PREFACE

For many, the terms aging, maturation and senescence are synonymous and used interchangeably, but they should not be. Whereas senescence represents an endogenously controlled degenerative programme leading to plant or organ death, genetic aging encompasses a wide array of passive degenerative genetic processes driven primarily by exogenous factors (Leopold, 1975). Aging is therefore considered a consequence of genetic lesions that accumulate over time, but by themselves do not necessarily cause death. These lesions are probably made more severe by the increase in size and complexity in trees and their attendant physiology. Thus while the withering of flower petals following pollination can be considered senescence, the loss of viability of stored seeds more clearly represents aging (Norden, 1988). The very recent book "Senescence and Aging in Plants" does not discuss trees, the most dominant group of plants on the earth. Yet both angiospermic and gymnospermic trees also undergo the above phenomena but less is known about them. Do woody plants senesce or do they just age? What is phase change? Is this synonymous with maturation?

While it is now becoming recognized that there is no programmed senescence in trees, senescence of their parts, even in gymnosperms (e.g., needles of temperate conifers last an average of 3.5 years), is common; but aging is a readily acknowledged phenomenon. In theory, at least, in the absence of any programmed senescence trees should live forever, but in practice they do not. Is death simply a response to external environmental factors?. As trees grow older, their growth rates decrease, and although they apparently never stop growing, very old trees increase in size rather insignificantly. Under natural conditions, a plot of the cumulative height and diameter growth by dominant trees in a stand exhibits a sigmoidal growth curve, with the maximum annual increment occurring relatively early in the age of the tree (Assmann, 1970, quoted in Greenwood, 1988). The time at which the maximum increment occurs appears to be species-specific; and for the same species occurs later on relative poor soils, but at the same relative height and diameter. While there is little doubt that the maximum size a tree can attain is primarily a function of its genetics, is incremental growth more a function of size rather than chronological age? Is the phase-change process a consequence of the amount of growth that has occurred or is it the result of the physiological consequences of increased size (Greenwood, 1988)?

There are other equally intriguing questions. Do the above changes arise from the accumulation of harmful metabolites with time, or from the physical, biophysical and physiological consequences of trees having to sustain such a large mass, the requeriments to move large volumes of water and nutrients, and photosynthates over great distances? Although the debate as to whether meristems themselves age continues, more and more researchers have come to accept this idea, as first suggested by Shaffalitsky de Muckadell (1959); so much so that today we accept the fact that the oldest part of a tree chronologically is the youngest part developmentally, and attempt to utilize this fact in clonal propagation of woody plants.

The organizers of the 1989 NATO Advanced Study Institute (ASI) on the "Molecular Basis of Plant Aging" recognized these and other dilemmas we face in understanding the behaviour of woody plants. They explicitly state that "Aging is a phenomenon of considerable theoretical importance in relation to morphogenic control, differentiation and determination in plant development. It also has practical importance due to its implication in several economical areas such as flowering, fruit set, "in vitro" tree manipulation, genetic improvement, etc".

Although many theories have been advanced to explain aging, the mechanisms involved in this process still are among the least understood factors in biology. Thus, to increase our knowledge in this scientific field will be very useful for a better understanding of plant biology.

Due to the loss of morphogenic competence, aging is one of the most critical barriers to capture special genetic traits of selected trees. In order to fully exploit the possibilities that tissue culture technologies provide for forest tree improvement, it is imperative to establish first the conditions to maintain plant tissues in their most reactive phase.

Thus I was delighted to accept the invitation of Prof. Roberto Rodríguez of the University of Oviedo, to participate in this ASI, which was held in Ribadesella, Asturias, Spain from June 25 to July 8, 1989. The objective of such ASI is to disseminate advanced knowledge not yet in University curricula and foster international scientific contacts through high level teaching courses. The organizers of this ASI accepted this mandate, and rose to the challenge of providing a detailed description of the process which occurs during aging. Thus, some 70 participants from 15 countries, consisting of graduate students, post doctoral fellows, recently and long established researchers from Universities, Government Research Institutions and Private Industry assembled in ribadesella to address their charge.

The programme was divided into five sections, namely, 1. Juvenility, maturation and rejuvenation, 2. Vegetative propagation, advantages and limitations, 3. Ultrastructural, genetic and biochemical characteristics of aging and senescence, 4. Modulators of aging and maturation, and 5. Genetic manipulations. Information was presented in the form of major lectures (review and primary data), posters and short presentations. The work of each section ended with a round-table discussion. The results of these deliberations are captured in this volume.

It is not easy to summarize in a few sentences the gist of a meeting with so wide a theme and with such a large number of presentations, both oral and by posters. Nevertheless, in a very superficial way, one can divide the meeting in two very broad areas. These were: 1) problems and practices of woody plant tissue culture, and 2) biochemical and molecular aspects of aging. Any such division is bound to be arbitrary and several papers in this volume fall into neither area, and perhaps this division structuralizes the ASI, which has led to the production of this very important volume.

A number of papers dealt with the culture and manipulation of woody plants, particularly as these were affected by the maturation process. Some technology, such as use of the vibratome for explant production, thin layer methodology and micrografting techniques, was also presented. Factors affecting culture establishment and multiplication, problems of vitrification, polyphenol production, generation of somaclonal variation, the use of minimal culture media, including the possible harmful effects of cytokinins, and the gaseous environment on the cultures all received attention. Because mature woody species are less responsive in culture, not only was the nature of the phase-change discussed, but empirical approaches to reactivate or reinvigorate woody explants for ease of manipulation in culture were also described. Some physiological and biochemical aspects of regeneration were also covered.

The second major focus was on the genetic biochemical and molecular basis of phase change, and aging in woody species. The use of information from senescent herbaceous systems served as a model for understanding aging and its related phenomena, as many of the manifestations of aging are similar to senescence. Nitrogen metabolism, oxidative stress, free radical generation, and the role of phytohormones were among the topics covered. One view that seemed to emerge is that the rate of results from aging, a balance between oxidative stress damage and regenerative repair capacity. Lastly, the potential genetic manipulation of forest trees by traditional and molecular approaches to generate the forest tree of tomorrow highlighted the last session.

The value of NATO ASIs, such as this one, cannot be overestimated. It brought together citizens of various countries, scientists from different disciplines, people of both sexes and of different ages and experiences for a period of two weeks to think on the common topic. Different perspectives were brought to bear on the subject and the format allowed for the free and unfettened exchange of ideas. Although many questions remain uncovered, we are all a little clearer in our understanding of aging and maturation in woody plants, of the role that stress plays in tissue cultures, etc. This volume allows us to share our experiences with a much wider audience. A trust that all of you who read and study their articles will gain as much knowledge and pleasure in doing so, as we who participated in this ASI had during our two weeks in Ribadesella.

The organizers and Scientific Committee under the Directorships of Roberto Rodríguez and Don Durzan deserve our sincere gratitude for job well done.

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