Preface

Life on earth has probably existed for more than 3.5 billion years. During this timespan, organisms have continuously been subjected to changing environmental conditions. Apparently, the capacity to adjust to changes is one of the most important properties of the living state. This can be possible only if organisms sense and respond to changes occurring around them rapidly enough to meet oncoming challenges. It implies that organisms are capable of modifying themselves and of passing on modifications to successive generations.

In this volume, various responses of plants to changes in their environment are described. Environmental changes may trigger pre-existing switches in developmental programs that reversibly modify the phenotype or, in other instances, induce the elaboration of new developmental programs that include permanent, heritable, DNA modifications.

A plant simultaneously faces two environments. The shoot, above ground, faces such parameters as light intensity, light quality (wavelength), photoperiod, CO_2 concentration, relative humidity, temperature, pollution, and pathogens. The root, in the soil, faces such parameters as water availability, mineral nutrient concentrations, salt concentrations, O_2 concentration, soil compactness, temperature, heavy metals, pathogens, and symbiotic organisms that assist the plant in obtaining nutrients. All these parameters affect plant growth and development. The shoot informs the root of aerial conditions, while the root informs the shoot of soil conditions. This information is transmitted by transfer of molecules such as phytohormones, minerals, photosynthates, and water. When external conditions are not compatible with the developmental trajectory being expressed, the plant has the capacity to modify its developmental program. It is this capacity of plants to modulate their developmental trajectory that is discussed in this book.

Topics have been chosen to provide examples of different types of stresses and of plant responses encountered in nature. They are written by experts who have contributed to the development of their field in recent years. The contributors were completely free to express their opinions; each one, including the editor, is solely responsible for his or her opinions. The chapters in Part I provide necessary background in order to have the perspective to appreciate the information presented in the chapters that follow.

The evolution of scientific thought has shaped our outlook. A researcher's concept of what is possible determines the interpretation of what he or she has observed. The concept of what is possible is also the driving force for planning further experimentation. Since the response of plants to the environment cannot be described without discussing information from several fields of research, this volume presents information on whole plant physiology, on the role played by phytohormones and on the development of competence to respond to phytohormones, on interactions between different types of organisms, as well as on modulation of genome organization and on evolution.

Humans have an inherent difficulty in understanding the world in which they are living. This has given rise to various hypotheses designed to explain natural phenomena. Some hypotheses have eventually become dogmas, beliefs that are accepted without any need to be demonstrated. Science has developed because some individuals had a need to reduce the dogmas to a minimum. Scientific reasoning has been based on "as logical as possible" interpretation of data. This approach is often referred to as "Ockham's razor," after William of Ockham (1285–1349), who stated that "entities are not to be multiplied beyond necessity" (which means: do not overinterpret results). This principle was also invoked by others, as when Galileo (1564–1642) defended the simplest hypothesis of the heavens. The French mathematician Henri Poincaré (1854–1912) expressed the opinion that scientific studies should be free of dogmas.

A living organism is extremely complicated, and often, its behavior is not, *a priori*, predictable. The response of a plant depends on a multitude of biological pathways having numerous interconnections. In such an intricate network, mechanisms responsible for responses to stress are difficult to unravel. Logic based on a single linear pathway concept cannot be used to describe the mechanisms involved. As Trewavas (Aust J Plant Physiol 1986, 13:447–457) has pointed out, in a network, control mechanisms are little understood, and behavior upon perturbation is usually counterintuitive. Moreover, some phenomena seem to be beyond our capacity to understand.

As our knowledge of the living process progresses, the brilliant hypotheses of yesterday often become the hindering dogmas of tomorrow that interfere with the further advancement of science. A typical example of the lack of openness of new ideas followed the discovery of transposable elements in plants by Barbara McClintock in the early 1940s. At first, this concept was not accepted because it did not fit the dogmas of the time. More than 30 years later, after transposons had been rediscovered in other types of organisms, McClintock's discovery was accepted by the scientific community, and she finally received the Nobel prize in 1983. McClintock, however, not only suggested the existence of transposons but also that under stress the genome has a capacity for rapid reorganization (McClintock, Stadler Symp 1978, 10:25–47). This concept has not yet been accepted, although it has also been documented by others such as Durrant, and Cullis on flax (Cullis, Adv Genet 1990, 28:73–97). These authors showed that certain flax genotypes are modified phenotypically when germinated and grown in unbalanced mineral nutrients. High excess of nutrients causes the aerial part of the plant to be much bigger, while very low nutrient concentrations cause the aerial part of the plant to be much smaller. When seeds of these big or small plants are germinated and grown in balanced mineral nutrient media, the new phenotype of the parent persists. These phenotypic modifications have been maintained for all generations tested, and are accompanied by changes in the copy number of certain repetitive DNA families, suggesting that genetic modifications occurred within one generation.

Compartmentation into fields of knowledge and of research is a serious problem in science. Each field has its own jargon, journals, societies, and meetings. Nature, however, is not compartmented according to fields. In this volume an attempt has been made to present relevant data on the response of plants to environmental stresses, from modulation of gene expression to rapid genome reorganization, presenting different aspects and opinions, even if controversial.

This book will interest all those interested in life.

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