Assessment of Wood Qualities for Tree Breeding

II. In Pinus pinaster Ait. from Western Australia

By J. W. P. NICHOLLS*), H. E. DADSWELL*) and D. H. PERRY**)

(Received for publication April 16, 1963)

Introduction

A useful summary of information on *Pinus pinaster* has been published recently by SCOTT (1962). This summary highlights the paucity of published data regarding the wood characteristics of this species. Due to its ability to grow well on very poor sandy soils *P. pinaster* is regarded as a valuable plantation species in several States in Australia, and the above-mentioned lack of knowledge regarding wood characteristics is therefore an embarrassment when planning afforestation in these areas.

P. Pinaster embraces several geographic races and the Forests Department, Western Australia, has conducted provenance trials since 1929 to determine the relative value of four of these races, *viz.* Leiria or Portuguese, Landes, Esterel and Corsican. These trials have shown the Portuguese raoe to have superior inherent vigour, and the Corsican race to possess the highest quality stem form. Fron: these results taken in conjunction with those of RYCROFT and WICHT (1947) in South Africa, it was concluded that the Portuguese race offers the greatest potential for breeding purposes, and the combination of its vigour with the superior form of the Corsican population will bring about the maximum degree of tree improvement for the species (HOPKINS, 1960).

So far as is known, the only information available on wood characteristics for the species is that of RYCROFT and WICHT (1947) and BISSET *et al.* (1951). RYCROFT and WICHT recorded mean values of specific gravity for five races of P. *pinaster* based on determinations carried out on entire transverse disks taken at about 0.6 m above ground level. Variations in mean density between races were slight, but the average for the Portuguese variety was significantly greater than all others with the exception of that for the Landes race. BISSET *et al.* reported average tracheid lengths for five trees of each of the four races on trial in Western Australia. All of the trees were of the same age and approximate size and had been subjected to the same treatment on a uniform site. Determinations of fibre length for the late wood of the first, second and last-formed growth rings at the one metre level were obtained. No great consistency within the races was noted, and no significant superiority in tracheid length was found for any one race.

Such a background is hardly sufficient evidence on which to base a breeding Programme for this species, and the present project was designed to augment this limited information. It was hoped to demonstrate differences in wood characleristics where these exist by the examination of the wood of selected trees from each of the above-mentioned four races of *P. pinaster*. Results from this examination would also serve to establish standards for these populations.

In a project of this kind in which small genetical differences are sought, environmental variation between trees should be reduced to a minimum. It was therefore fortunate that, material for this study was available from a single plantation compartment where the selected trees were subject to the same edaphic factors and the same silvicultural conditions. The most likely departure from environmental uniformity is that due to micro edaphic factors, but there is no reason to suppose that this influence would be other than randomly disposed over all trees.

Other work, involving four small groups of *P. radiata* from two localities, has indicated that as few as ten trees can provide representation for a population (NICHOLLS and DADSWELL, 1961 b), and that wood properties in this species are similar to those in *P. pinaster* (NICHOLLS and DADSWELL, 1961 a). Therefore, differences between the four races of *P. pinaster* should become apparent by examining material from ten selected trees of each race.

Previous work has also shown that fibre length, basic density and spiral grain are the important characteristics for the evaluation of wood quality (DADSWELL and NICHOLLS, 1959; NICHOLLS and DADSWELL, 1960, 1961 a and b). Though longitudinal shrinkage has not been found to be a troublesome defect in *P. pinaster* (NICHOLLS and DADSWELL, 1961 a) it was felt that this property should be investigated in the present case. It was planned, therefore, to examine the wood taken from the selected trees to determine the following: (a) ring width, (b) per cent. late wood, (c) average cell length, (d) basic density, (e) longitudinal shrinkage, (f) incidence of compression wood, and (g) incidence of spiral grain, by using material from successive growth rings from the pith.

The precautions to be observed in sampling procedure to minimize the effect of systematic variation in wood characteristics within the tree have been set out elsewhere (NICHOLLS and DADSWELL, 1962). It was observed that it was not proper to compare tracheid lengths between even-aged trees which showed differences in early height growth, if the trees were sampled at a fixed level above ground. RICHARDSON (1961) has suggested that samples should be located with reference to the number of internodes from the apex, and CHALK (1961) has indicated that, ideally, sampling should be carried out at a level which is proportional to the height of the tree. In the present study, which is concerned with even-aged trees, RICHARDSON'S suggestion was adopted by sampling at such a height that specimens showed a constant number of growth rings. After consideration of several conflicting requirements. such as the need to avoid disturbances near the base of the tree (NICHOLLS and DADSWELL, 1962), convenience in harvesting the specimen, and the wish to include as many rings as possible, a sampling age of twenty-six years was chosen. In addition, extra specimens were removed at breast height from certain trees of the Esterel and Leiria race to allow a comparison of results from samples taken at a fixed height with those fram samples gathered on the basis of a common age. This comparison is also reported below.

Material

The trees for examination were selected on the basis of external characteristics as good quality stems from a single plantation compartment at Gnangara in Western Australia.

*) Division of Forest Products, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia.
**) Forests Department, Western Australia.

This area was planted in 1931 as a provenance trial for *Pinus pinaster*. The soils here are deep grey sands which have been highly leached and possess a very low nutrient value. However, application of phosphate to these soils results in satisfactory growth of *Pinus pinaster*. Because it is possible for the application of fertiliser and also thinning to affect ring width, the times of treatments are listed: applications of fertiliser 1933, 1934, 1936, 1939, 1942 and 1958; thinning 1955.

Wood specimens were obtained by the method of BROWN (1958) or, in some cases, by felling to provide sections extending from bark to bark and including the pith. These samples were approximately 6 cm long (in the direction of the grain) and 6 cm wide. Sampling was carried out mid-way between whorls of branches along a north-south direction with the exception of tree M1 which was sampled along an east-west diameter.

Specimens were taken at such a height as to show 26 annual rings in each section and in twelve cases, extra specimens were harvested at a nominal breast height. They were then packed in polythene bags, forwarded to the laboratory by air freight, and immediately placed in a cold room until required for examination. *Table 1* sets out details of tree data and sampling height.

Experimental Procedure

Transverse strips ½ cm thick were sawn from the specimens as received and retained for reference. The shorter radii of the remaining portions were selected as likely to contain least compression wood and were sawn to produce radial strips measuring 4½ cm along the grain and 1½ cm in the tangential direction. The end surfaces were planed smooth and the growth rings marked and numbered serially from the pith to the bark. The strips were then divided into two end-matched pieces, one 3 cm and the other 1½ cm long. The following observations and determinations were carried out on the green material from each tree.

To eliminate unnecessary work, selected rings from each specimen were examined as follows — the first 7 growth rings from the pith, then every alternate growth ring to the 19th, followed by every fourth ring to the bark. Longitudinal shrinkage determinations were restricted to to the first 9 growth rings from the pith.

(a) Ring width and late wood component:

This was determined by viewing the reference strips against a strong white light using a low power lens having a superimposed engraved scale divided into 0.1 mm.

(b) Incidence of spiral grain:

From the 3 cm strip, pieces 1 mm thick were split from the late wood of successive growth rings. The grain direction in each ring was determined by measuring the angle between the line disclosed by peeling a thin sliver from the longitudinal surface, and the 3 cm edge of the piece.

(c) Longitudinal shrinkage:

For the determination of this property the 1 mm thick pieces split from the late wood were recut to a finished size 2½ cm along the grain and ½ cm wide. The length of each piece was measured and then remeasured after drying in an oven at 103° C for 4 hours. The longitudinal shrinkage from the green to the oven-dry state was calculated as a percentage of the green dimension.

(d) Average fibre length:

For this determination the late wood of successive growth rings was used and the fibres separated by treatment in a macerating mixture of equal quantities of 100 vol. hydrogen peroxide and glacial acetic acid kept at 100° C for 2 hours. The freed fibres were washed, agitated, and then sampled so that in each case 50 whole fibres taken at random were measured at 40 magnifications using a projection microscope.

Table 1. — Details of Pinus pinaster trees supplying specimens for the analysis of wood characteristics: — All trees were planted in 1931 and originated in Compartment 19, Gnangara, Western Australia. They were sampled along a north-south diameter with the exception of M1 which was sampled along the east-west diameter. Sampling height — (a) to show a ring count of 26 years; (b) breast height.

Geographic Race	Tree No.	Class	Height m	Sampling Height m (a)	(b)	Geographic Race	Tree No.	Class	Height m	Sampling Height m (a)	(b)
Landes	L1A	Dom.	15.9	1.88		Esterel	M1	Co-dom.	14.1	1.02	
	L2A	Dom.	16.9	1 91			M2	Dom.	14.6	1.35	1.12
	L3A	Dom.	16.7	1.91			M3	Sub-dom.	12.2	1.07	
	L4A	Dom.	17.1	1.94			M4	Dom.	13.8	1.02	1.22
	L5A	Dom.	16.1	1.78			M5	Co-dom.	13.8	1.22	
	L6A	Co-dom.	15.6	1.48			M7	Sub-dom.	11.6	0.82	1.02
	L7A	Co-dom.	14.7	0.79			M8	Dom.	14.6	1.05	1.22
	L8A	Dom.	15.1	1.22			M9	Co-dom.	12.2	1.27	1.12
	L9A	Co-dom.	15.7	1.22			M10	Dom.	13.6	1.15	0.92
	L10A	Co-dom.	15.4	1.04			M11	Sub-dom.	12.8	0.80	0.97
Leiria	E1	Dom.	22.6	4.42		Corsican	C1A	Co-dom.	14.1	1.07	
	E1A	Co-dom.	22.0	3.21			C2A	Co-dom.	13.9	1.12	
	E2	Dom.	22.6	3.86			C3A	Co-dom.	12.8	1.02	
	E2A	Dom.	23.4	3.96			C4A	Dom.	14.2	1.22	
	E3	Dom.	19.9	2.64			C5A	Co-dom.	13.5	1.02	
	E3A	Dom.	21.9	2.95			C6	Dom.	14.4	1.58	
	E4	Sub-dom.	19.1	2.45			C6A	Dom.	13.8	1.27	
	E4A	Co-dom.	20.5	2.14	1.15		C7	Dom.	15.0	2.04	
	E5	Dom.	21.7	4.50			C7A	Dom.	14.4	2.29	
	E5A	Dom.	21.1	2.45	1.22		C8	Dom.	13 8	1.22	
	E6	Dom.	21.4	4.17							
	E6A	Dom.	20.2	2.60	1.30						
	E7	Co-dom.	20.5	3.66							
	E7A	Dom.	19.0	2.30	1.22						
	E8A	Dom.	18.9	2.30	1.22						

(e) Basic density:

From the strips 1½ cm along the grain and 1½ cm wide, successive growth rings were separated at the junction of the late wood of one ring with the early wood of the next. Resinous infiltrates were removed from the small blocks by treatment with an alcohol-benzene mixture in a Soxhlet extraction apparatus. The volume of the specimens was obtained by measuring the weight of displaced water by means of a microtorsion balance. The specimens were then dried at 103° C for 4 hours and weighed. From the results the basic density (ratio of oven-dry weight to green volume) was calculated.

(f) Incidence of compression wood:

This was determined by the microscopic examination of radial-longitudinal sections 20 μ thick taken from the late wood zone.

Results and Discussion

Detailed results were obtained for each tree using the specimens showing ring counts of 26 years. These values were averaged for each race according to growth ring number from the pith, to produce means for fibre length, basic density, ring width, longitudinal shrinkage and percentage late wood. These means have been plotted against growth ring number, and results are shown in *Figure 1*. Ring one was not used because experience has shown that this ring is not always representative. It often contains much compression wood, the late wood is generally very diffuse, small knots and leaf traces are troublesome, and the small radius of curvature makes it very difficult to carry out accurate measurements. Results from growth rings found to contain compression wood were not used in the production of the mean curves. Finally, so that a consistent number of trees was represented from each race, only results from ten of the fifteen trees available from the Leiria population were used in the formation of *Figure 1*.

Some appreciation of differences between races can be obtained from this presentation, but in addition, the above-mentioned results were subjected to an analysis of variance for the features of fibre length, basic density, ring width and spiral grain. The results of this analysis are summarized below.

Average fibre length. On the average, trees of the Landes race had significantly longer fibres than those of the Corsican race, but differences between races varied with ring number from the pith. Thus, in rings close to the pith, trees of the Landes population had longer fibres than those of any other race but for rings further from the pith, those of the Esterel and Leiria races produced longer fibres than were found in the Landes material, while the trees of the Corsican race showed shorter fibre lengths than those of other races, except in growth rings 2, 3 and 4.

Basic density: — The basic density values for the Corsican were significantly lower than those of any other race. Only small differences in average density were revealed between specimens from the Leiria and Landes races, although the sign of the differences varied from ring to ring. Values for the Esterel race were midway between those for the Corsican and those for the Leiria and Landes races.

Ring width: — Trees of the Leiria race had, fairly consistently, the greatest ring widths, whilst between rings 3 and 15, trees of the Landes race exhibited the smallest radial growth rate. However, from ring 16 to the bark, the ring widths for Landes, Esterel and Corsican races were similar, and generally lower than those for Leiria.

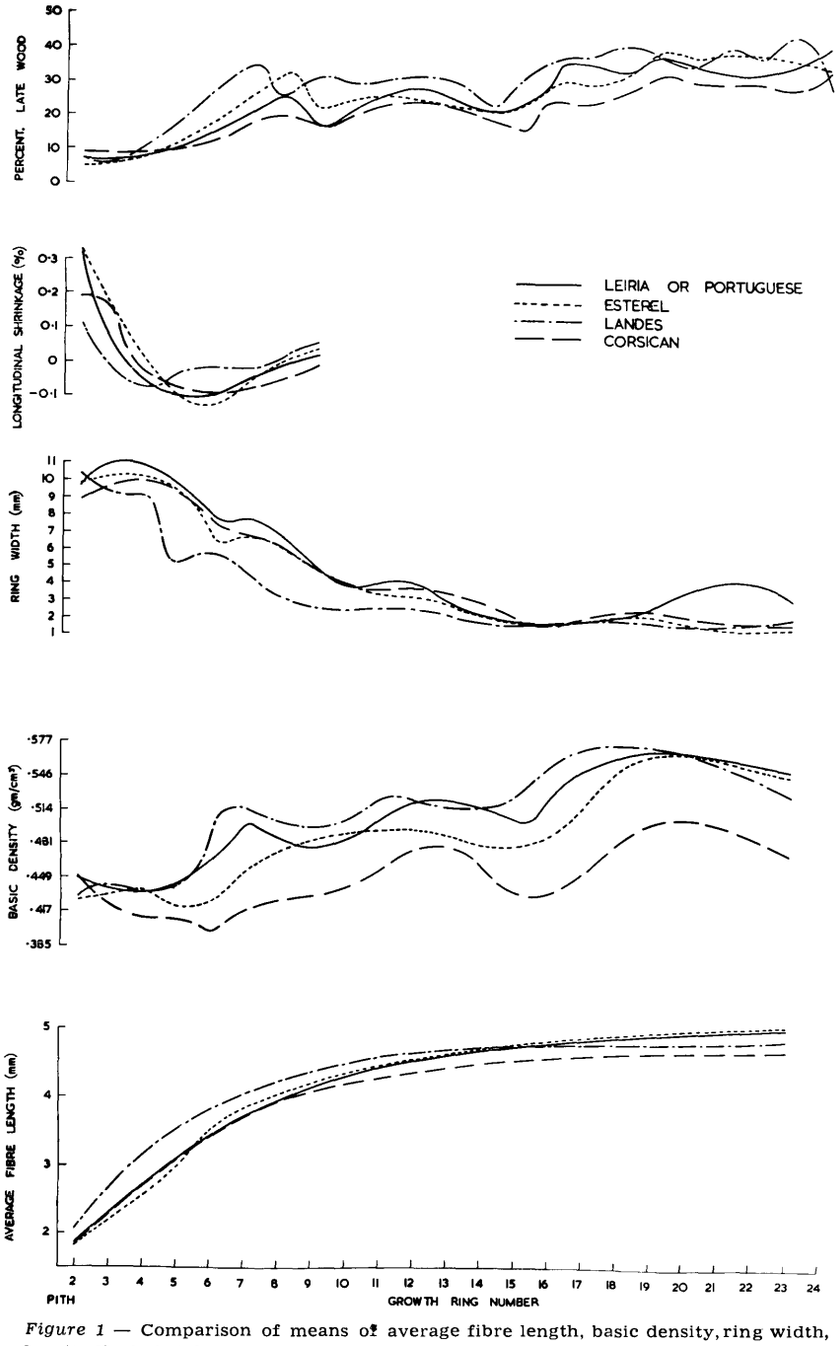

Figure 1 — Comparison of means of average fibre length, basic density, ring width, longitudinal shrinkage and per cent. late wood for 10 selected trees from each of four races of *Pinus pinaster*.

Spiral grain: — There were no significant differences between races for this feature.

Considering between-race differences for the features which are important for the evaluation of wood quality, the overall picture presented by the results obtained shows only small variations between the four races, but several points are noteworthy.

In the case of fibre length, where it is desirable to have as long an average length as possible, the superiority of trees of the Landes race in the juvenile zone of wood would be advantageous in the utilization of thinnings. Furthermore, the fibre lengths appear to reach a constant value at an earlier age than those of the other populations, indicating in this respect an earlier maturing period for this race. However, it is not known whether the maturing age is governed by genetic factors or otherwise, so that further work is indicated before this aspect of fibre length variation can be fully assessed.

No significant differences between races were noted for values of grain spiral angle. However, these results were based on determinations carried out along one radius in specimens taken at a single height. Such sampling may not be truly representative as spiral grain has been found to vary greatly, both circumferentially and with height in tree (Northcott, 1957). This has been confirmed in other stems of *P. pinaster* (unpublished data) but insufficient specimens have been examined to date to show whether this variation is random or systematic. More information is needed therefore before precise sampling procedures can be applied for the most sensitive between-tree comparison of this feature.

The greatest difference between races was recorded for basic density. Results for the Corsican race were significantly lower than those for the other three races, the mean for the Leiria trees being some 15 per cent. greater than that for the Corsican trees. However, desirable values of basic density may be provided by either the Leiria or the Corsican trees since the preference for high or low basic density in a species depends on the way in which the material is to be utilized (Dadswell and Nicholls, 1959). These density requirements are based on variations in cell wall thickness associated with changes in late wood content, and it is to be noted that the differences in percentage late wood between the specimens from the Corsican and Leiria races is also of the order of 15 per cent. If it is intended to carry out inter-racial crossings between the Corsican and Leiria races, the basic density values of the hybrid progeny should be midway between those of the parents (Pryor *et al.*, 1956); that is, similar to the values for the specimens of the Esterel race.

As in previous work (Nicholls and Dadswell, 1960, 1961 a and b) longitudinal shrinkage values were less than 0.3 per cent. except in the first few growth rings adjacent to the pith or in material containing compression wood. Spiral grain, if any, was eliminated from the specimens when preparing them for examination. No significant differences in shrinkage were observed between the four races.

To compare the effect of sampling by the alternative methods referred to earlier, detailed results were also obtained for the twelve additional specimens taken at a nominal breast height from trees of the Esterel and Leiria races (see *Table 1*). These results were tabulated according to growth ring number from the pith together with the results from the same trees sampled to show 26 growth rings. An analysis of variance was carried out to disclose differences between the two sets of results for fibre length and basic density. An analysis was also taken for the five sets of results obtained from the Leiria trees numbering the rings from bark to pith as well as from pith to bark. By this means the variation due to age and height could be separated. In the case of basic density, the only significant difference was found at ring 23 for the samples from the Esterel race. For fibre length, however, significant dif-

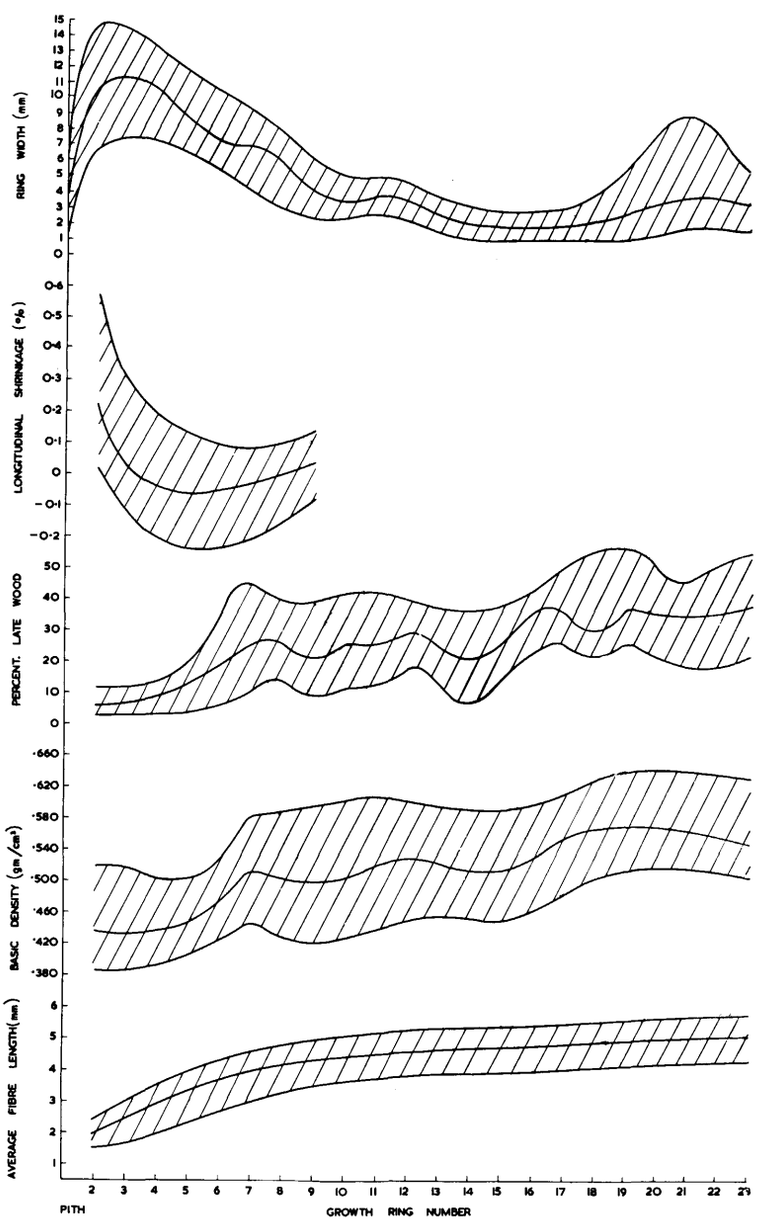

Figure 2. — The variation of both mean and extreme values of average fibre length, basic density, per cent. late wood, longitudinal shrinkage and ring width, through successive growth rings from the pith for 15 trees of *Pinus pinaster* (Leiria race) sampled at 26 years.

ferences which could be attributed to both height and age effects were observed between the results for the two sets of samples. Taken separately, differences were found for an age variation of ± 1 year and for a height variation of 1 m in the range from 1 m to 2.5 m. Although these differences are small they do illustrate the extreme care which must be exercised in locating samples for between-tree comparison of fibre lengths.

Finally, for the results obtained for the 15 trees of the Leiria race, sampled at 26 years, means were prepared according to the growth ring number from the pith, for fibre length, basic density, per cent. late wood, longitudinal shrinkage and ring width. In *Figure 2* these means have been separately plotted against growth ring number, together with smoothed curves showing the limits of variation about these means. As before, results from ring 1 and from growth rings found to contain compression wood in any but slight amounts were excluded..

From the "bands" obtained for each feature it is possible to gain a good appreciation of the range of variation in the material examined. For the fibre length and basic density results for these 15 trees the upper extreme is seen to be some 14 per cent. greater than the mean. This is an indication of the amount of variation which is available for exploitation by selection within a race, though it is realized that some portion of this may be due to random micro environmental factors.

Conclusions

Appraising wood quality on the basis of fibre length, basic density and spiral grain, the results of this study have indicated that differences between the four geographic races of *Pinus pinaster* are small.

However, it is considered that single specimens per tree as used herein may not be satisfactory for the evaluation of spiral grain, and therefore that the differences between races for this feature may be larger than were revealed in these results. More work is required to indicate correct sampling procedures for the proper assessment of this feature.

Fibre length differences between races were small, so that the choice of a race will have little effect on progeny values. However, results from the Leiria population have indicated that a wide range of fibre lengths may be expected within each race, so that selection within a race should produce gains for this feature.

On the other hand, basic density results showed marked differences, both between and within a race, indicating a large amount of variation for this feature within the species as a whole. Therefore, progeny differences result not only from selection within a race but also from the choice of a race or by inter-racial crossing. Furthermore, whereas superior fibre length is always desirable, the preferred basic density values are governed by the probable utilization of the material. If the main avenue of conversion is to be sawn timber, then high basic density will confer the best strength properties for such material, and high density should be the criterion when selecting for this feature. Therefore, since the highest density was recorded for the Landes and Leiria populations, the best strength properties will be achieved by selecting trees with above average basic density within these races.

However, if external characters are also taken into account, progeny which in addition to high basic density and good fibre length, will possess superior vigour and reasonable form should result from selecting parents within the Leiria population.

Acknowledgements

The authors wish to thank the Conservator of Forests, Forests Department, Western Australia, for the wood specimens used in this investigation.

Appreciation is also recorded of the assistance of Misses G. Douglas and J. Sibthorpe in the carrying out of the detailed measurements on which the results of this investigation have been based; and of the assistance of Miss N. Ditchburne, Division of Mathematical Statistics, C S. I. R. O., in the statistical analyses and for the helpful discussions relating to them.

Summary

The wood characteristics of material from ten trees from each of four geographic races of *Pinus pinaster, viz.*, Leiria, Corsican, Esterel and Landes, have been examined. Analysis of the results has provided an indication of the extent of variation between these four races.

Only small differences were found for fibre length values, but the basic density results from the trees of the Corsican race were markedly lower than those from trees of the Landes and Leiria races. More work is needed before a proper evaluation of spiral grain differences can be obtained.

Results from the examination of fifteen trees of the Leiria race provided an indication of the range of variation in wood characteristics.

It was concluded that the Leiria race offers high density, good fibre length, superior vigour and reasonable form in a species which has good potential for breeding improvement.

The need for careful sampling procedures for between-tree studies of wood features has been stressed.

Résumé

Matériaux de 10 arbres pour chacun des quatre races géographiques du *Pinus pinaster* (de Leiria, de Corse, d'Esterel et des Landes) étaient examinés. L'analyse des résultats nous a révélé la différance parmi ces quatre essances.

Pour la longueur des fibres, seulement des différances minutes étaient constatées, par contre la densité basale de la race Corse était plus bas que seules des races de Landes et de Leiria. Mais il nous faut plus d'études scientifiques pour évaluer proprement les fils hélicoïdeaux.

L'examination des éprouvettes d'essai des 15 billes de la race de Leiria nous a indiqué la variation et l'ordre des caractéristiques du bois.

Nous avons conclus que la race Leiria à une densité haute, des fibres de bonne longueur, une vigueur supérieure et une forme raisonnable pour cette essance, ayant des bonnes possibilitées pour améliorer leur cultivation.

Attention fut attiré à la necessité de pour suivre le chantillonage systématique regardant les caractéristiques du bois.

Zusammenfassung

Es wurden 10 Bäume von jeder der vier geographischen Rassen von *Pinus pinaster* (aus Leiria, Corsica, Esterel und Landes) untersucht. Die Analyse der Beobachtungen ergab ein Maß für Unterschiede zwischen den vier Rassen.

Nur kleine Unterschiede wurden zwischen den Faserlängen festgestellt, hingegen sind die Grunddichte-Ergebnisse der Corsica-Rasse niedriger als die der Landes- oder der

Leiria-Rasse. Um Unterschiede bei den Spiral-Fasern ermitteln zu können, sind mehr Untersuchungen erforderlich.

Die Resultate bei den 15 untersuchten Bäumen der Leiria-Rasse brachten Hinweise für den Schwankungsumfang bei Holzeigenschaften.

Es wurde geschlossen, daß die Leiria-Rasse einen hohen Dichtegrad, eine gute Faserlänge, große Festigkeit und eine recht gute Form besitzt, daß sie also eine Rasse mit guten Möglichkeiten für die Forstpflanzenzüchtung darstellt.

Die unerläßliche Notwendigkeit einer sorgfältigen Probenahme für solche Holzstudien wurde betont.

Literature

Bisset, I. J. W., Dadswell, H. E., and Wardrop, A. B.: Factors influencing tracheid length in conifer stems. Austral. For. **15**, 17—30 (1951). — Brown, A. G.: The extraction of large wood samples from living trees. J. Forestry **56**, 764 (1958). — Chalk, L.: Wood anatomy. Advancement of Science **18** (75), 460—466 (1961). — Dadswell, H. E., and Nicholls, J. W. P.: Assessment of wood qualities for tree breeding. I. In *Pinus elliottii* var. *elliottii* from Queensland. Div. Forest Prod., Tech. Paper No. 4, C. S. I. R. O., Australia, 1959. — Hopkins, E. R.: Variation in the growth rate and quality of *Pinus pinaster* Ait. in Western Australia. Bull. No. 67, 1960, Forests Dept., Western Australia. — Nicholls, J. W. P., and Dadswell, H. E.: Assessment of wood qualities for tree breeding in *Pinus radiata* D. Don from the Australian Capital Territory. Div. Forest. Prod., Project WS 18-2. Progress Rept. No. 1, C. S. I. R. O., Australia, 1960. — Nicholls, J. W. P., and Dadswell, H. E.: Assessment of wood qualities for tree breeding in *Pinus pinaster* Ait. from South Autralia. Div. Forest Prod., Project WS 122-2. Progress Rept. No. 1, C. S. I. R. O., Australia, 1961 a. — Nicholls, J. W. P., and Dadswell, H. E.: Assessment of wood qualities for tree breeding in *Pinus radiata* D. Don from South Australia. Div. Forest Prod., Project WS 18-2, Progress Rept. No. 4, C. S. I. R. O., Australia, 1961 b. — Nicholls, J. W. P., and Dadswell, H. E.: Tracheid length in *Pinus radiata* D. Don. Div. Forest Prod., Tech. Paper No. 24, C. S. I. R. O., Australia, 1962. — Northcott, P. L.: Is spiral grain the normal growth pattern? Forestry Chronicle **33**, 335—352 (1957). — Pryor, L. D., Chattaway, M. M., and Kloot, N. H.: The inheritance of wood and bark characters in *Eucalyptus*. Autral. J. Bot. **4**, 216—239 (1956). — Richardson, S. D.: A biological basis for sampling in studies of wood properties. TAPPI **44** (3), 170—173 (1961). — Rycroft, H. B., and Wicht, C. L.: Field trials of geographical races of *Pinus pinaster* in South Africa. Paper Fifth Brit. Emp. For. Conf., Gt. Brit., 1947. — Scott, C. W.: A summary of information on *Pinus pinaster*. Forestry Abstr. **23** (1), I—VIII; **23** (2), IX—XVIII.

Untersuchungen zum ökologischen und genetischen Birkenproblem*)

Von Hermann Dieterich

(Eingegangen am 18. 1. 1963)

1 Einleitung

In den letzten Jahren wurden bei einigen Baumarten systematische Züchtungsarbeiten eingeleitet. Dazu müssen jedoch die nötigen praktischen und theoretischen Voraussetzungen vorhanden sein, und v. a. muß eine begründete Vorstellung über das genetische Verhalten des Züchtungsmaterials existieren. Die Baumrassenforschung macht daher heute einen wesentlichen Schritt auf dem Wege zu einer planmäßigen Züchtungsarbeit mit Forstpflanzen aus (Stern 1958, S. 2). Es soll im Folgenden der Versuch gemacht werden, einiges zur Klärung der Fragen beizutragen, die uns von der Gattung *Betula* zu diesem Thema gestellt werden.

Im untersuchten Gebiet, dem Küstenraum der Nordsee (Jütland, Schleswig-Holstein, nördl. Niedersachsen und die Niederlande), kommen folgende 4 Arten dieser Gattung urwüchsig vor: die beiden Baumbirken *Betula pendula* Roth (Sand-, Warzen- oder Hängebirke) und *B. pubescens* Ehrh. (Moorbirke), die Strauchbirke *Betula humilis* Schrk. und schließlich an wenigen Reliktstandorten die Zwergbirke *Betula nana*. Als forstlich wichtige Arten sollen hier nur die beiden Baumbirken untersucht werden.

Die Birke erweist sich für eine Reihe von Aufgaben (Windschutz, Straßenpflanzungen) von besonderer Bedeutung und ist aus der modernen Forstwirtschaft als Schirm- und Mischholzart nicht mehr wegzudenken. Um so mehr mußte es unbefriedigend sein, nur auf relativ schlechte durchschnittliche Qualität innerhalb der autochthonen Bestände zurückgreifen zu können.

Die Birken sind seit langem als Formenkreis mit großer morphologischer Variationsbreite bekannt. So schreibt Regel (1865): „Die Gattung Betula gehört in die Reihe jener schwierigen Gattungen, welche den Monographen fast zur Verzweiflung bringt, d. h. zu der Verzweiflung an der Möglichkeit, hier dauernd Ordnung zu schaffen." Seither ist die Literatur über dieses Problem stark angewachsen und es sind die verschiedensten Ansichten über Art und Entstehung der Formenmannigfaltigkeit geäußert worden. Hier soll versucht werden, Klarheit über die möglichen Ursachen dieser Vielfalt zu erhalten und v. a. zu prüfen, ob und in welchem Umfang eine spontane Kreuzung beider Arten dabei eine Rolle spielt.

Zur Nomenklatur sei kurz bemerkt: Linnaeus (1753) faßt beide Arten als eine Species (*Betula alba*) auf. Diese wurde von Ehrhart (1791) aufgeteilt in *B. pubescens* Ehrh. und *B. verrucosa* Ehrh. Zuvor hatte aber Roth (1788) eine *Betula pendula* Roth beschrieben, die sich als identisch mit der später aufgestellten *B. verrucosa* Ehrharts erwies, so daß *Betula pendula* Roth nach den Nomenklaturregeln als der gültige Name anzusehen ist (vgl. auch Mansfeld 1940, S. 70).

2 Verbreitungsgeschichte

21 Nacheiszeitliche Verbreitungsgeschichte

Die Verfolgung der nacheiszeitlichen Verbreitungsgeschichte unserer beiden Arten stößt zunächst auf eine methodische Schwierigkeit. An Hand fossiler Pollenablagerungen ist eine Unterscheidung weder morphologisch noch größenstatistisch mit Sicherheit möglich (Firbas, F. u. I. 1935), da die Pollen durch äußere Einflüsse und bei der Aufbereitung des Materials verändert werden können. Nur in Einzelfällen wird es möglich sein, Unterscheidungen mit einem großen Grad von Sicherheit vorzunehmen (Firbas, 1949, S. 114). Absolut verläßliche Artbestimmungen setzen Funde von Großresten (Früchte, Fruchtschuppen, Blätter) voraus.

Über die Rückzugsgebiete der Baumbirken während der letzten Eiszeit ist wenig bekannt. Firbas (1949, S. 116) nimmt aber zumindest für *Betula pubescens* auf Grund ihrer geringen Wärmeansprüche die Möglichkeit einer eiszeitlichen Überdauerung nördlich der Alpen an. Bei dem

*) Dissertation der Philosophischen Fakultät der Universität Kiel.