Micropropagation of difficult-to-root white spruce using tiny segments from genetically improved seeds aims for more wood formation in a prolonged juvenile phase, and efficient nitrogen use on poor soil.

Improving woody crops

Don J. Durzan

Genetic engineering and cell and tissue culture have already begun to influence the breeding and vegetative propagation of superior rootstocks and woody perennial trees for efficient forestry systems and urban plantings. In our laboratory, hard-to-root biomass species such as Douglas-fir, white spruce, and jack pine have been cloned through micropropagation. The American elm has been propagated from cell suspension cultures. With similar methods being used for fruit and nut trees, valuable rootstocks of *Prunus* and *Pistacia* species are at the point of being cloned and modified to capture the maximum genetic variation available. Currently, a considerably smaller proportion is obtained through conventional selection and breeding.

Problems with woody species based on their large size, age, complex natural products, and elusive reproductive processes are being bypassed with invigorated tissues, which may double the genetic gains affecting productivity. Gains being sought through selection, propagation, and engineering include resistance to insects and disease, production of pathogen-free stocks, rapid growth of wood-producing tall trees, and inhibited wood production in small fruit trees to foster precocious fruiting and convenient mechanical harvesting. In our cloning experiments, we are searching for trees less dependent on nitrogenous fertilizers, more responsive to cultural practices, and able to grow in poor and saline soils, on steep slopes, and in dry and harsh climates.

Some, but not yet all, of the superior trees can now be propagated independently of the constraints of natural climatic cycles. Cherry, almond, and pistachio trees and tissues are being reduced to cells so that multiple copies of each variety are available on a massive scale for performance tests in many environments. This technique permits us to estimate the total available genetic variation and to sort out interactions between genetics and environment. Early screening to certify new varieties for quality and trueness to type is becoming more efficient. However, problems with the control of growth and maturity of tissues still limit our approaches to tree improvement. Nevertheless, members of the Department of Pomology have started to collect and preserve valuable varieties as tissue cultures for our Germplasm Repository to be opened in 1982.

Now that cell suspensions of many woody species can be established, application of recombinant DNA technologies to protoplasts is being evaluated. We are exploring how to fuse protoplasts, induce phase changes, and improve upon the biosynthetic potential of cells especially for the products of photosynthesis and the building blocks of proteins. Efforts are under way to scale-up low molecular weight transformations and the conversion of biomass using immobilized cell and enzyme systems.

Don J. Durzan, Chairman, Pomology, U.C., Davis.

Geneticist Bill Libby with his prized 14-year-old coast redwood clones at the Russell Reservation test plantation near Berkeley.

Cloning coast redwoods

William J. Libby

In a redwood breeding program, time is a problem. Between germination (or planting) and harvest as a renewable source of wood, a redwood must survive and grow in a minimally managed environment for three to eight decades. Trees in park and amenity plantings may be expected to grow for centuries, or even millenia. Redwood foresters thus, and properly, tend to be conservative.

The first step in redwood breeding has been to identify families or populations of trees that are well adapted to particular sites. This is based on the reasonable assumption that, having evolved on a site, they are adapted to it. Site adaptation is important not only in California, in the native range of the redwood, *Sequoia sempervirens*, but also in places like France and New Zealand, where the redwood is gaining importance as an exotic plantation tree.

In most years, in the central part of the redwood's native range, demand for seedlings far exceeds the supply of local-origin seed. One solution to this problem is to clone redwoods native to the plantation region. We have four options with this approach. The first is to find young native seedlings that have successfully established themselves and to bring cuttings from them into the greenhouse. Since the trees are juvenile, their cuttings root easily, and a small collection of known-origin clones can be expanded to thousands of young trees in two or three years.

A second option is to take cuttings of outstanding mature trees. Such cuttings are difficult to root, and they frequently grow in branch form for many years when they do root. Such rooted cuttings planted together should produce a large amount of seed, which could be used to establish new stands. However, there are still problems in obtaining abundant seed production in such seed-orchards, and the site-adaptation of the open-pollinated offspring from a multi-parent seed-orchard is uncertain.

As a third option, outstanding parent trees are crossed in specific combinations, and their juvenile seedling offspring are cloned and tested. We are looking not only for adaptation to various sites but also for clones for-