kennen. Abbildung 10c, die gleichzeitig einen Blick auf eine drehwuchsige Mutterbuche und eine etwa 20jährige Buche ihrer Nachkommenschaft gewährt, läßt diese Ähnlichkeit besonders deutlich hervortreten.

Bei Buchen und vielleicht auch bei Eichen scheinen Zusammenhänge zwischen der Drehwüchsigkeit des Stammholzes einerseits und der vielfach gedrehten und gewundenen Zweig- und Astbildung andererseits zu bestehen. Es scheint auch, als ob die Drehungen und Windungen schon sehr frühzeitig und lange vor dem Sichtbarwerden des Drehwuchses am Stamm in Erscheinung treten, so daß dieses Merkmal vielleicht zur Frühdiagnose der Drehwüchsigkeit benutzt werden kann. Zusammen mit der immer wiederholten Feststellung, daß der Drehwuchs bei gleichen Standorts- und Bestandesverhältnissen sehr häufig gruppen- und horstweise (Abb. 2), oft scharf getrennt nach ausschließlich rechts bzw. links gedrehten Stämmen, auftritt, können diese Beobachtungen vielleicht als Hinweis auf die Erblichkeit des Drehwuchses gelten.

zusammenfassung

Da experimentelle Nachkommenschaftsprüfungen bei den Holzgewächsen sehr lange Zeit in Anspruch nehmen, die Kenntnis der Erbanlagen aber die Grundlage jeder züchterischen Arbeit bildet, wird versucht, Erblichkeitsprüfungen in der freien Natur vorzunehmen. Untersuchungsobjekte sind Eichen- und Buchenbestände im Lehrforstamt Bramwald der Forstlichen Fakultät Hann. Münden, nach Möglichkeit solche mit Naturverjüngung, welche die Einbeziehung wenigstens einer Tochtergeneration gestatten. Die Ergebnisse einiger Untersuchungen, die Hinweise auf die Erblichkeit des Früh- und Spätaustreibens, der Zweig-, Ast- und Kronenbildung und des Drehwuchses liefern, werden mitgeteilt.

Summary

Title of the paper: *Obtaining indications about individual inheritance in oak and beech.* — Experimental progeny tests in forest trees take up much time but a knowledge of inherent potentialities is the basis of all breeding work. An attempt has therefore been made to shorten the process by obtaining information from careful observations in the forest. The studies described are being made in parts of the „*Lehrforstamt* Bramwald" of the „Forstliche Fakultät in Hann. Münden". In this forest there are stands of oak and beech in which natural regeneration is practised thus allowing the study of at least one generation from the seed parents. The results of some studies giving indications of the heredity of late and early flushing, of the formation of branches of the crown and of spiral grain will be described.

Literatur

v. Arnswaldt, H.-J.: Die wipfelschäftige Buche. Allg. Forstzeitschrift 5, 265 (1950). — Burger, H.: Einfluß der Herkunft des Samens auf die Eigenschaften forstlicher Holzgewächse. VI. Mitt.: Die Buche. Mitt. Schweiz. Anst. Forstl. Versuchswesen 25, 287—326 (1948). — Burger, H.: Einfluß der Herkunft des Samens auf die Eigenschaften der forstlichen Holzgewächse. VII. Mitt.: Die Eiche. Mitt. Schweiz. Anst. Forstl. Versuchswesen 26, 59 (1949). — Cieslar, A.: Untersuchungen über die wirtschaftliche Bedeutung der Herkunft des Saatgutes der Stieleiche. Centralblatt ges. Forstw. 49, 97—149 (1923). — Dengler, A.: Waldbau auf ökologischer Grundlage. 3. Aufl. Berlin 1944. — Dobzhansky, Th.: Die genetischen Grundlagen der Artbildung. Jena 1939. — Fabricius, L.: Erkennung von Auslesestämmchen in Buchenjungwüchsen. Forstw. Cbl. 1929, 14. — Hauch, L. A.: Buchen- und Eichenkulturen in Bregentvedl Danmark. Centralbl. ges. Forstw. 39, H. 4 (1913). — Hauch, L. A.: Erblichkeit der Buche und Eiche. Centralbl. ges. Forstw. 35, 322—348 (1909). — Hauch, L. A.: Provenienzforsög med Eg. Det. forstl. Forsögsvaes. i Danmark. 4, 295—318 (1914), 5, 195—224 (1916—1921), 9, 1—30 (1925—1928). — Huber, B.: Untersuchungen über das Knospentreiben der Buche und einiger anderer Gehölze. Mitt. dtsch. dendrol. Ges. 51 (1931). — Johnsson, H.: Einige Fragestellungen der forstlichen Nachkommenschaftsprüfung. Z. Forstgenetik 2, 2—3 (1952). — Krahl-Urban, J.: Erbanlagen und Züchtungsmöglichkeiten bei Rotbuche, Stiel- und Traubeneiche. Z. Forstgenetik 1, 114—120 (1952). — Kurth, A.: Untersuchungen über Aufbau und Qualität von Buchendickungen. Zürich 1946. — Münch, E.: Beiträge zur Forstpflanzenzüchtung. München 1949. — Oppermann, A.: Renkbuchen im nordöstlichen Seeland. Mitt. dänisch. Versuchswesen 1908. Centralbl. ges. Forstw. 1909, 108. — Oppermann, A.: Baumformen und Rassen der Eiche. Det forstl. Forsögsvaes. i Danmark 12 (1932). — Rempe, H.: Untersuchungen über die Verbreitung des Blütenstaubes durch Luftströmungen. Planta 27, H. 1 (1936). — Rodenwaldt, A.: Die spättreibende Buche. Forstw. Cbl. 68, 151 (1949). — Rohmeder, E.: Beobachtungen über früh- und spättreibende Buchen. Forstw. Cbl. 1934, 517. — Schädelin, W.: Die Durchforstung als Auslese- und Veredelungsbetrieb höchster Wertleistung. Bonn-Leipzig. 1. Aufl. 1934, 2. Aufl. 1935. — Syrach Larsen, C.: Estimation of the genotyp in Porest trees. Medelelse Nr. 20 fra Skovtraeforaedlingen. Arboretet Hörsholm. 1947.

Berichte

(From Forestry Commission Research Station, Alice Holt Lodge, Farnham, Surrey, England)

Forest Tree Breeding in Britain

By J. D. Matthews

(Eingegangen am 19. 1 1953)

Dui-ing his recent address to the Society of Foresters of Great Britain Professor H. M. Steven drew attention to the favourable conditions for the application of genetics to Forestry in Britain (Steven 1952). The type of forestry piactised with the gi-eat variety of species employed and the emphasis on the afforestation of bare land gives full scope for the use of results. The science of genetics is very active in this country, interest in breeding strains is widespread and talented gardeners are available to develop the necessary techniques. There is also a particularly rich collection of tree species of diverse origins and strains available for the tree breeder.

The origins *of* the present *growing* stock

Thn natural woodlands of Britain were never rich in species and the importation of exotic trees has been in progress for several centuries. The more important native species include Scots pine *Pinus* silvestris L., ash *Fraxinus* excelsior L., beech F'agus silvatica L., oak Quercus pedunculata Ehrh. (syn. Q. robur L.) and Q. *sessiliflora* Salis. (syn. Q. petraea Lieb.), birch *Betula verrucosa* Ehrh. (syn. B. pendula Roth.) and B. pubescens Ehrh. Important early introductions include sycainore Acer *pseudo-platanus* L. which is now very widespread and sweet chestnut Castanea *sativa* Mill., which is common in the south of

England. Recently ANDERSON (1950) has suggested that the pedunculate oak (*Q. pedunculata* EHRH.) may also be an early introduction.

The first important conifer to be introduced was probably the Norway spruce *Picea abies* LINK. European larch *Larix europaea* D. C. (syn. *L. decidua* MILL.) was cultivated in England before 1629 but was not widely used. This species became extremely popular in Scotland after its introduction into the Dunkeld district of Perthshire, the generally accepted date being 1728.

During the eighteenth and nineteenth centuries Scots pine, Norway spruce and European larch were the principal species used to form plantations in Britain. In the present century and especially since the formation of the Forestry Commission in 1919 the Western North American conifers have been widely used. The species concerned are Sitka spruce *Picea sitchensis* CARR., Douglas fir *Pseudotsuga douglasii* CARR. *(syn. P. taxifolia* BRITT.), *Pinus contorta* DOUGLAS ex LOUDON, *Chamaecyparis Lawsoniana* PARL., *Tsuga heterophylla* SARG., *Thuja plicata* D. DON., *Abies procera* REHDER and *Abies grandis* LINDL. MACDONALD (1952) records that these nineteenth century introductions now account for twenty-three per cent of all coniferous plantations in Britain and Sitka spruce now covers a larger area than any other conifer except Scots pine.

Landscape gardening has been a strong force in moulding the British countryside. The gardens and parks of our country houses have been filled with a profusion of exotic species of flowers, shrubs and trees. Tree species from all parts of the world have been intimately mixed together in these collections and the breakdown of the geographical barriers normally separating the species has been so complete that several new hybrids have arisen spontaneously. The Dunkeld hybrid larch × *Larix eurolepis* A. HENRY is well known but another spontaneous hybrid of possible forest value is ×*Cupressocyparis leylandii* DALLIMORE. The last named hybrid arose first in 1888 when *Cupressus macrocarpa* HARTWEG was the female parent and *Chamaecyparis nootkatensis* SPACH. the pollen parent. The reciprocal cross also occurred spontaneously in 1911. The tree has been described by DALLIMORE (1926). It is moderately easy to propagate from cuttings (MATTHEWS 1952) and is being raised from cuttings on a commercial scale in the north of England.

A third example of spontaneous hybridisation arose at Westonbirt Arboretum Gloucestershire where some two hundred tree species and many more shrubs have been gathered together by successive owners (JACKSON 1927). × *Pinus holfordiana* A. B. JACKSON is a cross between *Pinus griffithii* M'CLELLAND and *P. ayacahuite* EHRENBURG. It was first planted at Westonbirt in 1906 and has been described by JACKSON (1933). This hybrid is vigorous and possesses a good habit of growth.

The development of provenance research

During the early days of the use of European larch and Douglas fir the first plantings were often used as seed sources and distinct strains soon developed (LARSEN 1951). SCHOTTE (1917), OPPERMANN (1923) and LARSEN (1937) have all drawn attention to the development of a "Scottish strain" of European larch which has been widely distributed and has produced some very fine plantations. More recently ROBAK (1946) has made a fresh study of the history of the Scottish larch and has stressed the heterogeneous nature of the strain — a view which is shared with ANDERSON (1932) and LARSEN (1937).

As the demands for seed and plants increased fresh importations of all species were made. The occurrence of failures, especially in European larch, led to an appreciation of the importance of seed origin. The first recorded trial of origins of larch compared Scottish, Tyrolese and Sudeten origins. It was planted at Stonecroft Northumberland in 1906 (ROSS 1914).

The first provenance trial planted by the Forestry Commission was laid down in 1926 at Drummond Hill Perthshire to compare various origins of European, Japanese and hybrid larch. Since that time several large trials of European larch have been established. The results indicate that the high elevation alpine larch does badly on all but the best sites and that larch of Scottish origin is usually the best. Sudeten larch is distinctive in appearance and is often as good as the Scottish larch in vigour of growth.

The work of CIESLAR and ENGLER led SOMERVILLE (1911) to establish a provenance trial of Scots pine at Brodie Castle, Morayshire. SOMERVILLE used seed of several continental origins sent by Dr. ENGLER in 1907 for comparison with local Scottish origins. Another early experimenter with Scots pine was Fraser STORY (1910). Unfortunately both of these older trials have lapsed but the Forestry Commission now have good provenance collections in England, Wales and Scotland. One of the best series is at Croxton Park Thetford where twenty-two origins are compared (WOOD 1950). The most vigorous height growth was found in the strains originating between 48 degrees and 52 degrees north latitude but better stem form was found among the Scandinavian and Scottish origins. The local "East England" strain to a large extent combined the properties of vigour and good form (WOOD and PINCHIN 1951).

The first provenance trials of oak date from 1927 and there are now several good trials of this species in England. Beech is also quite well represented in the southern trials. Although some are over twenty years old the oak and beech trials are only just beginning to show clear differences. One Dutch and two English origins of beech are showing promise.

Of other trials those of *Pinus contorta* are now demonstrating the superiority of the better coastal origins of this species. Douglas fir, Sitka spruce, *Pinus ponderosa* DAWSON ex LAWSON and *Pinus pinaster* AITON are represented in less extensive collections. When all are considered together these provenance trials form a very valuable source of material for tree breeding work.

The origins of tree breeding in Britain

The first British forester to explore the possibilities of tree breeding was AUGUSTINE HENRY. During the period 1910 to 1913 he experimented in the production of new trees by hybridisation in the hope of obtaining fast growing kinds that would produce timber rapidly (HENRY 1910, 1920).

HENRY's interest had been aroused during the collection of information for *"Trees of Great Britain and Ireland"* completed in 1913. This valuable work, written in collaboration with H. J. ELWES, is one of the principal sources of information about the location of outstanding trees of exotic and indigenous species in Britain. In 1919 HENRY collaborated with MARGARET FLOOD in recording the history of the Dunkeld Hybrid larch and of the London plane × *Platanus acerifolia* (HENRY and FLOOD 1919a, 1919b). By 1920 he had sufficient confidence in the future of tree breeding to recommend the formation of an international station in a region with a favourable climate.

H. J. ELWES also had a strong interest in the possibilities of utilising hybrid vigour in forestry. About the year 1900 he suggested to Mr. KEIR the gardener at Dunkeld that seed should be collected from a Japanese larch, *Larix leptolepis* MURRAY, growing close to two European larches (ELWES and HENRY 1907) and "about three hundred yards east of Dunkeld House" (CHITTENDEN 1931). Seedlings of the Dunkeld hybrid larch were said to have appeared among the progeny.

ELWES also recommended, in his postscript to *"Trees of Great Britain and Ireland"*, that as a general practise seed

of most species should be collected "from known healthy parents growing in the same or similar locality to that where they are to be planted and rejecting in the nursery all but the most vigorous". MACDONALD (1930) presented a review of existing work on forest genetics in Europe and America and recommended that seed should be collected from the best plantations of native and exotic species in this country. He further suggested that some limit should be placed on the distribution of seed and that local seed and plant requirements should be met, as far as was possible, from good sources in the same locality.

In 1946 the Forestry Commission invited their Research Advisory Committee to report "on the potentialities of research into forest tree genetics and its application to British forestry" and in 1948 a section specializing in tree breeding was formed at the *Alice Holt Research Station* in Surrey.

The aim of the Genetics section is to develop strains showing increased vigour of growth, improved stem form, better adaptation to adverse conditions such as drought, frost and exposure to wind, increased resistance to diseases and insect pests and improved timber quality. The programme of work is based upon the Advisory Committee's recommendations and includes:

1. A survey of the existing woodlands to locate the best possible seed sources and to select individual trees of outstanding merit *(plus trees)* for use in future breeding work.
2. The development of improved methods of vegetative propagation; the study of the biology of flowering and fruit formation; the trial of methods of stimulating flowering and tests of methods of controlled pollination.
3. The testing of selected "*plus*" trees by means of clonal trials of the genotype and progeny trials.
4. The formation of seed orchards for the production of improved strains of pine, spruce, oak and beech (by the "*strainbuilding*" method of JOHNSSON [1951]).
5. Inter-specific and intra-specific hybridisation between selected individuals with the objects of obtaining heterosis.
6. The development of resistance breeding and of inbreeding.
7. The use of naturally occurring and artificially induced polyploid forms and of *X*-radiation to produce new and improved varieties.

Some progress has been made in the first four stages of the programme particular attention being paid to beech, European, Japanese and hybrid larch, Scots pine and Sitka spruce. Comparatively little controlled pollination work has yet been attempted.

The survey of seed stands

The existing woodlands of all the species of economic importance are being classified for seed collection purposes. The categories are:

A or PLUS. Woodlands of outstanding vigour and form of growth which are suitable for use as regular seed sources on an intensive scale. The standard set is high and these woodlands are being reserved and treated so as to increase the seed production (see Figure 1).

B or NORMAL. Woodlands of good vigour and form of growth which are suitable for seed collection purposes.

C or MINUS. Woodlands unsuitable for seed collection purposes.

The process of classification involves a description of the site and a detailed assessment of the tree crop. Climate, geology and soil, the vegetation type and the situation of the plantation are described and an assessment of site quality is attempted. Rate of growth and the incidence of disease and insect attack are next considered. Then the tree crop is assessed using an ocular scoring method similar to that proposed by SUCECKI (1946) for

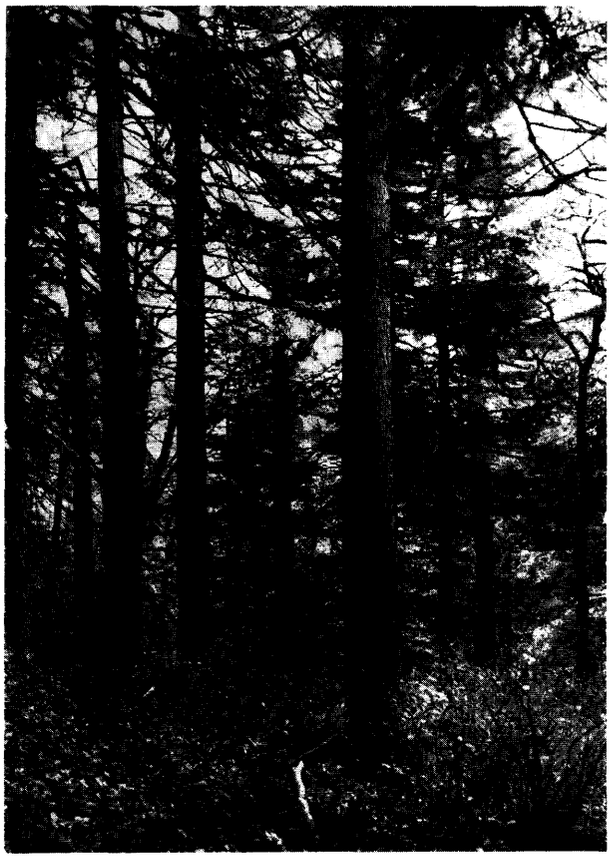

Fig. 1. The Survey of Seed Stands. A plus stand of European larch, Ballindalloch Estate Banffshire, Scotland. Planted about 1766. Mean height 110 feet (33 metres), mean girth 6 feet 8 inches (mean diameter 64 centimetres). — *Courtesy of Forestry Commission.*

Scots pine in Poland and to that in use in Holland at present (JANSEN and VAN BROEKHUIZEN 1952).

The register of seed stands now contains over 500 classified entries and about 150 woodlands are being assessed each year. The register for Corsican pine *Pinus laricio* var. *corsicana* LOUD. (syn. *P. nigra* var. *poiretiana* SCHNEIDER) is complete and that for beech is approaching completion.

A number of plus stands of Scots pine have been converted into seed stands by the removal of all but the best phenotypes. Seed has been collected from each of these plus stands with the object of establishing trials of the progeny on a number of differing sites. The plus stands yielding progeny which are vigorous and well formed will be registered as ELITE seed stands.

The Selection of Plus trees

The process of selecting plus trees follows the lines described by ANDERSSON (1948) and LÜCKE (1952) but there are variations in detail for each species. Greatest emphasis is placed upon vigour of growth in height and girth, perfect straightness of stem, small size of branching, complete freedom from disease and insect attack and ability to bear seed (see Figure 2). The trees are selected, marked, numbered and recorded during the survey of seed stands. Scion material is collected for grafting (or for the rooting of cuttings in the case of plus trees of *Sequoia, Thuja, Chamaecyparis* and *Tsuga*) and seed is collected for trials of the progeny derived from free pollination. The seed is sown in permanent seed beds at Alice Holt using at least five replications of plots containing 300 to 500 sound seed each.

The field trials are divided into short term or intensive trials and long term or extensive trials. The short term

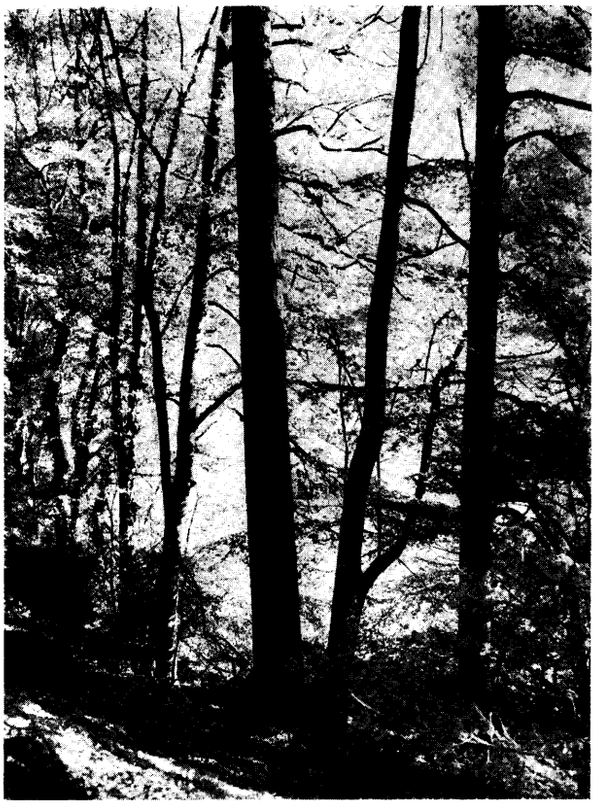

Fig. 2. The selection of plus trees. A plus tree of European larch, Dunkeld House Estate, Perthshire, Scotland. Planted about 1750. Height 135 feet (41 metres), girth 10 feet (diameter 97 centimetres). — *Courtesy of Forestry Commission.*

trials are used for the first investigation of a large number of progeny and thirty-six plant plots are employed with many replications. A "balanced incomplete block" design has been used for a trial of this type involving the progenies of twenty Sitka spruce parents.

The long term trials are designed to give final yield figures and fewer parent trees are involved. The plots are larger than in the short term trials and at least five replications are employed. Randomised block designs are proposed for these trials.

The bulk of future progeny trials will be based upon controlled crosses between selected parents so that the maximum benefit can be derived from the large effort required to lay out and maintain these trials.

Vegetative propagation

The history of the vegetative propagation of coniferous and broadleaved tree species in Britain is surprisingly long. The Report of the Conifer Conference of 1892 (ANON. 1892) contains several references to the use of grafting and the rooting of cuttings to overcome the shortage of seed of exotic tree species during the early nineteenth century. LARSEN (1937) has also drawn attention to a number of old examples of grafting in our arboreta and botanical gardens. The work of STEWART (1932) and KEMP (1948) at the Royal Botanic Gardens, Edinburgh has added much to our knowledge. GARNER (1944, 1947) and SHEAT (1948) have both produced valuable works of reference on grafting and the rooting of cuttings.

Propagation by Grafting

The propagation of plus trees is conducted in three stages. Firstly there is the initial "*fixing*" of the plus trees. The scion material is often poor and a small number of grafts are attempted under the best possible conditions. The bulk of this work is concentrated at Grizedale in the English Lake District (see Figure 3).

The successful grafts are planted in lines or small groups in a central collection. This "*tree bank*" is used as the source of scion material for the second stage of propagation in which clones are produced by outdoor grafting for trials of the genotype and for experimental seed orchards. Finally clones of the tested elite parents will be mass produced in the open nursery and used for the establishment of the final seed orchards.

Experimental grafting is done at Grizedale both under glass and in the nursery, the objects of all experiments being to develop suitable methods for outdoor grafting. The subject of the first experimental study was Corsican pine. The employment of sturdy rather short one year wood coupled with the drastic reduction of foliage to a small rosette of needle bundles around the leading bud and the use of a very long veneer cut on stock and scion, gave the best results with this species (see Figures 4 and 5). The rootstocks were one plus one transplants of Scots pine, Corsican pine, *Pinus contorta* and *Pinus montana*. The first named species appears to be the most suitable. Corsican pine rootstocks are rather more difficult to handle in the nursery and in pots.

Most grafting of all species has so far been done during the months of January, February and March under glass and during March, April and May in the open. More attention is to be paid to autumn grafting especially for the pines.

Species which have been successfully grafted in the open nursery include European and Japanese larch using the veneer side graft and Douglas fir using the rind graft. Some success has been obtained with beech using the whip and tongue graft and three to four year old scion wood (MATTHEWS 1952). Sitka spruce has proved a difficult subject and will be the subject of grafting experiments during the coming spring.

Propagation by Dormant and Summer Wood Cuttings

The advantages of the use of cuttings in trials of the genotype are obvious and it may be that eventually clonal rootstocks can be developed for seed orchards. The advances made by the fruit orchard specialists at the East Malling Research Station, Kent suggest that the selection

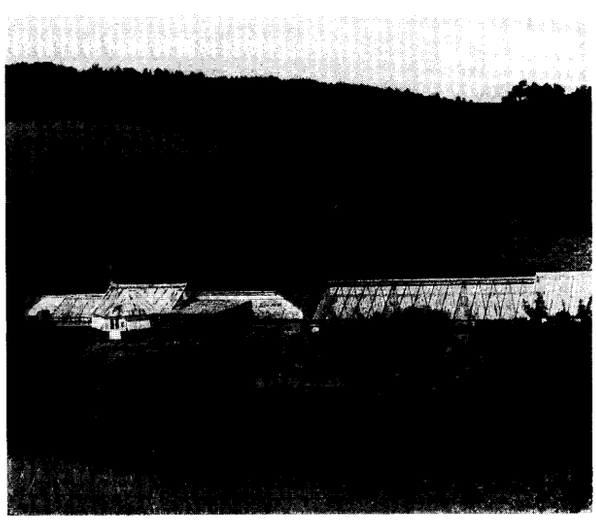

Fig. 3. Propagation by grafting. The Grizedale Propagation Centre, English Lake District. A general view showing glasshouses, shaded plunge beds for hardening off grafts and cuttings and walled garden used for outdoor grafting. — *Courtesy of Forestry Commission.*

Fig. 4. Experimental grafting of Corsican pine, Grizedale English Lake District. The veneer side graft; note the long veneer cut on stock and scion and reduction of the foliage of the scion. — *Courtesy of Forestry Commission.*

Fig. 5. Experimental grafting of Corsican pine, Grizedale Lancashire. The veneer side graft. A successful union. Grafted 25. 2. 52, photographed 5. 7. 1952. — *Courtesy of Forestry Commission.*

of rootstocks will be of profitable line of work in tree breeding.

Considerable attention has been paid to the best propagation conditions for the large scale rooting of cuttings from plus trees. At Alice Holt four types of propagation frame are under test, the use of electrical heating of the growth media is being studied, a number of different rooting media are being compared and methods of applying the growth promoting substances have been tested.

(a) Type of propagation frame: A commercial span-roofed frame nine feet wide and known as the "*Twin light*" has proved suitable for the propagation of *Sequoia sempervirens* and is a good design. Recently a new type of frame incorporating sub-irrigation has been tried. The water is carried to the rooting medium by means of a glass wool wick supported by a metal grid. The method as first developed by MULLARD (1951) employed Vermiculite as the growth medium but other media are being tested at Alice Holt.

(b) Electrical soil warming: In 1950 the first experiments were made with the General Electric Company's system of electrical soil warming (BROWN 1947). This is a low tension bare wire system and working temperatures of up to 70° FAHRENHEIT can be maintained in propagation frames when a loading of seven to nine watts per square foot (seventy five to ninety watts per square metre) of frame is employed. The system includes thermostatic control and has proved reliable and easy to operate. The speed of rooting of ×*Cupressocyparis leylandii* and *Sequoia sempervirens* has been increased when heat is used. A new pair of frames has been built to continue the comparisons of heated and unheated media and trials with cuttings of more difficult species are to be continued.

(c) The propagation medium: O'ROURKE and MAXON (1948) and PRIDHAM (1948) have reported the successful use of Vermiculite as a rooting medium. Exfoliated Vermiculite is a micaceous mineral expanded by heating and a preliminary trial with × *Cupressocyparis leylandii* at Alice Holt resulted in an improvement over quartz sand in the number of cuttings rooted (MATTHEWS 1952). More extensive trials involving quartz sand, pumice, sorbex peat and vermiculite, singly and in various mixtures, have been made using an eighty year old tree of *Sequoia sempervirens* as the source of cuttings. The results in an unheated propagating frame have been striking as Table 1 shows:

Table 1. *Sequoia sempervirens*

Number of Cuttings Rooted in Various Propagation Media (Summerwood cuttings inserted 21. 6. 51; final assessment 24. 11. 52)

Propagating Medium	Average Number of Cuttings Rooted		
	(Maximum 8)	Transformed figures*)	
Quartz sand	1,5	25,7	
75% sand 25% peat	4,6	49,1	
75% sand 25% Vermiculite	5,0	52 6	
50% sand 50% peat	6,0	60,3	
50% sand 50% Vermiculite	5,6	57,0	
Sorbex peat	6,3	62,9	±5,46
75% peat 25% Vermiculite	6,6	65,4	
50% peat 50% Vermiculite	6,4	63,5	
Grade C Vermiculite	6,4	63,8	
25% Pumice 75% Vermiculite	6,6	65,2	
50% Pumice 50% Vermiculite	5,1	53,1	
Pumice	3,0	38,1	
Differences for 5% significance	—	15,4	
Differences for 1% significance	—	20,6	

*) The data were transformed, before analysis, by use of BLISS' angular transformation.

Sand and pumice used alone give very significantly smaller numbers of rooted cuttings than most of the other media. There were no significant differences bet-

ween the numbers of cuttings rooting in the other media, but it is notable that peat, vermiculite, and mixtures of peat and vermiculite all gave better results than mixtures in which sand was used. The mixture of 75% vermiculite with 25% pumice also gave a large number of rooted cuttings.

(d) The use of growth substances: The concentrated dip method of applying indole butyric acid recommended by GARNER (1944) has been thoroughly tested. The concentration of one milligram of the growth substance per one cc. of 50 per cent alcohol has increased the speed of rooting and the number of roots developed by cuttings of ×*Cupressocyparis leylandii*, ×*Larix eurolepis*, European larch, *Metasequoia glyptostroboides* and Sitka spruce.

The importance of the previous history of the material used as cuttings has been well demonstrated by many authors and this aspect of propagation has not been neglected. Coppice shoots from the base of a tree of *Sequoia sempervirens* have rooted more readily than shoots from the lower middle and upper parts of the crown. Cuttings from one of ten trees of *Sequoia sempervirens* of similar age and growing on the same site began to root sixty days after insertion in contrast to the usual period of two to three hundred days for this species. A decrease in rooting capacity with increase in age of the parent tree has been found in *Sequoia sempervirens*, × *Larix eurolepis*, Sitka spruce and *Pinus radiata*.

The Study of the Biology of Flower and Fruit Production

The shortage of seed of Corsican pine led to an intensive study of the flowering and fruit production of this useful tree. This Mediterranean species is being used well north of its natural range in Britain and cone production has been unreliable. The youth of the bulk of our plantations, the comparatively cool moist conditions during the summer months in Britain and the relatively close conditions of stocking maintained for the production of clean timber have all contributed to the shortage of seed. Strangulation and girdling of the stems of twenty year old trees has been successfully used by HOLMES and MATTHEWS (1951) to increase cone production. Other experiments in progress involve the application of inorganic nutrients to the forest floor in combination with partial stem girdling.

The unusually warm dry and sunny summers of 1947 and 1949 were followed in 1949 and 1951 by an abundance of Corsican pine seed and the distribution of the crop was mapped in both years. Seed collection areas have been demarcated in the best plantations of eastern and south-eastern England and heavy thinnings are being employed to release the crowns of the seed trees and stimulate flowering and cone production.

Observations of the flowering and fruit production of all our economic species are to be made in the future. It has become apparent that damage by spring frosts to the flowers has much to do with the scarcity of European larch seed in Britain. Beech normally produces mast at long intervals but the warm dry summers of 1947 and 1949 were both followed by good beech masts in 1948 and 1950 (BROWN 1952).

Summary

The favourable conditions existing for the application of genetics to forestry in Britain are stressed, and the diverse nature of the growing stock is described. A brief historical survey of the development of provenance and genetics research ends with an outline of the programme of work of the Forestry Commission's Genetics Section.

A survey of woodlands of all the economic species is in progress with the objects of locating plus seed sources and plus trees. The propagation and testing of *plus* trees is described.

Propagation by cuttings is dealt with in some detail and various types of propagation frames, the electrical soil warming equipment and the use of growth substances are discussed.

The advantages of Vermiculite as a propagating medium for rooting cuttings is demonstrated. Finally some information is presented about the correlation of dry warm summers with good seed crops of Corsican pine and beech in Britain.

Zusammenfassung

Titel der Arbeit: *Forstpflanzenzüchtung in Großbritannien.* Die Forstwirtschaft Großbritanniens bietet günstige Ansatzpunkte für genetische Arbeiten. Die unterschiedlichen Verhältnisse bei den heute in England vorkommenden Holzarten werden angedeutet. — Nach einem kurzen geschichtlichen Überblick über die Entwicklung der Provenienzforschung und über einschlägige genetische Arbeiten wird das Arbeitsprogramm der *„Sektion Genetik"* der *„Forestry Commission"* umrissen.

Eine Inventur der Wälder Englands ist derzeit im Gang, bei der *„Plus-Samenbestände"* und *„Plusbäume"* für alle wirtschaftlich wichtigen Holzarten festgelegt werden. Vermehrung und Prüfung von Plusbäumen werden beschrieben.

Die *Stecklingsvermehrung* wird eingehender behandelt, und verschiedene Typen von Vermehrungskästen werden beschrieben. Die elektrische Erdheizung und die Anwendung von Wuchsstoffen werden diskutiert.

Die vorteilhafte Anwendung von *„Vermiculite"* als Bewurzelungsmedium für Stecklinge wird an Hand von Versuchsergebnissen gezeigt.

Abschließend wird auf Zusammenhänge zwischen trokkenwarmen Sommern und guter Samenernte bei der Korsika-Kiefer (*Pinus laricio* var. *corsicana* LOUD.) und bei der Buche unter englischen Verhältnissen hingewiesen.

Literature Cited

ANON.: Report of the 1891 Conifer Conference. Journ. Royal Horticult. Soc. **14** (1892). — ANDERSON, M. L.: Report on the preliminary stages of an investigation into various races of European larch. Scottish Forestry Journ. **46**, 7—27 (1932). — ANDERSON, M. L.: The selection of tree species. Oliver and Boyd, Edinburgh, 1950, 71. — ANDERSSON, E.: The Association of Forest Tree Breeding. Svensk Papp. Tidn. 1948, Nr. 1—3. — BROWN, C. A. C.: Electrical soil warming. Farming **2**, 5 (1947). — BROWN, J. M. B.: Climate and Soil in relation to Beech Grown in Britain. Report on Forest Research for 1951, H.M.S.O. 1952. — CHAMPION, H. G.: Genetics and Forestry. Quart. Journ. Forestry **39**, 74—81 (1945). — CHITTENDEN, F. J.: Conifers in cultivation. Journ. Royal Horticult. Soc. 1932. — DALLIMORE, W., and JACKSON, A. B.: A new hybrid conifer. Kew Bulletin 3, 113—115 (1926). — DALLIMORE, W.: Two possible forest trees for Britain. Quart. Journ. Forestry **39**, 90—91 (1945). — DALLIMORE W., and JACKSON, A. B.: A handbook of *coniferae*. London 1948, p. 263, p. 492. — GARNER, R. J.: Propagation by cuttings and layers. Techn. Comm. **14**, Imp. Bur. Horticult. and Plantation Crops, 1944. — GARNER, R. J.: The Grafter's handbook. Faber and Faber, London 1947. — HENRY, A.: Elm seedlings. Quart. Journ. Forestry **4**, 224—234 (1910). — HENRY, A., and ELWES, H. J.: Trees of Great Britain and Ireland. Vol. 2, p. 388, 1907. — HENRY, A., and FLOOD, M. G.: The history of the Dunkeld Hybrid larch, *Larix eurolepis* with notes on other hybrid conifers. Proc. Royal Irish Acad. **35** *B*, 58—66 (1919). — HENRY, A., and FLOOD, M. G.: The history of the London plane *Platanus acerifolia* with notes on the Genus *Platanus*. Proc. Royal Irish Acad. **35** *B*, 9—28 (1919). — HENRY, A.: The artificial production of vigorous trees by hybridization. Quart. Journ. Forestry **14**, 253—257 (1920). — HOLMES, G. D., and MATTHEWS, J. D.: Girdling or banding as a means of increasing cone production in pine plantation. Forestry Commission, Forest Record Nr. 12, 1951. — JACKSON, A. B.: Catalogue of the Trees and Shrubs at Westonbirt, Oxford 1927. — JACKSON, A. B.: A new hybrid pine. Gardeners Chron. **93**, 152—153 (1933). — JANSEN, E. C., and VAN BROEKHUIZEN, J. S.: Selectie van de Groveden. Nederl. Boschb. Tijdschr. **24**, 289—303 (1952). — JOHNSSON, H.: Experien-

ces and results of ten year's breeding at the Swedish Forest Tree Breeding Association. Proc. III World Forestry Congr., Nr. 3, Special Papers. — KEMP, E. E.: Some aspects of plant propagation by cuttings with special reference to the Selection of material. Journ. Royal Horticult. Soc. 73, 291—365 (1948). — LARSEN, C. SYRACH: Forest Tree Breeding. Royal Vet. and Agricult. Coll. Yearbook. Copenhagen 1934. — LARSEN, C. SYRACH: The employment of species types and individuals in forestry. Royal Vet. and Agricult. Coll. Yearbook. Copenhagen 1937, p. 21, 24, 29. — LARSEN, C. SYRACH: Advances in forest genetics. Unasylva 5, 15—19 (1951). — LÜCKE, H.: Züchtungsversuche mit Kiefer *(Pinus silvestris)* und Lärche *(Larix decidua* MILL.) in Niedersachsen. Z. Forstgenetik 1, 74—77 (1952). — MACDONALD, J. A. B.: Genetics and British Forestry. Scottish Forestry Journ. 44, 65—77 (1930). — MACDONALD, J.: The place of North Western American Conifers in British Forestry. South British Commonwealth Forestry Conference. Canada 1952. Item 7 a Sylviculture. — MATTHEWS, J. D.: Forest Genetics Report on Forest Research for 1950. H. M. Stationary Office, London 1951. — MATTHEWS, J. D.: Forest Genetics Report on Forest Research for 1951. H. M. Stationary Office, London 1952. — MULLARD, S. R.: Growing plants without soil. Country Life 1951, 104—105. — OPPERMANN, A.: Dyrkning af Laerk i Danmark. Det Forstl. Forsøgsvaesen i Danmark 7, 1—324 (1923). — O'ROURKE, F. L., and MAXON, M. A.: Effect of particle size of vermiculite on rooting of evergreen cuttings. Proc. Amer. Soc. Horticult. Sci., East Lansing 51, 654—656 (1948). — PRIDHAM, A. M. S.: Comparison of quartz sand, cinders and vermiculite on rooting of evergreen cuttings. Proc. Amer. Soc. Horticult. Sci., East Lansing 51, 657—658 (1948). — ROBAK, H.: Litt om Den Skotske Lerkerasen og dens historie. Tidsskr. f. Skogbruk 54, 149—159 (1946). — ROSS, G.: Experimental larch plantation at Stonecroft Estate Northumberland. Quart. Journ. Forestry 8, 216 (1914). — SCHOTTE, G.: Lärken och dess betydelse i Svensk Skogshushalling. Medell. f. Statens Skogsförsöksanst. 2 (1916—17). — SHEAT, W. G.: Propagation of trees, shrubs and conifers. Macmillan, London 1948. — STEVEN, H. M.: Improvements in practise. Scottish Forestry 2, 1 and 2 (1948). — STEVEN, H. M.: Progress of technical forestry. Forestry 25, 91 (1952). — STEWART, L. B.: Propagation of conifers. Conifers in cultivation. Journ. Royal Horticult. Soc. 1932. — SOMERVILLE, W.: Experiments with Scots pine seed from various sources. Quart. Journ. Forestry 5, 303—312 (1911). — SUCECKI, K.: A scheme for improving the collection of seed from elite pine stands. Sylwan 92, 167—179 (1946). — STORY, F.: Seed experiments with *Pinus silvestris*. Transact. Royal Scott. Arboricult. Soc. 23, 168 (1910). — WOOD, R. F.: Provenance studies. Report on Forest Res. for 1949. H. M. Stationary Office, London 1950. — WOOD, R. F., and PINCHIN, R. D.: Provenance studies. Report on Forest Res. for 1950. H. M. Stationary Office, London 1951.

(Aus der Bundesanstalt für Forst- und Holzwirtschaft, Abt. Forst- und Holzwirtschaftspolitik, Reinbek)

Neuere sowjetische Arbeiten über Forstpflanzenzüchtung und forstliche Samenkunde*)

Von E. BUCHHOLZ

(Eingegangen am 12. 9. 1952)

Die ersten Arbeiten einer forstlichen Pflanzenzüchtung in Rußland werden auf S. KURDIANI zurückgeführt, der im Jahre 1912 eine Schrift über die *Organisation der Selektion von Forstpflanzen* veröffentlichte (14). Im Jahre 1925 erschien eine weitere Arbeit von N. KOBRANOW (11) über die *Selektion der Eiche.* Erst in den dreißiger Jahren begann man dann in stärkerem Maße, sich mit der Forstpflanzenzüchtung mehr zu beschäftigen im Zusammenhang mit dem Problem der „Verkürzung des Zeitfaktors" in der Forstwirtschaft, als die Frage der Wiederbegründung abgeholzter Flächen mit raschwüchsigen Holzarten in den waldarmen Gebieten akut wurde.

Die meisten älteren russischen Arbeiten über Forstgenetik sind veröffentlicht in der von Prof. ROBERT v. REGEL gegründeten Schriftenreihe „Trudy po prikladnoi botanike, genetike i selekzii" (Bulletin of applied botany, genetics and plant breeding), von welcher mehrere Serien mit zahlreichen Beiheften herausgegeben wurden. Die Redaktion dieses Zentralorganes hatte längere Zeit der bekannte Direktor des Unions-Institutes für Pflanzenzüchtung *(W J R)* Prof. N. J. WAWILOW.

Seit Kriegsende wird vom Institut für Genetik eine neue Schriftenreihe unter dem Titel „Trudy Instituta Genetiki" (Arbeiten des Instituts für Genetik) herausgegeben, von welcher bereits 20 Lieferungen vorliegen. Hier werden aber meist Fragen der allgemeinen und theoretischen Genetik behandelt. Aufsätze über Forstgenetik erscheinen in den forstlichen Fachzeitschriften „Lesnoje chosiaistwo" (Waldwirtschaft), „Les i step" (Wald und Steppe), „Selekzia i Semenowodstwo" (Selektion und Samenkunde) sowie in den Zeitschriften und Mitteilungen verschiedener forstlicher Hochschulen und Forschungsinstitute. Vor kurzem hat das Institut des Waldes der Akademie der Wissenschaften, die zentrale Dachorganisation für die forstliche Forschung in der Sowjetunion, in Band 8 (1951) seiner Mitteilungen „Trudy Instituta Lesa" eine Sammlung von Abhandlungen über Selektion der Holzarten veröffentlicht (2, 6, 25 u. a.).

Trotz der frühzeitig begonnenen Versuchsarbeiten sind nach Feststellung der Ende Januar 1950 vom Institut des Waldes einberufenen Konferenz über Fragen der Selektion der Holzarten und der forstlichen Samenkunde die Ergebnisse der russischen Arbeiten auf den genannten Gebieten bei einigen Fortschritten im allgmeinen wenig befriedigend und entsprechen nicht den Anforderungen. Als Ursache hierfür wird die Rückständigkeit der Forstwirtschaft im zaristischen Rußland und die langandauernde Herrschaft von „unfruchtbaren Ideen des Weismannismus-Morganismus" in der biologischen Wissenschaft festgestellt. In den Beschlüssen der Konferenz heißt es weiter (25, p. 205): „Ausgehend von den Vorstellungen der formalen Genetik über Vererbung haben einige Gelehrte, die sich sogar aktiv für die Entwicklung der forstlichen Selektion einsetzten, ihre Mitarbeiter auf phantastische Fristen von 1 bis 2 Jahrhunderten zur Heranzüchtung von neuen Baumarten vertröstet und sie damit von diesen Forschungen abgeschreckt. Andere versuchten die Selektionsarbeiten mit unfruchtbaren Methoden der Veränderung der Natur der Pflanzen durch Einwirkung scharfer Mittel (z. B. Röntgenbestrahlung, Colchicinbehandlung) auf Abwege von den wahren Gesetzmäßigkeiten der Pflanzenentwicklung zu bringen, indem sie die Hybridisierung als eine Methode zur Umkombinierung der Gene ansahen (wobei die Gene Merkmale sind, die mit dem Prozeß der individuellen Entwicklung in keinem Zusammenhang stehen), verfielen die Selektionäre auf den Weg der Zufälligkeiten bei der Auswahl der Kreuzungspaare, wodurch die Entwicklung der Selektion gehemmt wurde."

„Die Konferenz ist der Ansicht, daß eine weitere und erfolgreiche Entwicklung der Arbeiten auf dem Gebiet der forstlichen Selektion nur auf der Grundlage der fortschrittlichen MITSCHURIN'schen Biologie und der Errungenschaften von T. D. LYSSENKO möglich ist." Es handelt sich dabei nach L. PRAWDIN (25) um nachstehende „sowjetische Methoden der Hybridisierung".

1. Vermittler-Methode. Bei der Unmöglichkeit der Durchführung einer direkten Kreuzung zweier Pflanzen wird eine Pflanze zunächst mit einer näheren (verwandteren) Form gekreuzt, welche als Vermittler bezeichnet

*) Die Schriftleitung bringt aus Gründen einer objektiven Berichterstattung diese Literaturübersicht, ohne damit zu den Themen und zu den Ergebnissen Stellung zu nehmen.