Preface

Plants are generally considered to be passive and insensitive organisms. One can trace this strong belief back to Aristoteles, who positioned immobile plants outside of the sensitive life domain. The millennia that have elapsed between time of Aristoteles and the present day highlight the fact that it will very difficult to change this almost dogmatic view. For instance, one of the first serious attempts to rehabilitate plants was performed by no less than Charles Darwin, in 1880. At the end of the book *The Power of Movement in Plants*, which he wrote together with his son Francis, they proposed that the root apex represents the brain-like anterior pole of the plant body.

This volume, in fact the whole series, documents a paradigm shift that is currently underway in the plant sciences. In the last two or three decades, plants have been unmasked as being very sensitive organisms that monitor and integrate large numbers of abiotic and biotic parameters from their environment. That plants react to electric stimuli in the same manner as animals was shown by Alexander von Humboldt a few years after Luigi Galvani discovered the electrical stimulation of animal muscles in frogs' legs. Later, when animal action potentials were discovered in animals, similar action potentials were soon recorded in plants too. Initially only "sensitive plants" were tested, but some 30 years ago it was found that all plants use action potentials to respond to environmental stimuli. This rather dramatic breakthrough went almost unnoticed in the mainstream plant sciences. Only recently, the emergence of plant neurobiology has highlighted this neglected aspect of biology. The obvious conservation that occurs throughout evolution means that action potentials provide both plants and animals with evolutionary advantages that are crucial to their adaptive behavior and survival. As plants evolved action potentials independently of animals, this phenomenon also holds the key to illuminating the mystery of convergent evolution, a phenomenon that does not conform to the classical Darwinian principles of biological evolution.

Recent advances in chemical and sensory ecology have revealed that plants communicate via volatile and allelochemical chemical messengers with other plants and insects. By using a wide variety of volatiles, plants are able to attract or repel diverse insects and animals, enabling them to shape actively their biotic niche. The number of volatile compounds released and received by plants for communication is immense, requiring complex signal-release machinery, as well as "neuronal" decoding apparatus to correctly interpret the received signals. These aspects of plant activity have not been studied yet. Plants integrate and memorize numerous sensory "experiences" in order to adapt effectively to an ever-changing environment.

Plants also show active behavior, including kin and self/nonself recognition, cognition, and a plant-specific form of intelligence. In order to find their prey, parasitic plants use sophisticated sensory detection systems, and after colonizing the prey tissues they conform to an animal-like heterotrophic lifestyle. Plants often apply deception as an effective strategy to manipulate other organisms, including insects, other animals, and perhaps even us humans. They use colors, forms and odors, as well as taste-stimulating, nutritional and neuroactive substances to manipulate insects, animals and humans in order to aid their spread around the globe. Crop plants like wheat, maize, barley and rice are the most successful species in this respect. New concepts are needed and new questions must be asked in order to advance our rather rudimentary understanding of the communicative nature of sensory plants.

One of the goals of current plant science is to improve the agricultural properties and stress adaptabilities of plants. However, we will not achieve this goal until we unravel the communicative, sensory, and cognitive aspects of these organisms. Moreover, our civilization still is—and will continue to be in the future—fully dependent on plants, since they (together with unicellar photosynthetic organisms) are the only primary source of oxygen and organic matter on this planet. Recently, humans have begun to use plants extensively to produce biofuels. Due to the continuing problems with hunger in underdeveloped countries, this presents our civilization with a dilemma: what proportion of plants should be grown for food and what proportion for energy? Our future depends on us gaining a complete understanding of plants in their full complexity.

Bonn, October 2008 František Baluška