THURSDAY AFTERNOON SESSION

September 7, 1967

VICE-PRESIDENT TICKNOR: Our first session this afternoon will be on seed production of plants and will deal primarily with forest tree species. Our first moderator will be Mr. Ralph Jack of the Sierra Falls Nursery and Christmas Tree Farm, Silverton, Oregon. Mr. Jack, will you start this afternoon's program?

MODERATOR JACK: Our first speaker is Professor of Forestry, University of British Columbia, Vancouver, B. C. I would now like to present Dr. Philip Haddock:

THE IMPORTANCE OF PROVENANCE IN FORESTRY

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In order to be more certain of not being misunderstood, it is necessary to risk boring you by defining "provenance", at least as I intend to use the word. In forestry, it refers to the geographic origin of seed, or according to Callaham (1964) "the population of trees growing at a particular place of origin, and Wright (1962) "the original geographic source of a lot of seed (or pollen)." The term provenance should be restricted to the more or less precise origin of the naturally developed ("in situ") population from which the seed is directly derived. We need to recall that the phenotype, in contrast to the genotype, is what we have to deal with as our product. It is always the result of the reaction between the genotype and the environment. Failure to understand and appreciate this fact has been the cause of great misunderstanding, many errors in practice and much financial loss. It is probably unnecessary to stress these elementary matters to a group such as this, but perhaps the special nature of forest crops warrants some risk of repetition since some of you may not be familiar with the history of forestry and some of its special problems.

Callaham (1964), Langlet (1963), Lines (1965) and others have traced the historical background to the problems and nature of research in geographic variation in forest trees. These studies date back for almost two hundred years (Duffield, 1962). Perhaps educators and others not principally involved in this specialized research field may be as much at fault as any in the failure to recognize sufficiently the significance of within-species genetic variation. It would seem that practitioners have relied too greatly on the relative uniformity of morphological features used by taxonomists to distin-

guish between species and varieties and too little upon the demonstrably different but less conspicuous or less easily measured characteristics such as general physiology, phenology; particularly dates of bud setting and flushing; cold, heat, and drought resistance; susceptibility to insects and disease, growth form and wood quality. In fact, it may be true, as Langlet (1959) suggested, that "taxonomic subgroupings are then not only valueless (Langlet, 1934), but downright harmful (Huxley, 1939), since they suggest a non-existent homogeneity within conventional units which are in reality mere abstractions."

A related view is expressed and called to the attention of foresters by Duffield (1965) in his quotation from Ernst Mayr's work, "Animal Species and Evolution", to the following effect:

> ". . . All organisms and organic phenomena are composed of unique features and can be described collectively only in statistical terms. . . Averages are merely statistical abstractions; only the individuals of which the populations are composed have reality. . . For the typologist, the type is real and the variation an illusion, while for the populationist the type is an abstraction and only the variation is real. No two ways of looking at nature could be more different. . . The replacement of typological by population thinking is perhaps the greatest conceptual revaluation that has taken place in biology."

In the clear-vision of hind-sight, we may recognize that some of our mistakes have probably been due to this outdated typological thinking. Doubtless, we may conclude that, especially in species of such great geographic range as Scots pine (*Pinus sylvestris* L.) and Douglas fir (*Pseudotsuga menziesii* [Mirb.] Franco), taxonomy has notably failed to serve silviculture effectively (Haddock and Sziklai, 1966). When scientists have disagreed or failed to perceive certain principles clearly, it may not be quite fair to blame now obvious mistakes on practicing foresters who should have known better. The reasons for our mistakes in the past have been many and varied and there is little point in dwelling on them at length, but in recollection they may serve as horrible examples to be avoided in the future at all costs.

The long rotations in forestry, common especially in the past, have prevented prompt evaluation and recognition of both the serious and less serious errors. The time factor has also been partly responsible for certain inadequacies in records and communications caused by changes in personnel, the interruptions of wars, fires, and all the other disasters that can befall hopefully long-lived plantations. It should also be recalled that foresters first observed some of the effects of provenance before the time of Darwin and Mendel (Langlet, 1963), and that European forestry practice was well developed before the rediscovery of Mendel's Laws by geneticists

around the turn of the century. However, limited knowledge of forest tree physiology and the environmental sciences, as well as of genetics, combined with poor communiciations between botanist and forester, scientist and field man, have compounded the problem—and of course still hamper our progress.

One example may suffice to illustrate the magnitude of some of the losses represented by classic failures to consider provenance seriously. Farnsworth (1967) quotes a statement made in a paper presented by P. Bouvarel at the Sixth World Forestry Congress in Spain in 1966 as follows:

> ". . . it is evident that the failure or low productivity of certain reforestation programs are due to errors in the choice of seed. To quote one example among many, between 1870 and 1910 in France more than 50,000 hectares were planted with Scotch pine of poor race. The saving achieved on the cost of the seed, expressed in presentday values and capitalized up to 1960, represents 350,000 francs, against a loss in income, as compared with what would have been obtained with pine of good race (a greater quantity of better grade timber) of more than 300 million francs."

It is clear then that provenance is an economically important question in forestry, and has been for a long time.

An illustration of its immediate practical importance is found in the program reported by Schmidt (1967) involving a comprehensive provenance study in Douglas fir by the British Columbia Forest Service. We must know more about how far seed can be moved, since due to frequent cone-crop failures, especially at the higher elevations now being logged, we cannot always use local seed in reforestation. Other recent references involving questions of provenance in this region include those of Ching (1965), Ching and Bever (1960), Silen (1966) and Douglass (1965).

Provenance questions are a part of the growing research efforts in forest genetics and tree improvement now gaining long-needed recognition. Duffield (1962) stated:

> "The rapid extension of tree improvement activities and forest genetics research marks a major turning point in the development of forestry. It marks, even more clearly than the increased interest in reforestation, the transition from the exploitative to the productive phase in forestry. It is a development as significant in the history of forestry as the change from hunting and gathering to farming and herding in the history of our species."

Some time ago Wakeley (1954) recognized the crucial nature of provenance research when he wrote:

> ". . . The inescapable conclusion is that selections and hybrids must be made separately, region by region, within the framework of geographic races. To the extent that this

is true, provenance studies designed to identify such races and define their territorial boundaries are fundamental to other phases of tree improvement."

The use of the term "race" raises problems such as whether or not certain recognized variation in populations is continuous or discontinuous. To explore this question is beyond the scope of my paper. Perhaps it is sufficient to note that as Burley (1965) concluded, concepts of clinal and ecotypic variation are not mutually exclusive.

In British Columbia, in matters of tree improvement research, early interest centered on the most valuable and traditionally useful tree in our trade, the Douglas fir (*Pseudotsuga menziesii* [Mirb.] Franco). Although questions of provenance are still many and we need much more knowledge, (Schmidt, 1967), tree improvement work has been well started in some regions of the province through intensive selection of individual superior phenotypes, progeny testing, controlled pollination, vegetative propagation, individual and species hybridization, and seed orchard development (Orr-Ewing, 1966), Sziklai (1964). Doubtless, provenance limitations will affect the usefulness of many of the improved forms we can expect to come from this research.

Lines (1965) has recently prepared an excellent general summary of the provenance topic to which I can refer you for more information of an historical nature. He notes that many countries have passed legislation aimed at controlling the importation of tree seed so as to assure good quality and accurate knowledge of origin (i.e. provenance). Lines concluded that it pays to spend up to fifty per cent more for better seed.

We are only just now getting around to facing the issue of seed certification in western North America. Undoubtedly, we need better seed regulation, and perhaps some legislation, but it is also true that wise legislation has been hindered or made impossible by insufficient knowledge of the provenance field in many if not all of our important forest tree species. Recent developments in this important aspect of the provenance question have been reported by Farnsworth (1967) and Rudolf (1966).

I will outline some of the things we do and don't know about provenance in relation to some of our local species. Much of this is the outgrowth of the use of our species as exotics in various parts of the world, but especially in western Europe.

As a consequence of experience, foresters have evolved the rule of thumb, "local seed is best" (Duffield, 1962). In many situations we are still following this essentially very conservative rule, but in the light of more recent studies, especially in Europe, we have felt it necessary to test the validity of this rule and of course the use of exotics implies that it is not necessarily valid in a great many cases. For many years now, the value of North American species and the im-

portance of provenance in their use have been increasingly recognized by European foresters. In fact, very recently, members of research organizations have made expeditions to the Pacific Coast for the purpose of making their own accurately-controlled collections of forest tree seed, sometimes even going to individual seed tree collections for purposes of research. The ice age left Europe without a rich coniferous tree flora, so that exotics from western North America are now much sought-after. Because of their wide distribution, climatic adaptation, growth habits, excellent wood properties and freedom from serious diseases, some of the most desired species are: Sitka spruce (*Picea sitchensis* [Bong.] Carr.), Douglas fir (*Pseudotsuga menziesii* [Mirb.] Franco), and lodgepole pine (*Pinus contorta* Dougl.).

Some others, such as western hemlock (*Tsuga heterophylla* [Rafn.] Sarg.), western red cedar (*Thuja plicata* Donn ex D. Don.), and grand fir (*Abies grandis* [Dougl.] Lindl.) are also of interest, but are imported as yet largely on an experimental scale.

Sitka spruce is one of the most valued species and is used extensively by the Forestry Commission in Great Britain. It is also planted to a lesser extent in Ireland, Scandinavia, and Germany. It has been established that cold injury in the species is principally a problem of provenance (Haddock, 1966 citing Robak). Other evidence supports the importance of seed origin in Sitka spruce, and for some years the Queen Charlotte Island seed source has been sought for plantations in the colder areas of northern Europe to which the species is adapted. However, such broadly designated regions are no longer considered adequate. Increased attention is being directed to more precise provenance designations, because of the great topographic and associated climatic and edaphic variation in the environment. These factors are believed to have shaped the evolution and development of locally, genetically different populations over long periods of time (Burley 1965, Haddock 1966, and Haddock and Sziklai 1966).

Douglas fir was introduced more than a century ago to Europe by David Douglas. It is more demanding of soil than Sitka spruce and is also not so resistant to wind, so has found less general usefulness in Great Britain, but it is in great demand on the continent. Observers have long recognized that Douglas fir can be broadly divided into two major populations, sometimes given taxonomic status. These are variously known as the coast, "viridis", or "green" Douglas fir, and the interior, "glauca" or "blue", Douglas fir. Intermediate forms from the so-called "wet belt" of the Columbia Forest Region of interior British Columbia are of special interest to foresters in eastern Europe, whereas the coastal populations are those best suited to western Europe in general. The slow-growing, disease-prone continental, interior origins, especially those from the most arid sections, are of little interest

and utility as exotics anywhere. In parts of Great Britain, The Netherlands, France, and Denmark, provenances of Douglas fir from western Washington have long been preferred.

Recent studies in North America are now recording in more detail the great variation which exists in Douglas fir both within small geographic areas and over the range as a whole.

More recently, interest in lodgepole pine has increased and the critical importance of provenance in this species is being recognized. The coastal populations, known generally as shore pines, have been given varietal status by taxonomists, but the variation in populations within this form has been proved to be of much silvicultural significance, (Roche 1962, 1963, Lines 1966, Feilberg 1964, Haddock 1966). The species has been widely planted in Ireland and in Great Britain, as well as less extensively elsewhere in Europe, and the so-called "green" or coastal form (shore pine) has also been planted in New Zealand (Duff, 1966), where it is superior to the interior populations. In Great Britain and Ireland, shore pine represents the preferred group of provenances, whereas further east and north more continental provenances prove superior. In Great Britain and Ireland, an extensively imported provenance of the coastal population has been proved to be inferior to other coastal provenances, at least on some sites (Aldhous, quoted in Haddock, 1966). However, much more research is needed before the full possibilities for this species can be realized (Hagner, 1967).

I must mention a subject probably of greater interest to some of you than what has been covered so far. Christmas tree culture is a bit of a no-man's land between the horticulturist and the forester. For many years the concept in this part of the world was that Christmas trees were to be grown on the poorest sites where trees, mainly Douglas firs, would be suitably bushy due to slow height growth with short internodes. Recently, this concept, long out-of-date elsewhere, has been challenged here. At the same time, an even more deeply-rooted prejudice against exotics is being questioned. Plantations of Scots pine (*Pinus sylvestris* L.) have been established for many years on an extensive scale in eastern North America, particularly in the Lake States and Ontario, where it is increasingly grown for Christmas trees. In fact, it is probably no news to those of you here that this species has replaced Douglas fir in many areas and is now the single most widely-used Christmas tree species in the United States! Explanations for this may vary, but in other species as well as in this one, the aim now seems to be to use good sites and the best seed from properly chosen provenances or even particular genotypes suitably adapted to the proposed growing site, with high quality trees assured by additional appropriate cultural practices.

As indicated by the studies of Douglass (1966, 1967)

Douglas firs and Scots pines are being grown rapidly on good sites with cultural practices such as pruning and shearing and when the appropriate provenances have been selected, valuable trees may be grown quickly (Douglass 1965, 1966, 1967).

The variation between and within Scots pine provenances has long been studied in Europe and documented there and in the United States by a number of workers (Langlet 1959, 1963, Wright and Baldwin 1957, Douglass 1965). Douglass, as many of you know, has evaluated Scots pine provenances grown in Olympia and has also provided recommendations for Douglas fir, Scots pine, and shore pine seed origins, and has provided instructions for cultural practices applicable in the Pacific Northwest. He concluded that future provenance testing in this region for Christmas trees should concentrate on the seed origins of Scots pine from southern Germany, France, and Spain. These appear to be the most promising here in respect to color, growth rate and form, and in adaptability to shearing.

In conclusion, the role of provenance and its importance in forestry are certain to increase in keeping with the growth of artificial regeneration in forestry practice and as an accompaniment to accelerating and more intensive research programs in forest genetics and forest tree breeding.

LITERATURE CITED

Burley, J 1965 Genetic variation in *Picea sitchensis* (Bong) Carr A Literature Review *Commonwealth Forestry Review* 44: (1). No 119 47-59.

Callaham, R Z 1964 Provenance research investigation of genetic diversity associated with geography Pages 40-50 *Unasylva* 18 (2-3) 4

Ching, Kim K 1965 Early growth of Douglas fir in a reciprocal planting Research Paper 3 20 pages Forest Res Lab Oregon State University Corvallis

_____ and Dale Bever 1960 Provenance study of Douglas-fir in the Pacific Northwest region *Silvae Genetica* 9.1 11-17.

Douglass, Bernard S 1965 Evaluation of Scotch Pine provenance test at J Hofert Nursery near Olympia, Washington 4 pages, plus 14 pages tables U. S Forest Service, Portland, Oregon

Douglass, Bernard S 1967 Cultural practices for growing Christmas trees in the Pacific Northwest Managing your woodland, How to do it guides No 5 21 pages U. S Forest Service, Portland, Oregon.

Douglass, Bernard S. and Gary H Sander 1966 Recommended seed origins for Douglas-fir, Scotch pine and shore pine plantation grown Christmas trees in western Oregon and Washington 4 pages plus 4 pages tables U. S. Forest Service, Portland, Oregon

Duff, G 1966 Yield tables for unthinned stands of the "green" varieties of *Pinus contorta* in New Zealand Technical Paper No. 50. ODC 566. 36 pages. Wellington, N Z

Duffield, John W. 1962 Forest tree improvement old techniques and the new science of genetics H R MacMillan Lectureship. University of British Columbia 16 pages Vancouver, B. C

Duffield, John W 1965 Some influences of genetics on the thinking of foresters p 6-13, in Forestry in Science and Society 66 pages A Program Celebrating the Fiftieth Anniversary of Professional Forestry Instruction at the University of California. Berkeley, 1964

Farnsworth, C E 1967. Report of the Tree Seed Committee (SAF) *Jour. For.* 65 1.62.

Feilberg, L 1964 *Pinus contorta* (Lodgepole pine) its provenance and breeding. Damsk Skovforenings Tidskrift 49 267-296 F C T (Forestry Commission Translation) No 219 21 pages by R Jenson, Translator (Lit citations missing).

Haddock, Philip G 1966 Information available for other western species having sufficient generality to be applied to Douglas-fir seed movement problems Pages 8-22 Western Forest Genetics Association Proceedings, 1965, Olympia, Washington December 6-7, 1965 71 pages Pacific Northwest Forest and Range Experiment Station, Portland, Oregon

_____ and Oscar Sziklai, 1966 Seed collection zones for Douglas fir in Canada 16 pages 6CFM/E/C T 1/15 Sexto Congreso Forestal Mundial, Madrid, Junio, 1966

Hagner, Mats 1967 Personal Communication

Langlet, Olaf. 1959 A Cline or not a cline? — a question of Scots pine *Silvae Genetica* 8 1 13-22

_____ 1963 Practical results and current problems in provenance research in Sweden FAO/Forgen 63/-3/1 World Consultation on Forest Genetics and Tree Improvement Stockholm, 23-30 August 1963

Lines, Roger 1965 Provenance and the supply of forest tree seed. *Quart Jour. For.*, 59.1 7-15.

_____ 1966 Choosing the right provenance of Lodgepole Pine (*Pinus contorta*) *Royal Scottish For Soc*, 20 2.90-103

Orr-Ewing, A L. 1966 Inter-and intraspecific crossing in Douglas-fir, (*Pseudotsuga menziesii* [Mirb] Franco). *Silvae Genetica* 15 4.121-126.

Roche, Laurence 1962 Variation in Lodgepole Pine and its role in the genetic improvement of Coast Forms 102 pages — typewritten, M F Thesis, Faculty of Forestry, University of British Columbia, Vancouver, B C

Roche, Laurence 1963 The Shore variety of *Pinus contorta, Baileya* 11:1.11-14

Rudolf, Paul O 1966 Forest tree seed certification Tree Planters' Notes No. 77.9-16 U. S Department of Agriculture, Forest Service, Washington, D C 20250

Schmidt, Ralph. 1967 B C Forest Service initiates Douglas-fir provenance study B C Lumberman pages 72-74, March 1967

Silen, Roy R 1966a A simple, progressive, tree improvement program for Douglas-fir Res Note PNW 45 13 pages Pacific Northwest Forest and Range Experiment Station, Portland, Oregon

Silen, Roy R 1966b A 50-Year racial study of Douglas-fir in Western Oregon and Washington Pages 6-7 in Western Forest Genetics Association Proceedings, 1965 71 pages (Olympia Wn) Pacific Northwest Forest and Range Experiment Station, Portland, Oregon

Sziklai, Oscar 1964. Variation and inheritance of some physiological and morphological traits in *Pseudotsuga menziesii* (Mirb) Franco var *menziesii*. 151 pages Ph D thesis University of British Columbia, Vancouver, B C

Wakeley, Philip C 1954 The relation of geographic race to forest tree improvement *Journ. For*, 52 9.653

Wright, J W. and Baldwin H. I 1957 The 1938 International Union Scotch pine provenance test in New Hampshire *Silvae Genetica*, 6·2-14

Wright, Jonathan W 1962 Genetics of forest tree improvement FAO Forestry and Forest Products Studies No 16 399 pages Rome

MODERATOR JACK: Our next speaker is Dr. George S. Allen, Forest Research Laboratory, Victoria, B. C. He will speak to us on the important topic of stratification of tree seeds. Dr. Allen.