GENES
TREES
and
FORESTS
The LEGACY

Twelve thousand years ago, there were no forests in British Columbia. Glacial ice covered the land to a depth of thousands of metres. Slowly the climate warmed, the ice melted, and the glaciers retreated. From the south, from western refuges on Banks and Queen Charlotte Islands, and from the Nahanni, trees, shrubs and herbs began to return to land cleared by ice.

Animals followed their food supplies, insects pollinated flowers, fungi and bacteria broke down litter and enriched the bare earth. Slowly, new forests began to form.

Our magnificent forests of today are linked to those first early forests. Perhaps a hundred generations of trees separate the low elevation fire-regenerated forests of the Interior from those first colonizing individuals. On the coast there may be even fewer generations of some long-lived species because of the greater time between major disturbances.

The common thread that links the earliest trees to their current descendants is the complex biological molecule, deoxyribonucleic acid (DNA). This molecule contains the codes for growth, development and reproduction. Variations in its structure provide the wealth of genetic variation that we find in almost all living things.

Genetic variation is critical to the ability of organisms to accommodate changes in the environment. Geological history tells of many major and minor fluctuations in climate, even since the last glaciation. Cool summers were prevalent from 800 to 600 years ago, followed by a period of warm, dry summers until about a 100 years ago. Then a “little ice-age” saw glaciers advance once more. Now we are in another warming trend.

These fluctuations in climate mean that the offspring of long-lived trees often establish in very different environments than did their parents. As well, trees grow in a wide range of ecosystems and must accommodate daily, seasonal, and longer-term variations in environment. Maintenance of genetic variation is thus very important for the forests of British Columbia.
GENE CONSERVATION

The genetic legacy from the trees in our forests must be conserved. Geneticists have collected hundreds of samples from commercial tree species throughout their full range—from the centres of abundance to isolated populations at the edge of the distribution. Genes from these collections are found in hundreds of test plantations throughout the province. Many of the samples are stored, either as seed or as grafted material, in the gene archives on Vancouver Island and in interior British Columbia. As well, a network of wild stands is being identified for each species to maintain genetic variation on site.

MAINTAINING the LEGACY

None of the 40 species of trees in British Columbia is threatened with extinction. Their very abundance may lull us into complacency, but the danger is present of loss of genetic diversity to agricultural land clearing, urbanization and inappropriate logging practices. To guard against loss, the Ministry of Forests is implementing a variety of methods to identify and maintain genetic variation.

The work began in the early 1950’s with coastal Douglas-fir. Since then, geneticists have studied the patterns of genetic variation of several commercially important tree species. They examined the variation among trees from different geographic origins, often including examples from outside British Columbia. They then measured the relative amount of variation among trees in the same area. New techniques in molecular biology have permitted the measurement of genetic diversity within individual trees.

Geneticists found that conifers are among the most genetically diverse of all organisms yet examined. For example, at the biochemical level, Douglas-fir is almost three times more diverse than humans. This genetic diversity is generally distributed more among individuals than among stands of trees.

This information is guiding the maintenance and use of the genetic heritage in our commercial tree species.
Tree Improvement

Genetic diversity offers an opportunity to guide nature’s processes in ways more useful to people. The tree improvement program uses genetic principles to increase the wood available from lands allocated for timber production. As well, geneticists aim to improve other specific traits — wood quality and resistance to pests.

The typical tree improvement cycle starts in wild stands with the selection of trees which are exceptional for the traits of interest. Offspring from these trees are grown and measured to ensure that the observed traits are passed from parent to progeny. The parents showing the most stable transmission of desirable traits across a wide range of testing sites are propagated by scions or cuttings and established in seed orchards.

Spruce weevils enter and kill the main shoot at the top of vigorous, young spruce trees. This slows growth and creates multi-stemmed trees of low commercial value. Sitka spruce from stands around the Strait of Georgia show resistance to weevil damage. Growth of these Sitka spruce is not deformed, despite high weevil numbers.

Testing has shown that this resistance is genetically based. Seed orchards are designed to maintain high levels of genetic diversity. Many parents are included in a spatial arrangement that promotes an exchange of genes. We expect plantations from seed orchard seed to show about a 10% increase in growth rates and maintain high levels of genetic diversity.

Geneticists are working to improve growth and wood quality for a variety of tree species. They are also developing seedlings that are more resistant to certain pests — Sitka spruce that can grow where spruce weevil is common, and white pine resistant to blister rust.
PHENOTYPES and GENOTYPES

When we look at trees we see the phenotype — the interaction of genes (genotype) and environment. When breeding trees, what we see in the parents is not necessarily what we get in the offspring. Rapid growth, for example, may be the result of genotype but it is also influenced by environmental factors such as abundant nutrients, better drainage, and more light.

When geneticists select trees with desirable traits, they are selecting phenotypes. They must then test to determine how much of the variation they see is genotype and how much is environment. This is usually done by growing offspring from selected trees in common, uniform environments. Thousands of offspring are currently being evaluated in British Columbia.

Many people have been exposed to Darwin’s ideas of natural selection in which “only the fittest survive”. Some people believe that our forests are made up of trees that have been selected by nature for the site on which they grow. At the larger scale, this is true. For example, Douglas-fir in the interior is more frost tolerant than it is on the coast, and Sitka spruce from areas with intense weevil pressure has more resistant genotypes.

At a smaller geographic scale the forces of natural selection are dissipated by chance events such as the random movement of seed and pollen. Usually the first seed to germinate commandeers the resources and grows faster. The tree that grows in the light gets bigger than the one in the shade. The tree that is in the nutrient seepage area may outgrow its neighbours. This is why it is very important for geneticists to test that what they see is indeed controlled by genes.