raison avec F. *sylvatica*. Le croisement F. sylvatica ♀ × F. Sieboldii ♂ a donné quatre semis de un an.

Une méthode fut mise au point dans le but de tester la purete d'une descendance obtenue par pollinisation artificielle precoce, sans ensachage. Du pollen de hêtre pourpre fut employe pour ces tests, d'ou le nom de «méthode de contrôle au hêtre pourpre». Une ségrégation voisine de $^1/_1$ dans la descendance issue du croisement du hêtre vert avec le hêtre pourpre indique qu'il s'agit d'un cas de ségregation unifactorielle.

En 1953, 1954 et 1956 des etudes sur la pollinisation libre, faites dans un parc contenant des bouquets épars de vieux hêtres, ont montre l'efficacité de la pollinisation par le vent. On pense que la mauvaise fertilisation constatée sur quelques arbres etait due a une floraison trop precoce.

Zusammenfassung

Titel der Arbeit: Künstliche Kreuzungen in der Gattung Fagus.

Im Arboretum Hørsholm wurden Kreuzungsexperimente mit Buche nach den Richtlinien der in dieser Zeitschrift von NIELSEN und SCHAFFALITZKY (1954) veröffentlichten Arbeit fortgesetzt. Die Isoliertechnik wurde kaum verändert und war i. a. zuverlässig. Als vorteilhaft stellte sich heraus, die gewöhnlich nur geringen zur Verfügung stehlenden Mengen wertvollen Fagus-Pollens mit großen Mengen Lycopodium-Sporen zu mischen.

Weitere Selbstungsversuche bestätigten trotz einiger Ausnahmen die Tatsache, daß F. silvatica in hohem Maße selbststeril ist. Von der Kreuzung F. silvatica X *grandifolia* zog man Bastarde mit intermediären Blattmerkmalen und einer Tendenz zu überlegenem Wuchs gegenüber F. silvatica heran. Außerdem erhielt man vier einj. Sämlinge der Kreuzung F. silvatica X F. Sieboldii.

Es wurde eine Methode entwickelt, um die ,,Reinheit" einer Nachkommenschaft von sehr früh bestäubten und nicht eingetüteten Blüten festzustellen. Wegen der Verwendung von Blutbuchenpollen erhielt dieser Test den Namen „Copper Beech Control Method". Eine Aufspaltung etwa im Verhältnis 1 : 1 in der Nachkommenschaft einer Kreuzung zwischen normaler Buche und Blutbuche läßt auf einen Fall monofaktorieller Vererbung schließen.

Die ausgeprägte Wirksamkeit der Windbestäubung geht aus Studien der Jahre 1953, 1954 und 1956 an einigen verstreuten Altbuchengruppen in einem Wildpark hervor. Es wird vermutet, daß der geringe Samenansatz einiger Bäume auf die frühe Blütezeit zurückgeführt werden muß.

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Possibilities for Genetic Improvement in the Utilization Potentials of Forest Trees

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Introduction

The improvement of forest trees must be considered not only from the viewpoint of the producer, the landowner or forester, but also from the viewpoint of the consumer, the industry that uses the wood. The distinction between "forest requirements" and "use requirements" must always be recognized even where industry owns the land and grows its own timber.

Because the word "requirement" has been given some special meanings in some disciplines, a clear definition is in order here. In this paper, "requirement" is used in one of its most common meanings: "that which is needed . . . a required quality".

"Forest requirements", the characteristics and qualities of the tree that are of primary interest to the forester, can be quite clearly defined. In general, most importance will be placed upon hardiness in the region where the trees are to be grown, rapidity of growth, resistance to diseases and insects, and low cost of propagation and plantation establishment. Improvement of these characteristics will go far to reduce the investment risk and to increase the profit from the timber harvest.

"Use requirements" are the characteristics and qualities of the tree that determine its value for special uses. Many of these use requirements have not yet been defined.

The wood-using industries' rapidly increasing interest in forest tree improvement is aimed primarily at the possibilities for improving characteristics and qualities of wood that are reflected in the cost and quality of the finished products. Different wood-using industries have different use requirements. Even in the same industry, for example the paper industry, the requirements differ between individual companies; and in mills making a variety of pulp or paper grades the wood requirements depend on the particular end product.

For genetic improvement we need information on the effect that the individual characteristics of wood have on the manufacturing processes and on the finished products; and we must also have rapid methods for evaluating these characteristics in the living tree. Such methods have recently been developed for the determination of density, percentage of summerwood, and fibril angle; but more information is needed for the genetic improvement of

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wood to meet the diverse use requirements of wood-using industries.

Genetic Improvement in Use Requirements

Genetic improvement in the use requirements of timber and wood is possible because of the inherent variation in the wild population. But forest genetics is merely one of the sciences essential to the successful application of the art of silviculture; genetics cannot by itself produce high-quality timber and wood. The forest tree — the phenotype — is the product of its particular environment on its inherent potentialities, and the characteristics and properties of its wood are no exception; they are also the product of environmental effects on the inherent potentials of the individual. For quality production, it will be necessary to control the environmental factors as closely as possible through appropriate silvicultural practices. My discussion of the possibilities for improving the use requirements of forest trees is based on this thesis.

For the purposes of this broad discussion, genetic improvement procedure has been deliberately defined as "possible" because some of the indicated genetic improvement would not be advisable or practical. For example, in my opinion, in a tree with otherwise excellent timber quality, it would not be advisable to expend additional breeding work to obtain small-diameter branches or wide branch-angle. The work required to combine these two characters with others already obtained in an improved type would hardly be justified. Under intensive forest management, which is certainly essential for the growing

Table 1. — *Estimate of heritability and possible improvement procedure for characteristics apparent in tree or log*

Quality characteristics apparent in tree or log	Estimate of heritability[1])	Possible improvement procedure		
		Procedure[2])	To eliminate or reduce these tree or log defects	
			In hardwoods	In conifers
Growth rate				
Rapid height growth	+	GS	(Rapid growth may raise or lower wood quality depending on the species and use requirements.)	
Uniform height growth	—	Sg		
Rapid diameter growth	+	GS		
Uniform diameter growth	—	Sg		
Optimum stem form				
Straight, single stem	+	Gs	Sweep, crook, fork, double pith	Sweep, fork, crook, double pith
Circular, concentric growth	+	GS	Out-of-round	
Minimum taper	+	Gs		
No burls	?	R	Burls	
Optimum branching				
Minimum numbers	+	G	Number & distribution of knots	Number & distribution of knots
Maximum distance between internodes or branches	+	GS	Number & distribution of knots	Number & distribution of knots
Small diameter	+	Gs	Large knots	Large knots
Wide branch angle	+	Gs	Large knots	Large knots
Early pruning	—	S	Knots	Knots
No epicormic branches	+	GS	Knots	Knots
Free of:				
Wood rots	—	R	Dote, rot some bulges	Rot, spot rot
Stem-deforming agents	+	Gs	Crook, fork, canker	Crook, fork, canker
Stain in living trees	+	Gs	Stain	Stain
Soak in living trees	?	R	Soak	
Mineral streak and stain	?	R	Mineral streak & stain	
Insect damage	—	Sg	Holes, grub channels, pith fleck, flag worm	Insect damage
Animal damage	—	Sg	Bird peck, some scars	Some scars
Frost crack	+	G	Some seams and splits	Some splits & cracks
Dormant buds	+	G	Adventitious bud clusters	
Spiral grain	+	G	Spiral grain	Spiral grain
Loose heart	?	R	Loose heart	
Ring shake	?	R	Ring shake	Shake
Wind shake	?	R	Wind shake	Shake
Spider heart	?	R	Spider heart	
Gum spot	?	R	Gum spot	
Grease spots	?	R	Grease spots	
Pitch exudation	?	R		Pitch

[1]) + = Research or observational evidence for sufficient heritability to justify genetical improvement. — = Some evidence on heritability but not sufficient (at present) to justify genetical improvement, ? = No evidence available.

[2]) G = Genetical improvement (through selection and breeding). Gs = Genetical improvement followed by some degree of silvicultural control. GS = Genetical improvement and silvicultural control of equal importance. Sg = Silvicultural control plus genetical research to determine possibilities for genetical improvement. S = Silvicultural control. R = Exploratory researen needed. Present knowledge insufficient to suggest improvement procedure.

of highly improved trees, silvicultural control through pruning would still be necessary for highest quality production, particularly on shortened rotations. No priorities are indicated for particular characteristics because the importance of a characteristic varies with species and with the use of the wood.

In order to predict the possibilities for genetic improvement it is necessary to have some measure of the transmissibility of the characters that are to be improved. The therm heritability is generally used to indicate such an index of transmissibility, and various methods have been employed by plant and animal breeders to determine the degree of heritability. LUSH *(18)* proposed the following general formulae to express the relationship between

Table 2. — *Estimate of heritability and possible improvement procedure for characteristics not apparent in tree or log*

Physical, chemical, anatomical, and "use" characteristics affecting wood quality	Effect on quality[1]	Estimated heritability[2]	Improvement procedure[3]
Density			
High	+ —	+	GS
Low	+ —	+	GS
Uniform	+	?	Sg
Percent summerwood	+ —	—	R
Small fibril angle	+	+	G
Fiber and tracheid			
Length	+ —	+	G
Diameter	+ —	—	R
Wall thickness	+ —	—	R
Reaction wood			
Compression wood	—	—	R
Tension wood	—	+	GS
Abnormal grain (burly, wavy, interlocking)	+ —	+	G
Percent heartwood (earliness of formation)	+ —	?	R
Other anatomical characteristics (structure)	+ —	+	G
Chemical composition and properties. Percent and nature of cellulose, lignin, extractives (including resin), and ash-forming mineral components	+ —	+	GS
"Use" characteristics			
Mechanical properties. Static bending, compression parallel to grain, compression perpendicular to grain, hardness, shear parallel to grain (maximum shearing strength), cleavage, tension perpendicular to grain (maximum tensile strength), tension parallel to grain (ultimate tensile strength), toughness.	+ —	+	GS
Pulp and paper qualities	+ —	+	GS
Penetrability	+ —	+	G
Dimensional stability	+	+	GS
Durability	+	+	Gs
Machining and working qualities	+	+	GS
Nail-holding ability	+	?	R
Ease of gluing	+	?	R
Ability to hold paint	+	?	R

[1]) + = Improvement of quality. — = Impairment of quality. [2]) See footnote 1, table 1. [3]) See footnote 2, table 1

hereditary and environmental contributions to phenotypic characters:

$$\sigma_o^2 = \sigma_H^2 + \sigma_E^2 \text{ and } \frac{\sigma_H^2}{\sigma_o^2} = \frac{\sigma_H^2}{\sigma_H^2 + \sigma_E^2}$$

In these formulae σ_o^2 is the total variance, σ_H^2 is the additive genetic variance due to hereditary differences, and σ_E^2 is the variance due to the genotype-environment interaction. The formula at the right may be expressed in words as follows:

$$\text{Heritability (in percent)} = \frac{\text{Additive genetic variance due to heredity}}{\text{Total variance}} \times 100$$

A character with high heritability will show a high percentage; a low percentage will indicate that environmental factors are largely responsible for the expression of the character.

Percentage estimates of heritability are not available for the characteristics of timber and wood that are under discussion in this article. The estimates of heritability listed in the accompanying tables are based on personal evaluation of the literature and personal experience and observation during the past 33 years.

The estimated heritability of characteristics and properties related to use requirements and possible improvement procedure are presented in tables 1 and 2. Possible improvement procedures are summarized in table 3.

Improvement of Characteristics Apparent in the Tree or Log

With the exception of growth rate, the characteristics apparent in the tree or log (table 1) are based on the defects (columns 4 and 5) recognized in the tree and log grades now used in the United States.

Growth rate. — Rapid growth may raise or lower the quality of wood depending on the species and on the use requirements of the industry. Wide rings are not desirable for the manufacture of white pine match sticks and for rotary-cut Douglas-fir veneer; and in some species variable annual growth is also objectionable *(28)*. Rapid growth is desirable in many species, particularly in hickory, ash, and other ring-porous woods. A report on the relationship of growth rate to wood quality in poplar hybrids *(15)* offers the general conclusion that abnormally rapid growth will not be seriously detrimental to poplar wood-quality.

It is generally accepted that the heritability of height and diameter growth is sufficient for genetic improvement. Silvicultural control of environmental factors, such as proper selection of site and control of stand composition and density, will be essential to maintain optimum growth rates that are correlated with wood quality *(5, 29)*. There is no evidence on inheritance of uniformity of growth rate (uniform growth from year to year). At present, we can only assume that this must be regulated through proper silvicultural practice.

Optimum stem form. — The need for genetic improvement is now generally accepted. There is sufficient evidence to justify the conclusion that selection and breeding can produce inherently straight, single-stemmed trees. The heritability of circular, concentric growth and of minimum taper also warrants genetic improvement. Racial variation in form factor has been reported in *Pinus pinaster (39)*

Table 3. — *Summary of possible improvement procedure*

G - Genetical improvement	*Sg* - Silvicultural control plus research to determine possibilities for genetical improvement
Minimum number of branches	Uniform height growth
Elimination of frost cracks	Uniform diameter growth
Elimination of dormant buds	Insect damage
Elimination of spiral grain	Animal damage
Small fibril angle	Uniform density
Fiber length	
Abnormal grain	*S* - Silvicultural control
Other anatomical characteristics	Early pruning
Penetrability	
	R - Research
Gs - Genetical improvement followed by some degree of silvicultural control	Burls
Straight, single stem	Wood rots
Minimum taper	Soak in living trees
Small branch diameter	Mineral streak and stain
Wide branch angle	Loose heart
Stem-deforming agents	Ring shake
Elimination of stain in living trees	Wind shake
	Spider heart
GS - Genetical improvement and silvicultural control of equal importance	Gum spot
Rate of height growth	Grease spot
Rate of diameter growth	Pitch exudation
Circular, concentric growth	Percent summerwood
Maximum distance between internodes or branches	Fiber diameter
No epicormic branching	Fiber wall thickness
High or low density	Compression wood
Tension wood	Earliness of heartwood formation
Chemical composition and properties	Nail-holding ability
Mechanical properties	Ease of gluing
Pulp and paper qualities	Ability to hold paint
Dimensional stability	
Machining and working qualities	

and clonal variation in Monterey pine *(7)*. Silvicultural control will be required, particularly to maintain optimum and uniform spacing.

Optimum branching. — Heritability of branchiness, branch diameter, angle of branching, and tendency to produce epicormic branches, is sufficient for genetic improvement. In Monterey pine the inheritance of branch diameter and internode length has been reported from progeny tests; and clonal tests with this species have also demonstrated the inheritance of branch diameter, length and angle, length of internode, and number of whorls per annual shoot *(7, 39)*. Inherent variation in epicormic branching is indicated in yellow-poplar *(44)*. There is conclusive evidence for clonal variation in all of these optimum branching characteristics, exclusive of early pruning, in hybrid poplars (*). With the objective of short rotations, early pruning will require the application of artificial pruning or other cultural measures such as control of stand density.

Wood rots. — Information on heritability of wood rots is sketchy. There are indications of inherent variation in resistance to specific pathogens *(45)*, but much more research is needed for improvement recommendations.

Stem deforming agents. — The results of genetic research on resistance to cambial parasites, such as the white pine blister rust and bacterial canker of poplars, justify the prediction that trees can be developed to resist stem-deforming fungi and bacteria that invade the living cambium. There is evidence for the possibility of selecting ponderosa pines for resistance to the resin midge, an insect that causes distorted and twisted stems *(1)*, and for clonal variation in susceptibility of poplar hybrids to aphids that distort the leaders (*). This and other evidence on inherent variation in susceptibility of living timber trees to insect infestation *(21, 37)* justify genetic improvement for resistance to stem-deforming insects. Since such resistance to diseases and insects may not be 100 percent, particularly with improved tree types reproduced by seed, and for facultative parasites, some silvicultural roguing and culture to maintain maximum vigor will be a continuing necessity.

No sound predictions are possible on genetic improvement of resistance to stem deformation due to wind, snow, or ice. Research is required to determine (1) the range of inherent variation in susceptibility to such breakage, and (2) the variation in recovery from such damage with minimum stem deformation and without forking.

Stain in living trees. — European observations and studies on hybrid poplar clones indicate that there is sufficient clonal variation to predict genetic improvement (*). Environment may have sufficient modifying effect to require some silvicultural control, such as selection of proper site and protection against injury.

Insect damage. — There is no sound information on heritability of resistance to wood-infesting insects such as wood-borers and flag worm. Only inconclusive observational evidence is available for clonal variation among the hybrid poplars grown commercially in Europe. Since poplar-borer injury has been reported to be more severe on widely spaced poplars than in plantations with filler trees *(38,* *), silvicultural control and genetical research are indicated.

Animal damage. — There is practically no information on genetic variation in resistance to animal damage, such as bird peck and porcupine scars. Although it is known that there are differences in the palatability of individual trees to various animals, it is not known how much of this variation is due to the genotype *(11)*. Only silvicultural control can be advocated until more information on the genetic possibilities is available.

Frost crack. — It has been possible to select frost-crack-resistant poplar clones for commercial planting in northern Europe (*).

Dormant buds. — Heritability of this characteristic is apparent in the hybrid poplar plantations of Europe. They are abundant in some clones whereas other clones are relatively free of this defect (*).

(*) Asterick indicates that information is based on the author's personal observations and on verbal information received from European poplar experts.

Spiral grain. — Although there is still considerable discussion as to the relative importance of heredity and environment on the occurrence of spiral grain, its heritability is sufficient to predict practical elimination of this defect through selection and breeding *(7, 32).*

Improvement of Physical, Chemical, Anatomical and "Use" Characteristics

The characteristics listed under this heading in table 2 are overlapping and interrelated, not only in their effect on wood quality, but also in their heritability. Density, percentage of summerwood, and fibril angle are grouped together and capitalized because they provide the best criteria presently available for many important wood qualities *(22),* and because the Forest Products Laboratory has developed rapid methods for their evaluation that are particularly adaptable to the needs of genetic improvement *(23).*

Density. — There is now sufficient evidence to indicate that inherent racial and individual variation in density is sufficient to warrant genetic improvement *(31, 35, 39, 42, 46).* For *Pinus patula* and *Pinus radiata* it has been reported that there is no significiant correlation within a stand between specific gravity and diameter, that density is not influenced by rate of growth transversely within individual stems *(43).* Studies on clonal material are especially indicative of the heritability of wood density. Such studies have been made on hybrid poplars *(2, 9),* and on Monterey pine *(7).*

The over-abundance of information on the effect of environment on wood density indicates the importance of silvicultural control *(26).*

Though information on inheritance of uniform density is lacking, silvicultural control and genetics research is indicated.

Percent summerwood. — There is some evidence that percentage of summerwood is heritable *(46),* but more research is needed for improvement recommendations.

Fibril angle. — A recent publication indicates that in slash pine, fibril angle is directly correlated with tracheid length, and that tracheid length appears to be under rigid genetic control *(6).*

Fiber and tracheid dimensions. — There is considerable evidence for the heritability of fiber length *(4, 6, 32).* Although we have some information on fiber diameter and wall thickness *(4),* we need more research on the heritability of these characters.

Reaction wood. — Observations on clonal variation among hybrid poplars in Europe indicates sufficient heritability of the tendency to produce tension wood to justify genetic improvement of this character (*). Silvicultural control will also be necessary to avoid eccentric crowns and particularly leaning trees *(16).* There is indirect but still insufficient information on the inheritance of compression wood *(40).*

Abnormal grain. — There is an abundance of evidence on the heritability of abnormal grain in wood *(17, 25, 30, 32, 34).*

Other anatomical characteristics. — The anatomical structure of wood affects various use qualities such as machining, working quality, penetrability, and nail-holding quality — qualities in which variation between individual trees has been recognized. There is sufficient evidence on inheritance of anatomical characteristics to indicate good possibilities for genetical improvement *(4, 8, 9, 10).*

Chemical composition. — There is scattered information on inheritance of some of the chemical components of wood *(24, 35).* Studies on the effect of site and age on cellulose and lignin production in hybrid poplars indicate possibilities for improvement of these components through both genetical methods and silvicultural control *(12, 13, 14).*

"Use" characteristics. — This is a miscellaneous and incomplete group of properties and qualities of wood that result from various combinations of inherent characteristics subject to environmental modification. For example, in coniferous species, density, percentage of summerwood, and fibril angle are strongly correlated with mechanical strength, shrinkage, and pulp yields and properties *(22, 23).* The possibility of genetic improvement of particular use characteristics may therefore depend on the heritability of several individual anatomical, physical, and chemical characteristics. There are examples of heritable wood qualities that are unequaled for special uses. The wood of the cricket-bat willow, a hybrid clone that provides the best wood for cricket bats *(8),* is an example of high heritability. The excellent tone quality of the "Haselfichte", a special variety of spruce used in the manufacture of the Bavarian "Mittenwald" violins *(33),* may be the product of both genetic and environmental factors.

Mechanical properties. — The following quotation from Markwardt and Wilson *(19, pp. 42—43)* is probably a conservative estimate of individual variation in mechanical properties within a species:

"Probable variation of randnom tree from average for species:

"Property:	Percent
Specific gravity based on volume when green	4
Static bending:	
Fiber stress at proportional limit	9
Modulus of rupture	7
Modulus of elasticity	9
Work to maximum load	15
Impact bending:	
Fiber stress at proportional limit	8
Work to proportional limit	12
Height of drop	13
Compression parallel to grain:	
Fiber stress at proportional limit	12
Crushing strength	7
Compression perpendicular to grain:	
Fiber stress at proportional limit	14
Hardness:	
End	10
Side	9
Shearing strength parallel to grain	7
Tension perpendicular to grain	12

"The preceding tabulation presents an estimate of the probable variation of a random tree from the average for a species, for a number of physical and mechanical properties. The values are general figures derived from a number of species."

On the basis of the natural variation in mechanical properties and the heritability of the wood characteristics responsible for these properties, improvement will be possible through genetics and silviculture. For most rapid improvement we need more specific information on the relationship of individual wood characteristics to mechanical properties. The effect of growth rate is of sufficient importance to justify immediate and intensive investigation. Rapid growth in conifers is generally considered to result in lowered strength *(26, 27, 28),* but in *Pinus patula* and *P. radiata* it is reported that a large log grown relatively fast from the ninth year onwards will contain a higher percentage of strong wood than a small log of the same age grown relatively slowly from the ninth year onward *(43).*

Pulp and paper qualities. — The pulp and paper qualities of wood are affected by individual physical, chemical, and anatomical characteristics, and by combinations of these characteristics. Wood of high density, with a minimum of knots and — in some conifers — a minimum pitch content are qualities of the wood that are generally recognized as desirable. Variations in chemical composition are certainly reflected in the manufacturing processes and in the finished product. Response of the pulp to beating, the yield available within the range of commercial bleachability, and the maximum brightness attainable with any combination of commercial pulping and bleaching processes, are apparently functions of the chemical composition of the raw materials. Fiber length and the relative diameter per unit length are related to properties of the finished paper such as strength, formation, surface, and finish. The color, strength, brittleness, softness, bulk, density, opacity, absorbency, and surface of the paper, although very definitely influenced by the manufacturing processes, are in the last analysis apparently limited by inherent characteristics or qualities of the fibrous raw materials *(36).*

The variation in pulp and paper qualities between trees of the same species and the heritability of some of the characters responsible for these qualities warrant the assumption that improvement will require genetically improved types and silvicultural control *(14).*

Penetrability. — High penetrability is desired for chemical pulping but is undesirable for tight cooperage. This property of wood depends to a large extent on the presence or absence of tyloses. It has been reported that a triploid clone of the European aspen has heartwood quite free of tyloses, which are typical of the species *(41).*

Dimensional stability. — There is sufficient information on the heritability of the more important characteristics that affect shrinkage to predict improvement through genetics and silviculture.

Durability. — The superior durability of the heartwood of the shipmast clone of black locust *(Robinia pseudoacacia* L.) is proof of high heritability of this characteristic. Some degree of silvicultural control may be required to obtain a maximum percentage of heartwood.

Machining and working qualities. — Variation in these qualities between varieties and between individual trees of the same species are recognized by machine- and handworkers. In general, this variation may be due in equal measure to genetic and environmental factors. There is evidence for this conclusion from a study of the Swedish birches (25) and from observation and study of variation between the hybrid poplar clones grown commercially in Europe *(3, 10, 20, *).*

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Newsletter

A Meeting of Forest Tree Breeders

International Union of Forest Research Organisations, Section 22

In March, 1953, a meeting of members of Section 22 engaged in forest genetics and forest tree breeding was held at Hørsholm, Denmark. At this meeting problems of mutual interest were discussed and the contacts between these members of Section 22 were greatly strengthened. During the 12th Congress of I.U.F.R.O. at Oxford in 1956, a further meeting of the same kind was suggested and this was held in Britain from 23rd to 26th July, 1957. The headquarters of the meeting was the Forestry Commission's Research Station, Alice Holt Lodge, near Farnham, Surrey.

Twenty-two delegates attended the meeting, namely, K. HOLZER *(Austria)*, P. GATHY, A. DE JAMBLINNE and C. M. LARSEN *(Belgium)*, M. J. HOLST *(Canada)*, W. LANGNER *(Germany)*, R. MORANDINI *(Italy)*, M. VIDAKOVIĆ *(Jugoslavia)*, G. HELLINGA and E. C. JANSEN *(Netherlands)*, T. RUDEN *(Norway)*, E. ANDERSSON *(Sweden)*, T. E. BESKOK *(Turkey)*, M. V. EDWARDS, R. FAULKNER, K. A. LONGMAN, J. D. MATTHEWS, A. F. MITCHELL, T. R. PEACE, R. F. WOOD and P. F. WAREING *(United Kingdom)* and A. S. JABLOKOV *(USSR)*. The Chairman was Dr. C. S. LARSEN *(Denmark)*, Leader of Section 22.

Mr. J. MACDONALD, President of I.U.F.R.O. welcomed the delegates and opened the meeting. During the succeeding four days the delegates discussed the international exchange of tree breeding material, the terminology of forest genetics and forest tree breeding, inter- and intra-specific hybridization, breeding for timber quality an the physiology of flowering in forest trees.

The excursions included visits to classified seed sources and selected (plus) trees of various species in the New Forest, Hampshire, and to the nurseries, progeny trial ground and National Populetum at Alice Holt. Various aspects of progeny testing and seed orchard work were seen and Mr. D. T. SEAL of the Forestry Commission demonstrated his tree climbing and cone collection equipment, consisting of light ladders, nylon safety lines and rope scrambling nets, which are used for seed collection and pollination work on standing trees.

During the meeting Dr. HELLINGA distributed copies of the Articles of Association *Eucarpia*. The European Association for Research on Plant Breeding which was founded in July, 1956, at Wageningen, Netherlands, to promote scientific and technical co-operation in the field of plant breeding.

In closing the meeting the Section Leader thanked the Forestry Commission for having acted as hosts and thanked the delegates for having contributed so fully to the meeting. He referred to the possibilities of having a similar meeting in 1961 after the 13th Congress of I.U.F.R.O.

J. D. MATTHEWS
A. F. MITCHELL

Buchbesprechungen

Variation in tracheid length and wood density in geographic races of Scotch pine. By M. ROBERT ECHOLS. Bull. No. 64, Yale University, School of Forestry, New Haven, Conn. 1958. 52 pp., 7 tab., 15 figs., 7 pl. Price $ 1.50.

Scotch pine *(Pinus sylvestris* L.), also known as Baltic redwood and yellow deal, exhibits many differences in growth forms, which have come to be associated with geographic locations or provenances in Europe. Past investigations have shown that the more northern races make less annual growth and are more resistant to snow and ice damage and low temperatures than southern races. Also the northern races have straighter stems, shorter branches, shorter needles, and variable winter coloring.

For this study of variation in tracheid length and wood density in geographic races of Scotch pine, wood samples were obtained from 17-year-old trees representing fifteen European provenances. The trees were located on the Fox State Forest, Hillsboro, New Hampshire, where they were planted as a part of an international seed source study. The provenances selected ranged in latitude from 46 deg. N. (Italy) to 69 deg. N. (Norway), and the tree heights ranged from 25 feet down to less than 10 feet.

Wood samples were obtained in duplicate from fifteen trees in each plot with a large (11-mm.) increment borer. Field data on tree height, d. b. h., and bark thickness were recorded. One increment core from each pair was macerated, and the tracheids were stained and mounted on slides; the other core provided wood density measurements.

A very highly significant variation was found in tracheid lengths and also in wood density in the Scotch pine races. Significant groups were established with a multiple range analysis, and these were plotted on a base map.

A close association with the latitude of the provenance was found for tracheid length, tree height, bark thickness, d. b. h., and wood density. A very highly significant linear relationship was established for the following: wood density and d. b. h., d. b. h. and tree height, width of growth ring and tracheid length, wood density and tracheid length, and tree height and tracheid length. The correlation between wood density and width of growth ring was significant at the 2.5% level.

The most pronounced differences in the New Hampshire site and the provenances studied appear in *temperature* and *day length*. It is suggested that the trees from provenances having greater day-length in the summer are genetically adapted to the longer periods of light, and are prevented from making more rapid growth by the longer dark periods in the more southern latitude. (Autorreferat)

Experimental Designs. By W. G. COCHRAN and G. M. COX. 2nd edit. John Wiley, New York, 1957. 617 pp. 10.25 $.

Dieses "working manual for research workers and students in all branches of science" wird jetzt — sechs Jahre nach Erscheinen der ersten Auflage — zum zweitenmal herausgebracht. Es ist wohl das am meisten verbreitete Werk seiner Art und in vielen Institutsbibliotheken zu finden. Referent kann sich deshalb darauf beschränken, auf die wesentlichsten Neufassungen und Erweiterungen gegenüber der ersten Ausgabe hinzuweisen, die teils durch neuere Arbeiten erforderlich geworden waren, teils aus Gründen der Vollständigkeit in die Neuauflage übernommen wurden.

In *Kapitel 4* wurde ein Abschnitt über Versuchspläne angefügt, die Restvarianzschätzungen in Behandlungsfolgen erlauben. *Kapitel 6* wurde durch ein weiteres über faktorielle Versuche in fraktionierter Wiederholung ergänzt. Ebenso ist *Kapitel 8 A* gänzlich neu: Es behandelt die Analyse faktorieller Versuche mittels polynomialer Regressionen. Die Kapitel über Pläne mit unvollständigen Blocks wurden ebenfalls beträchtlich erweitert; so sind in *Kapitel 11* die teilweise balancierten Pläne mit unvollständigen Blocks sowie die Kettenblockpläne ("Chain-blocks") neu aufgenommen. Bei den unvollständigen lateinischen Quadraten *(Kap. 13)* sind jetzt auch teilweise balancierte Anlagen angegeben.

Wahrscheinlich werden die Erweiterungen im letztgenannten Teil für Zwecke der Forstgenetik am wertvollsten sein. Ein Blick auf die Tabellen zur Wahl des geeigneten Plans zeigt, daß jetzt für alle praktisch vorkommenden Prüfglied- und Wiederholungszahlen Pläne zu finden sind. Die Anschaffung der II. Auflage kann deshalb auch überall dort empfohlen werden, wo das Buch