Healthy.
" *cunninghamii*	E6	1971	Nil	A	Healthy, varied form and colour.
" *heterophylla*	E5	1971	Nil	A	Slow start, growth rate improving.
Callitris endlicheri	F13	1972	Nil	A	Bushy appearance.
Cedrus deodara (4206)	E13	1971	Nil	A	Fair, yellow colour.
Cupressus arizonica (4274)	D4	1970	Nil	B(6/77), E(6/77), H(2/80)	Good form, uniform and healthy.
" *lusitanica* (3922)	D2	1970	Nil	B(6/77), E(6/77), H(2/80)	Excessive branching, straight stems, deaths occurring at 1700 s.p.h.
" *lusitanica cv. knightiana*	E14	1971	Nil	F(2/80), E(2/80)	Healthy and vigorous.
" *macrocarpa* (4181)	D1	1970	Nil	B(6/77), E(6/77), H(2/80)	Variation in habit and colour.
" *sempervirens* (3548)	D3	1970	Nil	A	Eleven specimens, healthy.
Pinus canariensis (4026)	B19	1968	Nil	C(6/77), E(6/77), H(2/80)	Generally good form, though forks common.
" *canariensis*	G2	1973	Nil	D(2/80)	Poor form, variable colour.
Pinus caribaea (3279)	A4	1967	Nil	B(6/77), E(6/77), H(2/80)	Variable form.
" *caribaea* (3709)	A8	1967	Nil	E(6/77), H(2/80)	Sparse crowns, poor form.
" *caribaea* (4345)	D5	1970	Nil	B(6/77), E(6/77), H(2/80)	Poor form.
" *caribaea* (4296)	D9	1970	Nil	B(6/77), E(6/77), H(2/80)	Variable form.
Pinus clausa (5002)	E8	1971	Nil	E(2/80)	Healthy, poor form.
" *clausa* (5001)	E9	1971	Nil	E(2/80)	Healthy, poor form.
" *clausa* (5001)	E10	1971	Nil	E(2/80)	Healthy, poor form.
" *clausa* (5001)	G4	1973	Nil	A	Healthy, poor form.
Pinus contorta (4017)	B12	1968	Nil	A	Poor survival; growth and form poor.
Pinus coulteri (3822)	D21	1970	Mil	E(2/80)	Healthy, heavy branches.
Pinus elliottii (3710)	A2	1967	Nil	B(6/77), E(6/77), H(2/80)	Healthy, good form.
" *elliottii* (3563)	A3	1967	Nil	B(6/77), E(6/77), H(2/80)	Healthy, good form.
" *elliottii var. densa* (3353)	A5	1967	Nil	B(6/77), E(6/77), H(2/80)	Healthy, heavy branches developed after thinning.
Pinus glabra (5043)	F11	1972	Nil	D(2/80)	Healthy, crooked stems.
Pinus greggii (4090)	C5	1969	Nil	B(6/77), E(6/77), H(2/80)	Form has suffered on this site.
Pinus halepensis (3511)	B18	1968	Nil	B(6/77), E(6/77), H(2/80)	Fairly healthy, poor form.
" *halepensis var. brutia* (3643)	B10	1968	Nil	B(6/77), E(6/77), H(2/80)	Healthy, good form.
" *halepensis var. brutia* (4169)	C2	1969	Nil	B(6/77), E(6/77), H(2/80)	Poor survival (470 s.p.h.), bushy appearance, heavy branches.
" *halepensis var. brutia* (4343)	D10	1970	Nil	E(2/80)	Unhealthy, poor form, deaths occurring.
" *halepensis var. brutia*	G1	1973	Nil	D(2/80)	Unhealthy, poor form, deaths occurring.
" *halenpensis var. brutia*	G3	1973	Nil	D(2/80)	Unhealthy, poor form, deaths occurring.
Pinus jeffreyii (Riverside)	E2	1971	Nil	A	Poor survival, bushy appearance.
" *jeffreyii* (El Dorado)	E3	1971	Nil	A	Poor survival, bushy appearance.
" *jeffreyii* (San Diego)	E4	1971	Nil	A	Poor survival, bushy appearance.
Pinus kesiya (3308)	B8	1968	Nil	B(6/77), E(6/77)	Poor form, deteriorating health.

Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Pinus kesiya (4011)	C6	1969	Nil	B(6/77), E(6/77), H(2/80)	Fairly healthy, poor form.
Pinus leiophylla (4006)	B16	1968	Nil	B(6/77), E(6/77), H(2/80)	Heavy branches. Mixed with another species (*P. pseudo-strobus?*)
Pinus montezumae (4009)	B14	1968	Nil	B(6/77), E(2/80)	Healthy, poor form characteristics.
Pinus muricata (4219)	C3	1969	Nil	B(6/77), E(6/77), H(2/80)	Heavy branches, dense crowns, drought deaths occurring.
Pinus nigra var. maritima (3743)	B9	1968	Nil	B(6/77), E(6/77), H(2/80)	Healthy with acceptable form.
" *nigra var. maritima* (4018)	C1	1969	Nil	E(2/80)	Poor survival, majority of trees forked.
" *nigra var. nigra* (4285)	D16	1970	Nil	D(2/80)	Variable.
" *nigra var. maritima* (3335)	B11	1968	Nil	E(2/80)	Healthy, slower growth than plot B9.
" *nigra var. maritima* (4290)	D17	1970	Nil	D(2/80)	Fairly healthy.
Pinus oocarpa (4013)	B15	1968	Nil	B(6/77), E(6/77), H(2/80)	Forks common, heavy branches, responds well to thinning.
" *oocarpa* (4305)	D6	1970	Nil	E(2/80)	Poor form.
Pinus palustris (3712)	A7	1967	Nil	E(6/77)	Sparse crowns, variable form.
Pinus patula (4293)	D12	1970	Nil	B(6/77), E(6/77), H(2/80)	Healthy, good form, responds well to thinning.
" *patula* (3907)	D13	1970	Nil	B(6/77), E(6/77), H(2/80)	Healthy, generally good form, responds well to thinning.
Pinus pinaster (Progeny study)	D15	1970	Nil	C(6/77), G(6/77)	Vigorous and healthy, good form.
" *pinaster* (4238)	D18	1970	Nil	B(2/80), E(2/80)	Vigorous and healthy, probably the corsican strain.
" *pinaster*	A1	1967	Nil	B(6/77), E(6/77), H(2/80)	Vigorous, poor form, heavy branches.
Pinus pinea (4354)	D19	1970	Nil	B(6/77), E(6/77)	Majority forked, massive branches, bushy appearance.
Pinus ponderosa (3662)	B7	1968	Nil	E(6/77)	Poor survival (750 s.p.h.) heavy branches, bushy appearance.
Pinus ponderosa (Provenance trial)	D20	1970	Nil	E(2/80)	Provenance study, wide variation between races.
Pinus pseudo-strobus var. oaxacana (3978)	C4	1969	Nil	B(6/77), E(6/77)	Healthy, long inter-whorls, heavy branches.
Pinus pseudo-strobus var. tenuifolia (4291)	D11	1970	Nil	B(6/77), E(6/77), H(2/80)	Majority uncharacteristic. (Probably *P. leiophylla*).
Pinus pungens (5032)	F8	1972	Nil	D(2/80)	Unhealthy appearance, sparse foliage, poor form.
Pinus radiata (4318)	D8	1970	Nil	E(6/77), J(2/80), G(2/80)	Sparse unhealthy appearance.
" *radiata* (Monterey prov.)	F1	1972	Nil	C(2/80), E(2/80)	Healthy, reasonable form.
" *radiata* (Gualelupe prov.)	F2	1972	Nil	C(2/80), E(2/80)	Healthy, reasonable form.
" *radiata* (Cambria prov.)	F3	1972	Nil	C(2/80), E(2/80)	Healthy, reasonable form.

Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Pinus radiata (Año Nuevo prov.)	F4	1972	Nil	C(2/80), E(2/80)	Healthy, reasonable form.
" *radiata* (Cedros prov.)	F5	1972	Nil	C(2/80), E(2/80)	Healthy, reasonable form.
" *radiata* (Cambria prov.)	F6	1972	Nil	C(2/80), E(2/80)	Healthy, reasonable form.
Pinus rigida (5033)	F9	1972	Nil	D(2/80)	Poor growth, unhealthy appearance, deaths occurring.
Pinus roxburghii (3370)	A6	1967	Nil	C(6/77), E(6/77), H(2/80)	Healthy, variable form.
" *roxburghii* (4236)	D7	1970	Nil	B(6/77), E(6/77), H(2/80)	Healthy, butt sweep common.
Pinus serotina (4051)	C7	1969	Nil	E(6/77), B(2/80), H(2/80)	Poor form, thougl growth good considering ridge-top site.
Pinus taeda (3711, 3664, 3667, 3666, 3665, 3663)	B1-6	1968	Nil	B(6/77), E(6/77), H(2/80)	Healthy appearance, heavy branches.
Pinus taeda (3983)	B17	1968	Nil	B(6/77), E(6/77), H(2/80)	Heavy branches developed at 250 s.p.h., healthy.
Pinus thunburgii (4007)	B13	1968	Nil	B(6/77), E(6/77)	Multi stemmed, twisted trees common.
Pinus torreyana (4286)	D14	1970	Nil	E(6/77), H(2/80)	Poor survival (425 s.p.h.), heavy branches. Common for apical shoot to lose dominance.
Pinus virginiana (5034)	F10	1972	Nil	E(2/80)	Forks, multi-leaders and twisted branches common.
Pseudotsuga menziesii (4261)	E11	1971	Nil	A	Variable growth.
Sequoiadendron giganteum	F12	1972	Nil	A	Seven specimens - healthy.
Sequoia sempervirens (4159)	E12	1971	Nil	A	Variable, uncharacteristic poor form.

* Thinning and pruning key:

A - No treatment
B - Plot divided into 3 sections: 250, 500 and 1700 s.p.h.
C - Thinned to 500 s.p.h.
D - All trees pruned to half height.
E - All trees pruned to 2.1 m.
F - Thinned to 750 s.p.h.
G - All trees pruned to 5.0 m.
H - 250 s.p.h. pruned to 5.0 m.
I - Malformed trees removed.
J - Thinned to 250 s.p.h.

BUSSELL ARBORETUM - SILVICULTURAL HISTORY TO JUNE 1981

Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Abies religiosa (4338)	E8	1971	Nil	A	Two trees surviving.
Araucaria angustifolia (4282)	E10	1971	July 1974: 454 gm/tree "Nutrifert" #	A	Slow start, growth rate improving.
Araucaria cunninghamii	E12	1971	Nil	A	Gravelly site, poor growth, poor survival.
Callitris endlicheri	F1	1972	Nil	A	Gravelly site, uniformily healthy.
Cedrus deodara (4206)	E3	1971	July 1972: 113 gm/tree Super Cu Zn 'A' # Sept. 1972: 272 gm/tree Vigran 9:9:9 #	A	Healthy.
Cupressus arizonica (4274)	D8	1970	Nil	D(1/80)	Variable, improves towards S.W. (better soil).
Cupressus lusitanica (3922)	D9	1970	July 1974: 227 gm/tree "Nutrifert"	D(1/80)	Appears to be unsuited to gravelly soil.
Cupressus lusitanica cv. knightiana	E9	1971	Nil	A	Variable, unsuited to gravelly site.
Cupressus macrocarpa (4181)	D10	1970	Nil	D/1/80)	Variable form and growth.
Cupressus sempervirens (3548)	D11	1970	July 1974: 227 gm/tree "Nutrifert"	A	Typical, some deaths occurring.
Pinus ayacahuite (3977)	B6	1968	Nil	E(9/78), G(1/81)	Two specimens, healthy.
Pinus canariensis (4091)	C6	1969	July 1972: 113 gm/tree Super Cu Zn 'A'	B(9/79), E(9/78), H(1/81)	Fairly healthy, mediocre form.
Pinus canariensis	D24	1970	July 1972: 113 gm/tree Super Cu Zn 'A'	E(1/80)	Healthy.
Pinus caribaea (3709)	A3	1967	Nil	B(9/78), E(9/78), H(1/81)	Good form, small branches, sparse appearance.
Pinus caribaea (3279)	A4	1967	Nil	B(9/78), E(9/78), H(1/81)	Mediocre form.
Pinus caribaea (3899)	B2	1968	Nil	C(9/78), E(9/78), G(1/81)	Good form, healthy.
Pinus caribaea	B3	1968	Nil	C(9/78), E(9/78), G(1/81)	Mainly good form, healthy.
Pinus caribaea	B4	1968	Nil	C(9/78), E(9/78), G(1/81)	Mainly good form, forks common, healthy.
Pinus caribaea (4296)	D12	1970	July 1972: 113 gm/tree Super Cu Zn 'A'	B(9/78), E(9/78), H(1/81)	Healthy, good form.
Pinus caribaea (4345)	D23	1970	Nil	B(2/80), E(2/80), H(1/81)	Poor form, sparse appearance.
Pinus clausa (5002)	E2	1971	Nil	E(1/80)	Healthy appearance, multi-leaders common, deaths following pruning.
Pinus clausa (5001)	E4	1971	Nil	E(1/80)	Healthy appearance, multi-leaders common, deaths following pruning.
Pinus contorta (3414)	B22	1968	Nil	A	Poor survival, 5 trees remaining, poor growth and health.
Pinus contorta (4017)	D18	1970	Nil	A	Unhealthy, bushy appearance, dead tops, prolific cones.
Pinus coulteri	C16	1969	Nil	C(9/78), E(9/78)	Healthy, uni-nodal, large branches.
Pinus densiflora	D5	1970	Nil	D(1/81)	Unhealthy, very poor form, prolific cones.

Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Pinus elliottii (3710)	A6	1967	Nil	B(9/78), E(9/78),H(1/81)	Healthy, excellent form.
Pinus elliottii (3563)	A7	1967	Nil	B(9/78), E(9/78),H(1/81)	Healthy, good form.
Pinus elliottii (3984)	B9	1968	Nil	C(9/78), E(9/78),G(1/81)	Healthy, good form, some large branches.
Pinus elliottii var. densa (3353)	A8	1967	Nil	B(9/78), E(9/78),H(1/81)	Slower growth than *var. elliottii*, healthy, good form.
Pinus glabra (5043)	F13	1972	Nil	A	Variable growth, healthy.
Pinus greggii(4090)	C2	1969	Nil	B(9/78), E(9/78),H(1/81)	Healthy, straight stems, small branches.
Pinus halepensis (3515)	B28	1968	Nil	B(9/78), E(9/78),H(1/81)	Mainly healthy, short internodes, occasional heavy branches.
Pinus halepensis var. brutia (3643)	B18	1968	Nil	B(9/78), E(9/78),H(1/81)	Healthy, responds to thinning, good form, deaths occurring in unthinned section.
Pinus halepensis var. brutia (4343)	C5	1969	Nil	B(9/78), E(9/78),H(1/81)	Unhealthy, deaths occurring (drought?)
Pinus halepensis var. brutia (4169)	C10	1969	Nil	B(9/78), E(9/78),H(1/81)	Healthy, heavy branches developing after thinning.
Pinus halepensis var. brutia	F2	1972	Nil	A	Unhealthy in patches, deaths occurring.
Pinus halepensis var. brutia (5021)	F12	1972	Nil	A	Healthy, variable growth.
Pinus helepensis var. brutia (5103)	H1	1980	Nil	A	-
Pinus halepensis var. brutia (5106)	H2	1980	Nil	A	-
Pinus halepensis var. brutia (provenance study)	H3	1980	Nil	A	-
Pinus jeffreyii (Riverside)	E7	1971	Nil	A	Poor survival, remaining trees healthy, heavy branches.
Pinus jeffreyii (El Dorado & San Diego)	E13	1971	Nil	A	Poor survival, remaining trees healthy, heavy branches.
Pinus kesiya (3308)	A1	1967	Nil	B(9/78), E(9/78),H(1/81)	Mainly poor form, stem sweep common.
Pinus kesiya (3914, 4041)	D3	1970	Nil	D(1/80)	Four specimens, poor form, prolific cones.
Pinus kesiya (4011)	D20	1970	July 1972: 113 gm/tree Super Cu Zn 'A'	B(1/80), E(1/80),H(1/81)	Multi-stemmed, sparse and deteriorating crowns.
Pinus leiophylla (4006)	C8	1969	Nil	C(9/78), E(9/78),H(1/81)	Mixed with another species (*P. pseudo-strobus?*), poor form.
Pinus michoacana (4010)	B5	1968	Nil	C(9/78), E(1/81)	Heavy branches, variable health, aesthetic value only.
Pinus montezumae (4009)	C1	1969	Nil	B(9/78), E(1/81)	Healthy, poor form.
Pinus montezumae var. rudis (3504)	C12	1969	Nil	E(1/80)	Healthy, poor form, very heavy branches.
Pinus muricata (4220)	C13	1969	Nil	B(9/78), E(9/78),H(1/81)	Healthy, some heavy branches.
Pinus muricata (various provenance)	E14	1971	Nil	E(1/80)	Wide variation between strains
Pinus nigra var. maritima (3743)	B17	1968	Nil	D(1/80)	Uniform, good form, slow growth.
Pinus nigra var. maritima (4018)	C14	1969	Nil	D(1/80)	Slow growth.
Pinus nigra var. nigra (4285)	D15	1970	Nil	A	Poor survival, slow and variable growth.
Pinus nigra var. maritima (3335)	B16	1968	Nil	D(1/80)	Slow growth, good form.

Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Pinus nigra var. maritima (4290)	D13	1970	Nil	D/1/81)	Slow and variable growth.
Pinus oocarpa (3902)	B19	1968	Nil	B(9/78), E(9/78),H(1/81)	Variable form.
Pinus oocarpa (4013)	C11	1969	Nil	B(9/78), E(9/78),H(1/81)	Fairly healthy, stem sweep common.
Pinus oocarpa (4305)	D19	1970	July 1972: 113 gm/tree Super Cu Zn 'A'	B(1/80), E(1/80)	Poor form, crown disorder.
Pinus palustris (3712)	A5	1967	Nil	I(9/78), E(9/78),H(1/81)	Healthy, sparse crowns, few branches.
Pinus patula (3907)	C4	1969	Nil	B(9/78), E(9/78),H(1/81)	Healthy, vigorous, good form.
Pinus patula (4293)	D21	1970	Nil	E(9/78), B(1/80),H(1/81)	Healthy, butt sweep, growth deteriorates on gravelly soil.
Pinus pinaster (progency study)	B1	1968	Sept. 1974: 500 kg/ha Super Cu Zn 'A' +250 kg/ha urea	E(9/78), C(2/79),G(2/79)	Improved seed,showing good growth and form characteristics.
Pinus pinaster	C7	1969	Nil	F(9/78), E(9/78),J(1/81), G(1/81)	Vigorous, reasonable form.
Pinus pinaster (4238)	D14	1970	July 1972: 113 gm/tree Super Cu Zn 'A'	E(9/78), B(9/80),H(1/81)	Healthy, vigorous, probably the corsican strain.
Pinus pinea (4245)	C15	1969	Nil	B(9/78), E(9/78),H(1/81)	Healthy, poor form, heavy branches, bushy appearance.
Pinus ponderosa (3659)	B23	1968	Aug. 1971: 113 gm/tree Super Cu Zn 'A'	D(1/80)	Moderate growth, grey/green foliage, heavy branches.
Pinus ponderosa (3660)	B24	1968	Aug. 1971: 113 gm/tree Super Cu Zn 'A'	A	Poor growth, grey/green foliage.
Pinus ponderosa (3662)	B25	1968	Aug. 1971 113 gm/tree Super Cu Zn 'A'	E(9/78), C(1/81),H(1/81)	Vigorous uniform growth, straight stems, heavy branches.
Pinus ponderosa (3741)	B26	1968	Aug. 1971: 113 gm/tree Super Cu Zn 'A'	E(1/80), C(1/80),H(1/81)	Vigorous uniform growth, straight stems, heavy branches.
Pinus ponderosa (3661)	B27	1968	Aug. 1971: 113 gm/tree Super Cu Zn 'A'	A	Poor growth.
Pinus ponderosa (mixed provenances)	D7	1970	Aug. 1971: 113 gm/tree Super Cu Zn 'A'	E(1/80)	Wide variation between provenances
Pinus pseudo-strobus var. oaxacana (3978)	C3	1969	Nil	B(9/78), E(9/78),H(1/81)	Healthy, long inter-nodes, heavy branches.
Pinus pseudo-strobus var. tenuifolia (4291)	D22	1970	Nil	B(1/80), E(1/80),H(1/81)	Mixed with another species (*p. leiophylla?*),healthy
Pinus pseudo-strobus var. tenuifolia (3915)	D4	1970	Nil	E(1/80)	Eight specimens, variable.
Pinus pungens (5032)	F3	1972	July 1972: 113 gm/tree Super Cu Zn 'A' (half the plot)	A	Very poor survival (3 specimens), indications of poor form.
Pinus radiata var. binata	E14	1971	Nil	E(1/80)	
Pinus radiata (4318)	D1	1970	Nil	E(9/78), G(1/81)	Healthy, good form.
Pinus radiata var. binata (Guadalupe)	F6	1972	Nil	C(2/79), E(2/79)	Healthy, good form.

Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Pinus radiata (Cambria)	F7	1972	Nil	C(2/79), E(2/79)	Healthy, good form.
Pinus radiata (Cambria & Año Nuevo)	F8	1972	Nil	C(2/79), E(2/79)	Healthy, good form.
Pinus radiata (Monterey)	F9	1972	Nil	C(2/79), E(2/79)	Healthy, good form.
Pinus radiata (Scion orchard)	E15	1971	Nil	C(2/79), E(2/79)	Healthy.
Pinus rigida (5033)	F10	1972	July 1972: 113 gm/tree Super Cu Zn 'A' (half the plot)	A	Poor survival, twisted stems, bushy appearance.
Pinus roxburghii (4342)	D16	1970	July 1972: 113 gm/tree Super Cu Zn 'A'	B(1/80), E(1/80)	Healthy, dense crowns, heavy branches.
Pinus roxburghii (3370)	A2	1967	Nil	C(1/80), E(1/80), H(1/81)	Mainly healthy.
Pinus serotina (4051)	C9	1969	Nil	E(1/80)	Healthy, few straight stems.
Pinus taeda (3983)	B7	1968	Nil	C(9/78), E(9/78), G(1/81)	Healthy, vigorous, good form.
Pinus taeda (3980)	B8	1968	Nil	C(9/78), E(9/78), G(1/81)	Healthy, vigorous, good form.
Pinus taeda (3664)	B10	1968	Aug. 1971: 113 gm/tree Super Cu Zn 'A'	B(9/78), E(9/78), H(1/81)	Healthy appearance, good form.
Pinus taeda (3663)	B11	1968	Aug. 1971: 113 gm/tree Super Cu Zn 'A'	B(9/78), E(9/78), H(1/81)	Healthy appearance, good form.
Pinus taeda (3665)	B12	1968	Aug.1971: 113 gm/tree Super Cu Zn 'A'	B(9/78), E(9/78), H(1/81)	Healthy appearance, good form.
Pinus taeda (3666)	B13	1968	Aug. 1971: 113 gn/tree Super Cu Zn 'A'	B(9/78), E(9/78), H(1/81)	Healthy appearance, good form.
Pinus taeda (3667)	B14	1968	Aug. 1971: 113 gm/tree Super Cu Zn 'A'	B(9/78), E(9/78), H(1/81)	Healthy appearance, good form.
Pinus taeda (3711)	B15	1968	Aug. 1971: 113 gm/tree Super Cu Zn 'A'	B(9/78), E(9/78), H(1/81)	Healthy appearance, good form.
Pinus thunbergii (4007)	B20	1968	Nil	B(9/78), E(9/78), H(1/81)	Few straight stems, foliage deterioration in upper crowns.
Pinus thunbergii (4007)	D2	1970	Nil	A	Not typical probably another species. One specimen remains following cyclone induced stress in 1978.
Pinus torreyana (4286)	D17	1970	July 1972: 113 gm/tree Super Cu Zn 'A'	E(1/80)	Poor survival, sparse appearance.
Pinus virginiana (5034)	F11	1972	Nil	E(1/81)	Poor form, twisted branches, healthy.
Sequoia sempervirens (4159)	D6	1970	Aug. 1971: 113 gm/tree Super Cu Zn 'A' July 1972: 113 gm/tree Super Cu Zn 'A' Sept. 1976: 272 gm/tree Vigran 9:9:9	A	Patchy, growth rate improving, good form.

* Thinning and Pruning Key:

A - No treatment.
B - Plot divided into 3 sections: 250, 500 and 1700 s.p.h.
C - Thinned to 500 s.p.h.
D - All trees pruned to half height.
E - All trees pruned to 2.1 m.
F - Thinned to 850 s.p.h.
G - All trees pruned to 5.0 m.
H - 250 s.p.h. pruned to 5.0 m.
I - Malformed trees removed.
J - Thinned to 425 s.p.h.

\# Nutrifert; 5.2% N. 11.1%P.
Super Cu. Zn. (A); 8.7%P. 0.66% Cu. 0.6% Zn.
Vigran 9:9:9; 9%N 4%P 7.5%K.

MERIBUP ARBORETUM - SILVICULTURAL HISTORY TO AUGUST 1981

Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Callitris endlicheri	D3	1972	Aug. 1972: 57 gm/tree Super Cu Zn Aug. 1971: Agras No. 1 @ 500 kg/ha	A	Reasonable growth on poor site. Soil: surface laterite.
Cedrus deodara (4206)	C7	1971	Oct. 1971: 57 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	A	Variable, pale colour. Soil: grey sand.
Cupressus arizonica (4274)	B16	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	A	Poor growth, unhealthy appearance. Soil: grey sand.
Cupressus lusitanica cv. knightiana	C9	1971	Oct. 1971: 57 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	A	Variable, tip dieback. Soil: grey sand.
Pinus canariensis (4091)	A12	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	E(1980)	Poor, crowns deteriorating, fused needles. Soil: yellow sand.
Pinus caribaea (4212)	A8	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	B(1980), E(1980), C(3/81)	Healthy, pronounced lean and sweep. Soil: yellow sand.
Pinus caribaea (4092)	A13	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	B(1980), E(1980), C(3/81)	Sparse appearance, pronounced sweep. Soil: transitional sand.
Pinus caribaea (4296)	B5	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Agras. No. 1 @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Healthy, excellent form. Soil: yellow sand.
Pinus caribaea (4345)	C1	1971	Oct. 1971: 57 mg/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	G(3/81)	Poor,nutrient deficient, scrub competition. Soil: grey sand.
Pinus clausa (5001)	C3	1971	Oct. 1971: 57 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	G(3/81)	Nutrient disorders becoming apparent, multileaders. Soil: gravelly sand.
Pinus clausa (5002)	C2	1971	Oct. 1971: 57 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	G(3/81)	Nutrient disorders becoming apparent, multileaders. Soil: gravelly sand.
Pinus contorta (4017)	B17	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	A	Poor, severely nutrient deficient. Soil: grey sand.
Pinus coulteri (3822)	A15	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	G(3/81)	Variable; some trees dying for no apparent reason,including large trees. Soil: transitional sand.

Appendix 5C (cont.)

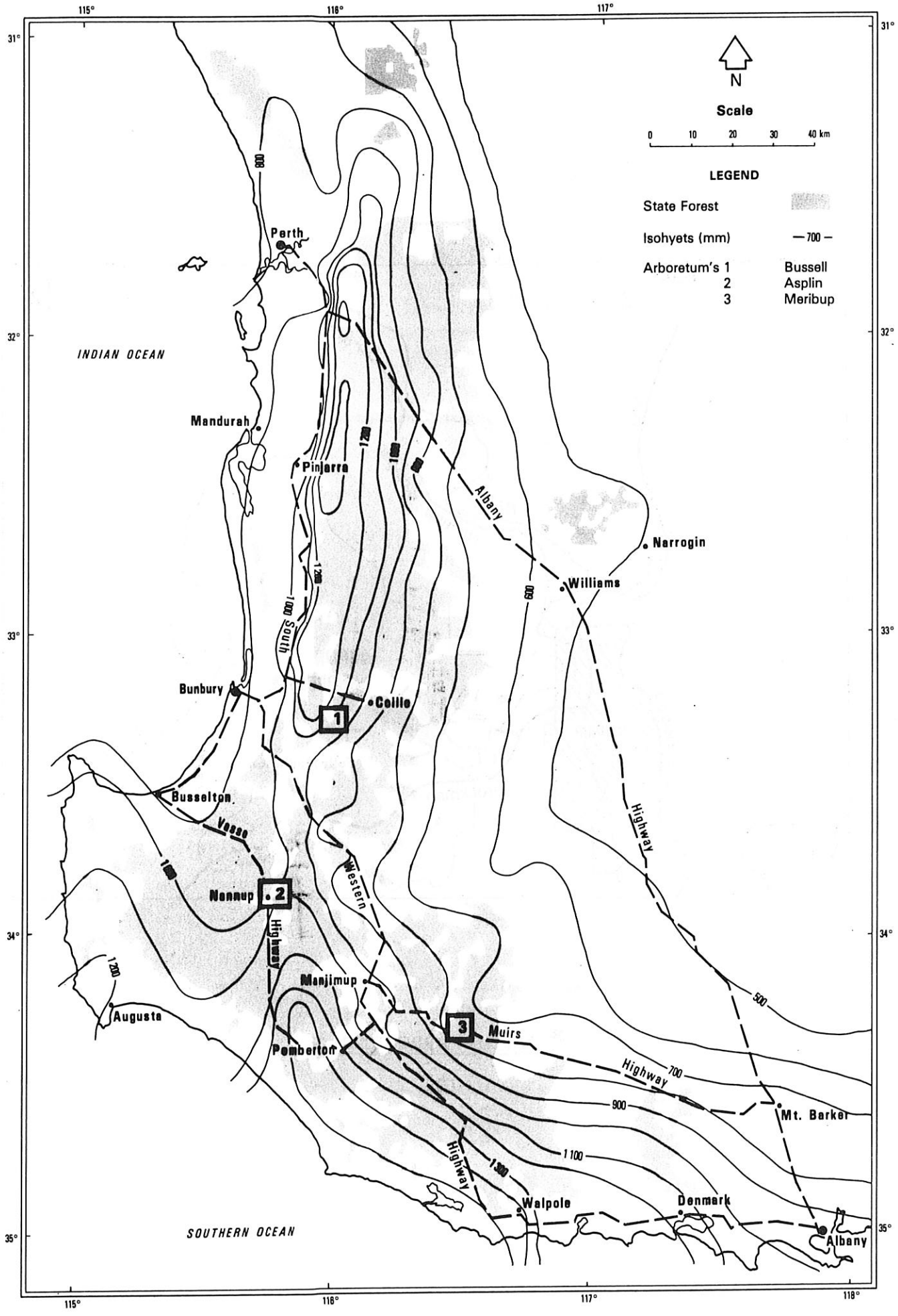
Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Pinus elliottii (4215)	A14	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	E(1980), B(3/81), C(3/81)	Healthy, good form. Soil: transitional sand.
Pinus greggii (4090)	A3	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Comparatively good growth, sparse crown, good form. Soil: yellow sand.
Pinus halepensis (4099)	A9	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	B(1980), E(1980), C(3/81)	Unhealthy, fused needles, sparse crowns, poor form. Soil: yellow sand.
Pinus halepensis var. brutia (4169)	A11	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	E(1980), B(3/81), C(3/81)	Becoming unhealthy, fused needles. Soil: yellow sand.
Pinus halepensis var. brutia (4343)	B4	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Mainly unhealthy, fused needles. Soil: yellow sand.
Pinus halepensis var. brutia (3643)	A10	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Becoming unhealthy, fused needles, good form. Soil: yellow sand.
Pinus jeffreyii (Riverside)	C4	1971	Oct. 1971: 57 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	A	Healthy. Soil: grey sand.
Pinus jeffreyii (San Diego)	C5	1971	Oct. 1971: 57 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	A	Healthy. Soil: grey sand.
Pinus jeffreyii (El Dorado)	C6	1971	Oct. 1971: 57 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	A	Healthy. Soil: grey sand.
Pinus kesiya (3308)	B3	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	F(1980)	Appears mixed with another species, unhealthy. Soil: yellow sand.
Pinus kesiya (4011)	B13	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	B(3/81), F(3/81)	Poor health, multistemmed, sparse crowns. Soil: transitional sand.
Pinus kesiya	B18	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn @ 500 kg/ha	A	Severely deficient, tip dieback, sparse crowns. Soil: grey sand.

Appendix 5C (cont.)

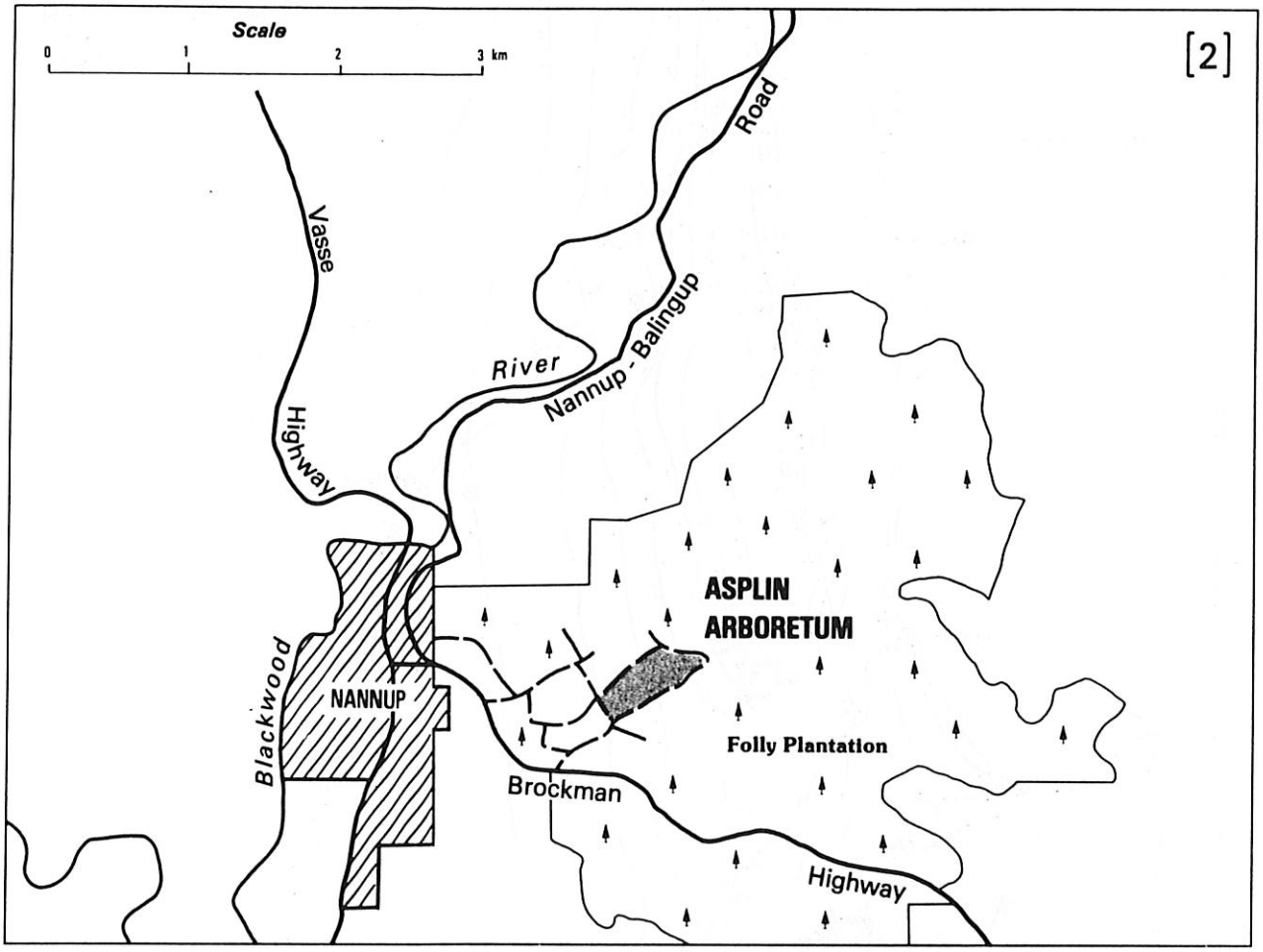
Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
Pinus leiophylla (4006)	B4	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	B(3/81), F(3/81)	Mixed with another species (*P. pseudo-strobus*?), unhealthy appearance, growth deteriorates towards the west (wet grey sand). Soil: transitional sand.
Pinus montezumae (4009)	A5	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	B(3/81), F(3/81)	Healthy, poor form. Soil: yellow sand.
Pinus muricata (4220)	A19	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Mainly healthy, heavy branches. Soil: yellow sand.
Pinus nigra var. maritima (4018)	A17	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	F(1980)	Variable growth, sparse appearance. Soil: transitional sand.
Pinus nigra var. nigra (4285)	B7	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	A	Uniform, healthy, multi-leaders common. Soil: yellow sand.
Pinus nigra var. maritima (3335)	A1	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	F(1980)	Variable, health declining. Soil: transitional sand.
Pinus nigra var. maritima (4290)	B8	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	A	Uniform, mainly healthy. Soil: yellow sand.
Pinus oocarpa (4013)	A16	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Unhealthy, poor form. Soil: transitional sand.
Pinus oocarpa (4305)	B10	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	F(3/81)	Nutrient deficient, poor form. Soil: transitional sand.
Pinus patula (4293)	B12	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Comparatively healthy, sparse appearance. Soil: transitional sand.
Pinus pinaster (progeny study)	B19	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	B(3/81), H(3/81)	Mainly good form and healthy. Soil: transitional sand.
Pinus pinaster (4238)	B9	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Healthy, vigorous, (may be Corsican var. of *P. pinaster*). Soil: yellow sand.

Appendix 5C (cont.)

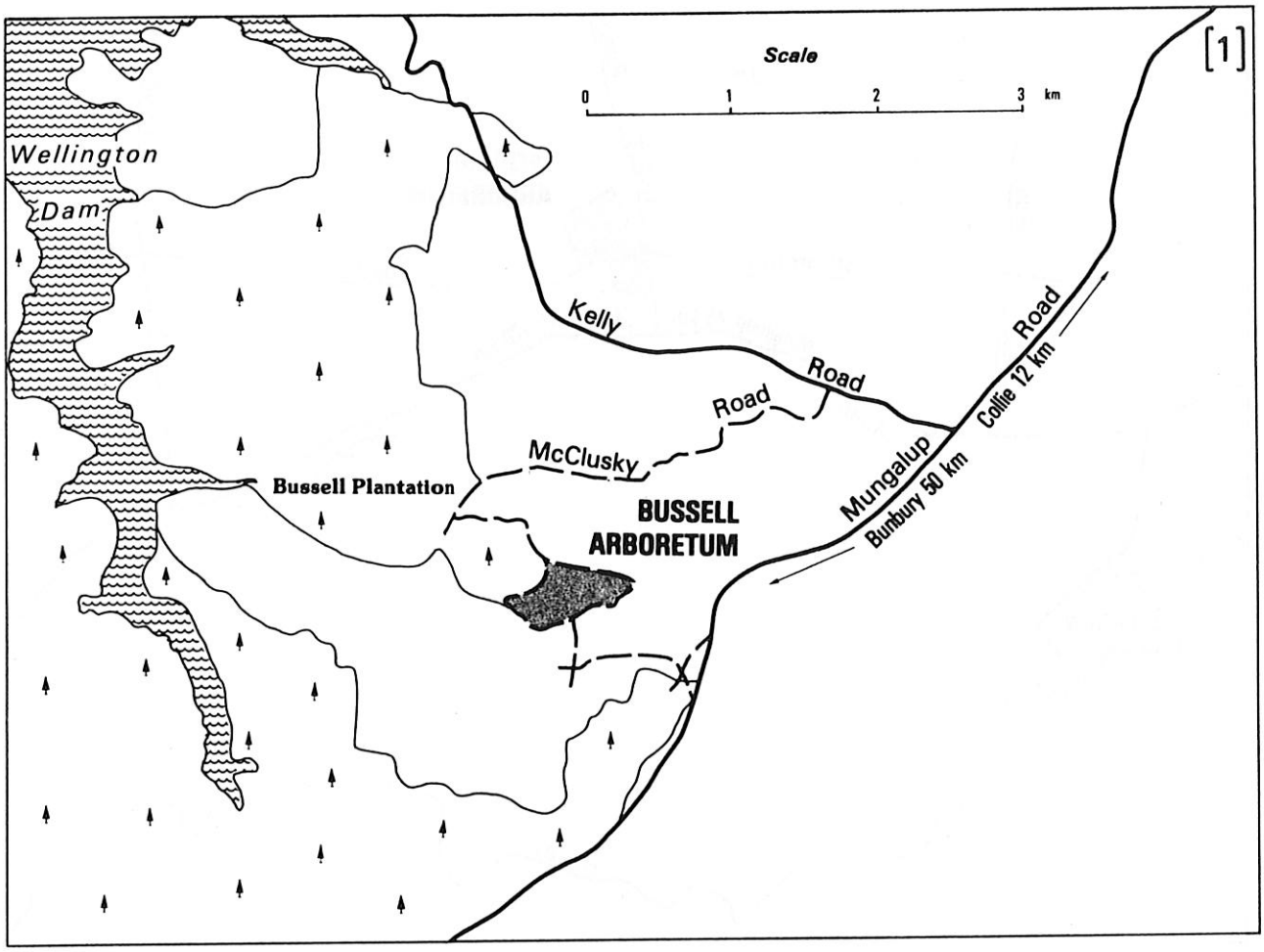
Species	Plot No.	Year Planted	Fertilizer History	Thinning Pruning treatment*	Remarks
pinus pinea (4245)	A6	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn @ 500 kg/ha	D(3/81)	Unhealthy, fused needles, short bushy appearance. Soil: yellow sand.
Pinus ponderosa (provenance study)	A2	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn @ 500 kg/ha	F(3/81)	Wide variation between provenances, some healthy, others severely deficient. Soil: yellow sand.
Pinus pseudo-strobus var. oaxacana (3978)	B15	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	B(3/81), E(3/81)	Sparse unhealthy appearance, fused needles. Soil: grey sand.
Pinus pseudo-strobus var. tenuifolia (4291)	B11	1970	Aug. 1970: 71 gm/tree Super Cu Zn	G(3/81)	Mixed with another species (*P. leiophylla?*), variable performance. Soil: Transitional sand.
Pinus pungens (5032)	D4	1972	Aug. 1971: 57 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	A	Poor survival, growth improves on laterite, deteriorates on wet grey sand.
Pinus radiata (4318)	B6	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Mainly healthy, deteriorates on grey wetter soils, good form. Soil: transitional sand.
Pinus rigida (5033)	D1	1972	Aug. 1972: 57 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	G(3/81)	Health deteriorating especially on heavier soils, fused needles. Soil: grey sand - sandy clay.
Pinus roxburghii (4342)	B2	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	B(3/81), G(3/81)	Variable, deficiency symptoms becoming evident. Soil: yellow sand.
Pinus serotina (4051)	A4	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Mainly healthy, fused needles becoming apparent. Soil: yellow sand.
Pinus taeda (4214)	A7	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	F(1980), B(3/81), C(3/81)	Mainly healthy, fused needles developing, good form. Soil: yellow sand.
Pinus thunbergii (4007)	A18	1969	Sept. 1969: 71 gm/tree Super Cu Zn Aug. 1981: Super Cu Zn 'A' @ 500 kg/ha	B(3/81)	Unhealthy, fused needles, sparse appearance. Soil: transitional sand.
Pinus torreyana (4286)	B1	1970	Aug. 1970: 71 gm/tree Super Cu Zn Aug. 1981: Agras No. 1 @ 500 kg/ha	F(1980)	Mainly healthy, some fused needles, scrub competition. Soil: transitional sand.
Pinus virginiana (5034)	D2	1972	Aug. 1972: 57 gm/tree Super Cu Zn Aug. 1981:	G(3/81)	Growth better on dryer lateritic site, poor on wet grey sand. Soil: laterite and grey sand.



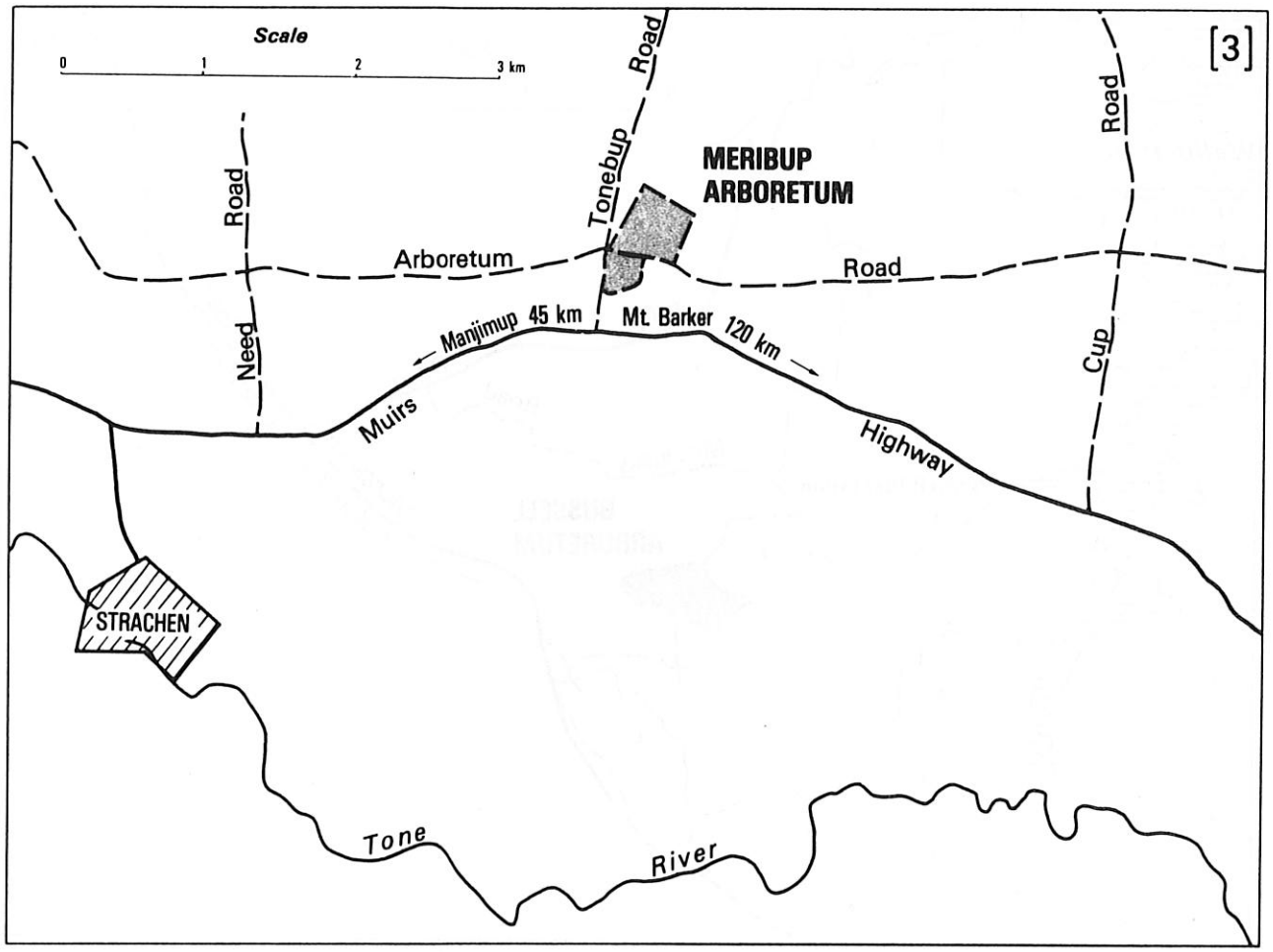
GENERAL LOCALITY MAP



ASPLIN ARBORETUM



BUSSELL ARBORETUM



MERIBUP ARBORETUM