

PREFACE

A characteristic feature of plants is their capacity to synthesize and store a wide variety of low-molecular-weight compounds, the so-called **secondary metabolites (SM)** or natural products. The number of described structures exceeds 100 000; the real number in nature is certainly much higher because only 20–30% of plants have been investigated in phytochemistry so far. In contrast to primary metabolites, which are essential for the life of every plant, the individual types of SM usually occur in a limited number of plants, indicating that they are not essential for primary metabolism, i.e. anabolism or catabolism.

Whereas SM had been considered to be waste products or otherwise useless compounds for many years, it has become evident over the last three decades that SM have important roles for the plants producing them: they may function as signal compounds within the plant, or between the plant, producing them and other plants, microbes, herbivores, predators of herbivores, pollinating or seed-dispersing animals. More often SM serve as defence chemicals against herbivorous animals (insects, molluscs, mammals), microbes (bacteria, fungi), viruses or plants competing for light, water and nutrients. Therefore, SM are ultimately important for the fitness of the plant producing them. Plants usually produce complex mixtures of SM, often representing different classes, such as alkaloids, phenolics or terpenoids. It is likely that the individual components of a mixture can exert not only additive but certainly also synergistic effects by attacking more than a single molecular target. Because the structures of SM have been shaped and optimised during more than 500 million years of evolution, many of them exert interesting biological and pharmacological properties which make them useful for medicine or as biorational pesticides.

In this volume of Annual Plant Reviews, we have tried to provide an up-to-date survey of the function of plant SM, their modes of action and their use in pharmacology as molecular probes, in medicine as therapeutic agents, and in agriculture as biorational pesticides. A companion volume – *Biochemistry of Plant Secondary Metabolism* edited by M. Wink – published simultaneously provides overviews of the biosynthetic pathways (enzymes, genes) leading to the formation of alkaloids, glucosinolates, cyanogenic glucosides, non-protein amino acids, flavonoids and other phenolics and terpenoids. The mechanisms of transport and storage were also discussed as well as a general outline of the evolution of secondary metabolism.

The present volume is the second edition of a successful first edition, which was published in 1999 and which has received many positive responses from its readers. To achieve a comprehensive and up-to-date summary, we have invited scientists who are specialists in their particular areas to update their previous chapters. The present volume draws together results from a broad area of biochemistry, pharmacology and pharmacy and it cannot be exhaustive on such a large and diverse group of substances. Emphasis was placed on new results and concepts which have emerged over the last decades.

The volume starts with a bird's eye view of the function and utilization of SM (M. Wink), followed by a more detailed overview over the various modes of action of SM (M. Wink and O. Schimmer), including interactions with the major molecular targets, such as biomembranes, proteins and DNA. Some emphasis is placed on DNA modifying metabolites, on mechanisms involved in cytotoxicity and on SM interfering with elements of neuronal signal transduction (neuroreceptors, ion channels). The production of SM for defence is not restricted to plants, but can also be seen in other sessile organisms. SM are especially abundant in marine organisms. A. Putz and P. Proksch explore chemical defence in marine ecosystems. Because plants have to defend themselves against bacteria, fungi and viruses, it is not surprising that many SM exert antibacterial, antifungal and antiviral properties. The antimicrobial properties are reviewed with a special emphasis on medical application (J. Reichling). Because many pathogens have become resistant against antibiotics (e.g. MRSA), antibiotic substances from plants with different modes of actions become more important in the future. Mankind has used medicinal plants for thousands of years to treat health disorders and diseases. Although many of the traditional applications have been replaced by synthetic drugs these days, phytomedicine and phytotherapy is still in use and receiving much attention. J. Heilmann reviews new findings of plant-derived drug in the context of anticancer and chemopreventive properties, and drugs with anti-inflammatory, antidepressant, anti-ischaemic, antimalarial and immunostimulatory activities. The final chapter addresses the problem of the production of SM as some of them are difficult to obtain and thus very costly. An alternative to the plantation of medicinal plants in the field is the production of SM in plant cell and organ cultures or by recombinant microorganisms. The recent results and developments are reviewed by W. Alfermann.

The book is designed for use by advanced students, researchers and professionals in plant biochemistry, physiology, molecular biology, genetics, agriculture and pharmacy working in the academic and industrial sectors, including the pesticide and pharmaceutical industries.

The book brought together contributions from friends and colleagues in many parts of the world. As editor, I thank all those who have taken part in writing and preparation of this book. I thank Theodor C. H. Cole for help in preparation of the index. Special thanks go to the project editor Catriona Dixon from Wiley-Blackwell and her team for their interest, support and encouragement.

Michael Wink
Heidelberg