PREFACE

As photosynthetic organisms that convert solar energy into chemical energy, plants are a primary source of organic compounds of all sorts and the object of a great covetousness for a myriad of biotrophic organisms. They represent a source of food for countless herbivorous, pollinating, parasitic, pathogenic and symbiotic organisms. These organisms are insects, nematodes, plants, bacteria, fungi and oomycetes to only cite the prominent ones. With no eyes, ears, nose and motility, plants would be most vulnerable if they had not developed sophisticated ways to perceive, recognize and manage the presence of all these swarming biotrophic organisms surrounding them. Upon all these biotic stimuli, plants know how to find the proper responses consisting in modifying their metabolism to produce repellent compounds and triggering their immune system against foes, or consisting in unrolling the red carpet out to attract and accommodate beneficial friends. This book provides our most recent knowledge on how plants communicate with their biotic environment, not only to safeguard their integrity but also to develop win–win cooperation. It shows that the chemical identity of the molecular signals, the pathways of their perception and transduction, the plant responses as well as the importance of these signalling processes from an ecological and evolutionary perspective are increasingly being unveiled. The book includes twelve chapters organized in three main parts that describe how plants communicate with other plants, with microbes and with animals.

Plant–plant signalling involves specific secondary metabolites, including volatile organic chemicals (VOCs), that are produced by plants under biotic stress. Then eavesdropping neighbouring plants can adjust their defences and increase their fitness after perceiving these VOCs (Chapter 1). Other secondary metabolites or allelochemicals can also be constitutively released by some plants and have a negative effect on neighbouring plants (Chapter 2), thus playing a role in plant competition and vegetation dynamics. In more intimate plant–plant interactions, like in root parasitic interactions, the plant parasite must recognize very specific host-released molecules to complete its life cycle (Chapter 3). Plants interconnected by the mycelium of symbiotic fungi, the common mycorrhizal network, can also exchange information. The fungus can transport warning signals produced by plants under biotic stress to neighbouring plants before they are themselves attacked (Chapter 4).

Plants also communicate with all kinds of different microbes. Some of them, mainly composed of bacteria, fungi and oomycetes, represent plant microbiota and live on the surface of seeds, roots and leaves. Their community is shaped by various trophic interactions and exchange of specific molecules (Chapter 5). Others are rhizobacteria living in the rhizosphere. They establish a close relationship with plant roots and play important roles for promoting plant growth and activating plant defences (Chapter 6). Less frequent but harmful microbes can also invade plant tissues and cause severe diseases. In a complex arms race, plants have learned to combat these pathogens while these latter have developed specific proteic weapons (effectors) to circumvent plant defence mechanisms (Chapter 7). To improve their nutrient acquisition, plants also establish symbiotic relationship with highly beneficial microbes such as nitrogen-fixing bacteria and mycorrhizal fungi. Intimate signalling pathways take place here. These pathways show striking commonalities as a result of a long history of plant–microbe coevolution (Chapter 8).

The interactions between flowering plants and their animal pollinators such as flies, bees, beetles, birds, bats and others are based on tricky communication involving visual, olfactory, gustatory or tactile signals that can be honest but also mimicked and deceptive (Chapters 9 and 10). Constitutively or after induction, plants also emit volatile chemicals which provide cues to repulse or attract herbivores. Plants can also perceive specific insect pheromones and modify their defence response (Chapter 11). Combinations of volatile, nonvolatile and chemotactic compounds originating from roots may also constitute long- and short-distance attractants to parasitic nematodes. Inversely nematodes produce specific chemicals and effectors that modify plant development and impede plant defence.

By describing the multiple and subtle ways by which plants interact with their biotic environment, this book addresses a fundamental aspect of plant biology and ecology. It has been conceived to target researchers specialized in one field of plant communication and interested to learn about other fields of plant communication. It is also for nonspecialist biologists and ecologists interested in plant biology such as biology/ecology teachers or students. Its originality is that the contributors, who are renowned scientists, belong to distinct scientific communities having different expertises in ecology, evolutionary biology and molecular biology. It addresses a topical subject as the natural biological processes described represent basic knowledge to develop low input sustainable agriculture.

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