Phenology and seasonality of woody plants: An unappreciated element in global change research?

Martin J. Lechowicz and Takayoshi Koike

It is regrettable, but not surprising, that phenology has received relatively little attention from ecologists. Phenological data are hard won, accumulating only slowly through careful, daily observations not well suited to the demands of a thesis project or a grant cycle. Organizing coordinated and standardized observations over many sites and many years is a daunting task not much in keeping with the priorities of most granting agencies. Until very recently, it was impractical to simulate realistic diurnal and seasonal climate regimes as a basis for controlled phenological experiments (Wang et al. 1994). Despite these difficulties work on the phenology of woody plants has continued and invites incorporation into a variety of ecological analyses. We convened a symposium at the XVth International Botanical Congress to highlight contemporary work on the phenology of woody species in the hope that this topic would gain wider recognition and support. The papers that follow include most of those presented at the symposium.

Helmut Lieth, who has long appreciated the importance of phenological studies (1974), provided an excellent introduction to the symposium. He reported on the long tradition of phenological observation, including contemporary efforts like the International Phenological Gardens that include clonal plantings at sites throughout Europe (Polte-Rudolf 1993). He emphasized the availability of long-term historical records of phenological observations (Lieth 1974; Polte-Rudolf 1993), which provide a basis and reference for current work. Martin Lechowicz drew on some of these historical records to explore the interrelationships among reproductive events and foliar phenology in eastern North American deciduous trees. Kihachiro Kikuzawa presented an overview of his models for foliar phenology, including an outline of their recent extension to questions of coordination between canopy architecture, leaf physiology, and leaf phenology. Takayoshi Koike reports an experimental study that followed the phenological as well as physiological responses of tree seedlings to elevated CO₂ levels. Heikki Hänninen presented a set of linked models that related phenological events to environmental signals; he illustrated the use of the models in an experiment manipulating the photoperiodic and thermal regimes of Pinus sylvestris. Finally, Peter Reich offered a review of foliar phenology in tropical regions, which served to broaden the discussion of the preceding papers that were based primarily on work at higher latitudes. These papers are neither comprehensive nor definitive in themselves but may serve to help stimulate a greater attention to the study of phenology, especially in the context of plant responses to global change.

With the notable exception of work by Cannell and his colleagues (Cannell and Smith 1986; Murray et al. 1989; Cannell 1990), until recently little of the rapidly advancing research on the effects of global change on woody species has concerned phenological effects (Eamus and Jarvis 1989; Bazzaz and Miao 1993; Mooney and Chapin 1994). Because of their longevity and limited rates of dispersal, woody plants may be especially vulnerable to the rapid shifts in climate associated with global change (Wang et al. 1994). The dependence of tree phenology on climatic signals is well established (Hunter and Lechowicz 1992; Kramer 1994), and the alteration of the seasonal coordination of photoperiod and thermal regime in a changing climate can have adverse effects on tree performance (Hänninen 1991). This may alter competitive relationships among forest trees and contribute to changes in their distribution and abundance, a possibility supported by paleoecological evidence. For example, the greater seasonal contrast in temperature and the increased springtime insolation in the Midwestern United States between 13,000 and 8000 BP led to forests rich in Ostrya virginiana and Carpinus caroliniana, both minor species in present forests (Delcourt and Delcourt 1994). It remains a significant but unresolved question whether any effects of climate change on individual species actually exert significant influence on productivity at the scale of global climate models (Ehleringer and Field 1993; Mooney and Chapin 1994). Perhaps the green wave that marks the onset of the growing season in satellite images of high latitudes (Schwartz 1994) will be little altered by climate induced shifts in species abundance or productivity. Nonetheless, we would argue that physiological studies that bear on variation in plant productivity are best interpreted in the context of phenological responses to seasonality.

M.J. Lechowicz. Department of Biology, McGill University, 1205 Avenue Dr. Penfield, Montreal, QC H3A 1B1, Canada.

T. Koike. Department of Environmental Science and Resources, Tokyo University of Agriculture and Technology, Satwai-cho 3-5-8, Fuchu, Tokyo 183, Japan.
References


---

Canadian Journal of Botany

Volume 73, Number 2, February 1995

---

Revue canadienne de botanique

Volume 73, numéro 2, février 1995

---

Phenology and Seasonality of Woody Plants: The Effects of Climate Change

*A symposium held at the 15th International Botanical Congress, Yokohama, Japan, August 1993*

---

**Phenology and Seasonality of Woody Plants: The Effects of Climate Change**

*Un symposium tenu lors du 15e Congrès international de botanique, Yokohama, Japon, août 1993*

---

Martin J. Lechowicz and Takayoshi Koike 147–148

Takayoshi Koike 149–157

K. Kikuzawa 158–163

P.B. Reich 164–174

Martin J. Lechowicz 175–182

Heikki Hänninen 183–201

Introduction / Introduction d’ouverture: Phenology and seasonality of woody plants: An unappreciated element in global change research?

Effects of CO$_2$ in interaction with temperature and soil fertility on the foliar phenology of alder, birch, and maple seedlings

Leaf phenology as an optimal strategy for carbon gain in plants

Phenology of tropical forests: patterns, causes, and consequences

Seasonality of flowering and fruiting in temperate forest trees

Effects of climatic change on trees from cool and temperate regions: an ecophysiological approach to modelling of bud burst phenology