ROLE OF INTRODUCED SPECIES IN FOREST GENETICS

by Stephen H. Spurr 1/

It has long been axiomatic in silviculture that the local or native tree is the safest and best tree to be grown by the forester. So widely accepted is this tenet that a strong naturalistic school has developed based entirely on the study of the phytosociology and ecology of native vegetation in undisturbed communities, and decrying the use of exotics for the creation of unfamiliar or artificial forest communities.

There is no question as to either the general merit of such an approach or that native vegetation is generally the safest vegetation to use in forest management. Nevertheless, the success of exotic forest trees in many parts of the world has been so great that it is desirable to examine experience with exotics if one is to arrive at a balanced view as to the importance of species origin in forest management.

Theoretically it would seem that if a given tree species has existed in a long-established free interbreeding population over a broad geographical area surrounding a given locality, natural selection should in the long run have produced local ecotypes extremely well adapted to local soil and climatic and biotic conditions. In general this seems to be the case. In the middle of the eastern white pine region, for example, there seems no question but that a local race of white pine is the best (Pauley, Spurr, and Whitmore, 1955).

The corollary seems also to be true. Wherever natural populations have not been long established, or are not freely interbreeding, or have not been distributed over a broad geographical area, then the possibility exists that natural selection has not functioned to develop a superior local ecotype, and that a population of genes from another geographical area might well be better adapted to local site conditions than the plants restri$_c$ted by accident or by history to the local site. Indeed, this seems to have been the case in most instances where forest trees have proved to be successful exotics. Let us examine a few examples.

In many of the recently glaciated portions of the Northern Hemisphere, and in other relatively young geologic sites, the present forest vegetation has been present only a relatively few centuries. For example, in the State of Michigan, the southern portion of the State was exposed only subsequent to the Cary substage of the Wisconsin glaciation about 13,000 years ago, and the northern portion of the State after the retreat of the Valders ice probably 10,000-11,000 years ago. As recently as

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8,000 years ago, the vegetation of the entire State was primarily spruce. Pine became abundant in the next few thousand years, but many of the more mesophytic hardwood species became established only about 3,500 years ago, or well into historic times in terms of the Western World. There is considerable doubt whether even today heavy-seeded species such as the American beech have completed their migration north following the retreat of the ice. As a matter of fact, well documented climatic changes in recent years are certain to be reflected in the long-time distribution of tree species in Michigan (Spurr, 1956).

With so many recent changes in the distribution of forest trees, and in fact still taking place, it is not at all surprising that certain exotic species do better in parts of Michigan than the native plants. In the Ann Arbor region, the local hardwoods seem well adjusted to the local site conditions, but such important conifers as Norway spruce, Scotch pine, and European black pine do better than conifer species brought in from the nearby northern forest.

An even better example of the effect of recent geological changes in the distribution of forest types and of the success of exotics may be found in Great Britain, where revegetation following the last glaciation was slow and was composed of species that migrated north from refugia in the Mediterranean area. Most of these species were of continental origin and have proved to be poorly adapted to the maritime climate of the British Isles. Extensive trials with exotics over more than a 200-year period have convinced most British foresters that such introduced species as Sitka spruce, Douglas-fir, grand fir, European larch, and Pacific Coast lodgepole pine, are better suited to the site conditions of England than the "native" Scotch pine which reaches its best form and development in the continental climate of the Balkan region. Among the hardwoods, even the European beech which has migrated northward across England during historic times, has not yet reached an equilibrium with the present-day climate. It may be considered an exotic even though it is not known whether its introduction was or was not influenced by men living in Britain during the period of its appearance.

Actually, all of western Europe is characterized by a paucity of tree species. The geography of western Europe, with the high mountains of the Alpine region, the Mediterranean, and the deserts of North Africa, has militated against the survival of many tree species over the climatic extremes of the Pleistocene Age. As a result, most of the European forest is composed of a very few species, primarily Scotch pine, Norway spruce, two native white oaks, beech, aspen, and white birch. About as many more species were relatively uncommon but have been successfully propagated on a larger area than they occupied a century ago and may be considered exotics on most sites in western Europe even today. These include both the Austrian and Corsican strains of the European black pine, the cluster pine, and European larch. It is little wonder that, with the scarcity of species, some introduced types have a very real place in the silviculture of western Europe. These include such North American species

as eastern white pine, northern red oak, and black locust, the latter species being widely introduced in the Balkans.

The main success with exotics as tree species, however, has been in the Tropics and in the Southern Hemisphere, regions where historical, geographical, and climatic conditions have prevented a normal distribution of trees by means of natural dissemination. Many of the economic plants of the Tropics, including the coconut, beefwood, rubber tree, common teak, and mahogany, have been disseminated artificially by man and have become successful exotics in many parts of the Tropics.

In the Southern Hemisphere great success with introduced conifers has been experienced. In Australia, New Zealand, Chili, and South Africa, several million acres have been successfully afforested to Monterey pine and other hard pines. Results have been phenomenal in many cases. On the better sites, it has proved possible to raise these plantations to maturity on a 30-year rotation, with heights in excess of 100 feet achieved and yields up to 10,000 cubic feet per acre. Although Monterey pine is the most successful and most widely planted exotic, Jelecote, cluster, slash, Caribbean, and other hard pines have also been established on a large scale with good results, as has Douglas-fir. Suitable sites were available for these various species but were not accessible because of the geographical distance, as well as the interspersion of oceans and the Tropics between the native range of the species and sites in the Southern Hemisphere ecologically adapted to their needs.

A similar case may be made for various eucalyptus species in California. In the San Francisco Bay area, Tasmanian blue eucalyptus grows far more vigorously and abundantly than any of the native species on the same sites. The lack of a suitable market for this difficult-to-merchandise species in no way detracts from the fact that the species is ecologically well suited to the sites in California on which it is grown.

Although it must be admitted that many exotic plantations have failed, yet the fact remains that there have been sufficient successes to demonstrate conclusively that the local tree is not always the best tree for a given site. We may well try to extract any general principles that can be evolved from our worldwide experience with exotics.

The naturalistic school of forest site and silviculture holds, in effect, that natural selection can be depended upon to evolve a suitable species for local forest sites. In the light of present-day knowledge of genetics, we now know that natural selection must work only within the pool of genes available in a freely interbreeding population. As we realize how great the dynamic fluctuations have been in recent geologic times, and how recent have been many of the substantial changes both in the distribution of species and in the availability of sites, we now realize that in many cases a satisfactory population does not exist from which suitable natural races can be evolved. Most of the cases of successful introduction of exotics have occurred where the interposition of oceans, unfavorable

climatic zones, deserts, or simply the lack of time have prevented a suitable species from occupying an otherwise suitable site. Planting experience has shown that Douglas-fir is certainly better suited to the maritime climate and soil conditions of Scotland than the native Scotch pine. Monterey pine is obviously better adapted ecologically to growth on many of the soils of the southern temperate zone than are the species that had been able to migrate into these zones by natural dispersion channels. Certainly in the Ann Arbor, Mich., area, Norway spruce, European black pine, and Scotch pine grow more vigorously and are freer from insect and disease problems than are the native red pine brought down from 200 miles or more in the north or native shortleaf pine brought up from 200 or more miles in the south. In a real sense, the European species are more nearly native to this locale than are the exotics from other regions in the central United States.

The lesson, then, seems to be that we are not particularly concerned with whether a tree is native or exotic. It makes relatively little difference to the silviculturist whether the tree was introduced to an area by natural dissemination following retreat of the ice, by the seed being dropped from a bird flying overhead, or introduced more sanitarily as seed in an airmail envelope. What we are concerned with is that the tree must be ecologically suited to the environment in which it is to be grown. This environment includes not only the climatic and the soil factors, but also the total biotic complex of other plants, including fungi, and animals, including insects. If a tree has been grown in its geographical area for a long time, we may have learned that it is well suited ecologically to grow there and is therefore a native species. If, however, we bring in a species from outside and find by testing that it is even better suited ecologically to grow in our local community, then this species too may be considered a native and may be safely grown.

Our local species, therefore, will usually be the safest, even though they may not be the best. Many introduced species will fail, but a few may prove superior to native trees. They must, however, be thoroughly tested before they can be accepted and planted on a large scale. The aims of the forest tree improvement silviculturist, therefore, must be to put the right species on the right site. If this is done, we need not worry as to whether the tree got there "naturally" or "artificially."

As a corollary, in regions characterized by a rich and long-established tree flora, the possibilities of introducing exotics successfully are apt to be limited. Where the local flora is poor in numbers of species, however, where the trees that are present have migrated into the area in relatively recent times, and where they may not be ecologically adjusted to the local sites, then the possibilities of introducing new species into the local forests would appear particularly promising. Only by drawing upon both genetic and ecologic knowledge can the forest tree improvement specialist succeed in his mission.

References Cited

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Group Discussion

Asked to define a "native species" as considered in his paper, the speaker did so as follows: A native plant is one ecotypically well suited to the total environment in which it grows. Accordingly 1,000 years of growth of a species in one area does not necessarily qualify that species as "native."

Also reiterated was the point that because of long-time climatic changes none of the North American hard pines appear to be as well adapted to conditions in the Ann Arbor area as are some European species. Neither red pine, whose natural range lies to the north, nor shortleaf pine, whose natural range lies to the south, is as well adapted to this locality as are some species from a greater geographic distance.