Branching out

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Somatic embryogenesis: A reproduction method applicable to mature conifers?

You have found a tree with exceptional characteristics — perfect tapering, good vigour and desirable growth traits. It is such a great tree that you wish you could "copy & paste" it. Vegetative reproduction or, more specifically, somatic embryogenesis from shoot bud explants, may turn this dream into reality. But is this solution available to everyone? How does this technique work and what tree species can be cloned using it?

Somatic embryogenesis in brief

An embryo enclosed in a tree seed undergoes numerous transformations before it reaches the seedling stage and is ready for planting. Embryogenesis is the process that encompasses all of these transformations (see box). The term "somatic" indicates that the embryos are produced asexually.

From a seed or from shoot bud explants, the stages in somatic embryogenesis are the same.

Somatic embryogenesis (SE) is an *in vitro* (i.e., laboratory-based) cloning method for plants that results in the production, from a single seed, of a multitude of somatic embryos that grow into genetically identical trees. Vegetative reproduction (or propagation) creates copies (clones) having the same genetic make-up as the mother tree.


Photo 1.

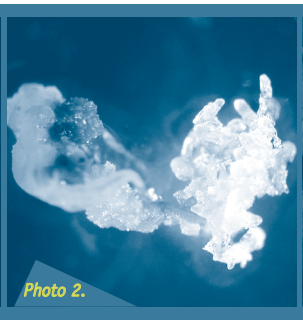
Photo 2.


Photo 3.

Photo 1. White spruce bud explant cultured on a growth medium for 15 days.
Photo 2. Early somatic embryos growing from a bud explant.
Photo 3. Mature somatic embryos developed after 7 weeks of culture from the early somatic embryos on photo 2.
Photos: K. Klimaszewska (CFS)

Stages in somatic embryogenesis

Stage 1: Initiation and proliferation

An embryo excised from a seed is placed on a Petri dish containing a medium that supplies the nutrients required for embryo development. After about six weeks, some of the growing tissue converts into embryogenic tissue. This proliferation process marks the initiation of somatic embryogenesis. During this phase, embryogenic tissue can be cryopreserved in liquid nitrogen for future use or for germplasm conservation.

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Stage 2: Maturation of embryos
Clumps of embryogenic tissue are transferred onto a maturation medium containing a plant growth regulator that promotes maturation of the somatic embryos.

Stage 3: Germination of embryos
The somatic embryos germinate to form roots and shoots, similar to plants germinating from seeds. The resulting plants are called "somatic seedlings."

Stage 4: Greenhouse culture and field planting
The somatic seedlings are transplanted into soil for further growth and acclimatization. After a greenhouse culture period, the seedlings can be planted in the field.

Somatic embryogenesis research at the Canadian Forest Service

The Canadian Forest Service (CFS) is a world leader in somatic embryogenesis and related research. It was one of the first research organizations to enhance the SE protocol and apply it to several tree species. Since 1985, CFS researchers have worked on European larch and Japanese larch, followed by black spruce and white spruce. Since then, the CFS has contributed significantly to the advancement of various aspects of somatic embryogenesis research, including its expansion to pine species. Pines were not responding to the SE protocols developed for larches and spruces and required extensive research to become responsive. CFS has pioneered research that resulted in the establishment of successful SE protocols for eastern white pine and its hybrids, jack pine, western white pine and, more recently, lodgepole pine (the latter through collaboration with the University of British Columbia in Vancouver). Research is also being conducted on other economically important or endangered conifer species, such as pitch pine, whitebark pine and western redcedar.

Rejuvenation of adult conifers

Somatic embryogenesis is a technique that does not work well with tissues extracted from adult conifers, in spite of all the advances made in forest tree biotechnology. The ability to clone adult trees (as opposed to juvenile ones) offers a significant advantage for the rapid improvement of forest trees because growth performance and other characteristics are already known. The challenges encountered in applying SE to adult white spruce were recently overcome by inducing somatic embryogenesis from shoot bud explants. By producing somatic seedlings from these explant tissues, scientists are recreating the development of a given tree from embryo to adult. Researchers are also striving to gain a better understanding of the causes of conifer resistance to clonal propagation by identifying the genes that trigger somatic embryogenesis.

Operational implementation

As with other technologies, the goal of somatic embryogenesis research is to develop operational applications. A few Canadian provinces and one forest company, J.D. Irving Ltd., are working in this area. Collaborative efforts by all forestry stakeholders (governments, universities, industry, etc.) are essential for the operational implementation of SE on a large scale.

USEFUL LINK:

Somatic embryogenesis in Quebec (in French only):
http://www.mrn.gouv.qc.ca/publications/forets/connaissances/recherche/Lamhamedi-Mohammed/DesPlants-des-Hommes-9-3-6-11.pdf

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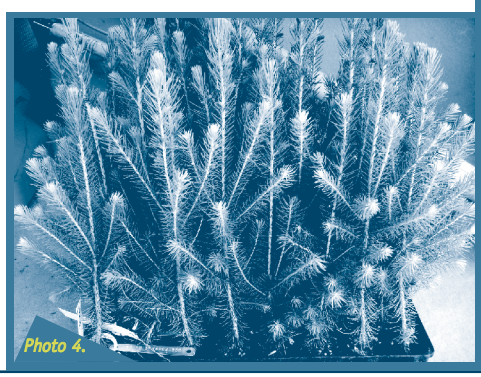
Photo 4.

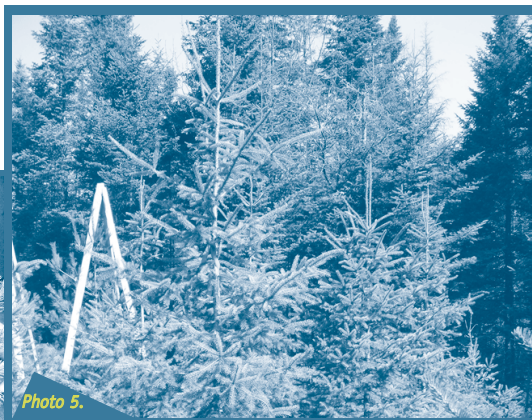
Photo 5.

Photo 4. Two-year-old somatic seedlings (juvenile copies) of the tree on photo 5.
Photo 5. Ten-year-old somatic white spruce.
Photos: K. Klimaszewska (CFS)

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