Preface

Chemistry becomes particularly interesting when reaching out to other disciplines and this has been documented impressively over the last few decades by many cooperative efforts with biology. One of these fields which is now over forty years old is what most chemists know as pheromone research, started in 1959 by Butenandt with the identification of the first pheromone, bombykol. But pheromones are only part of the larger area of inter-individual chemical communication in general. This means of transportation of information is not used to a great extent by human beings, but vastly exploited by other living organisms. The research on these subject is part of Chemical Ecology, a discipline which tries to understand why secondary metabolites are produced by a certain organism and what their effects and functions are in an ecological perspective. This field goes beyond the normally anthropocentric view of traditional natural product research with its focus on application for human welfare.

To understand a given chemical communication system normally one needs a close and fruitful cooperation between chemists and biologists, making this field particularly interesting for many scientists. Chemists are involved in this research by identifying the compounds which provoke behavioral or physiological changes in the receiver, synthesizing them or their analogs, often in enantiomerically pure form, to prove a structure and to provide material for biological testing, working on the biosynthesis, and doing research on the large biomolecules which are needed for formation or processing of the exogenous signal molecules.

The terminology used in this research area is not well established in the chemical community; while the term pheromone is widely known, semiochemical is not. Nevertheless, chemicals used in the communication between individuals are correctly called semiochemicals; recently the equivalent term infochemicals was introduced. These compounds can be further divided into pheromones, compounds used in communication between individuals of the same species, while allelochemicals serve interspecific communication. Most pheromones are releasers, i.e. they provoke a behavioral change in the receiver. More rare are primers, which provoke physiological changes. Allelochemicals can be divided into kairomones, which are advantageous for the receiver, while the emitter benefits from allomones. Synomones are advantageous for both the emitter and the receiver.

Many different functions of pheromones have been found since Butenandt. Aggregation pheromones attract both sexes to a special location, while sex pheromones are offered by one sex only to attract or arouse the other one. Trail pheromones used by ants mark food trails and alarm pheromones change the state of alertness of conspecifics. These are only some of the functions pheromones can have, and similar different functions can be found in allelochemicals as well.

This two volume book tries to give an overview from a chemical perspective about the progress made during the last decade in semiochemical research. Synthesis, a key field of organic chemistry, is covered in many chapters, but the most innovative work is presented concisely in the first chapter by K. Mori, the focus of which is on the synthesis of pheromones, which is mostly target oriented and only rarely used to invent new methodology. Most work has been done on insect pheromones, which is reflected by the selected synthesis and the number of chapters devoted to insects in this book. This chapter is followed by a review on the lepidopteran pheromones by T. Ando et al. This order is the best investigated so far, primarily because of the great economic importance of moths and butterflies. Some species are ideally suited to serve as model organisms in studies going beyond the identification of pheromones to signal perception (see the chapter by Leal) and biosynthesis (see the chapter by Jurenka).

Pheromone identification is still difficult because the structure of unique compounds present in small amounts in mixtures of similar molecules has to be elucidated. This topic will be discussed in detail by Ando as well as by others, showing nicely the recent progress in analytical techniques. The following chapter by R. Jurenka deals with insect pheromone biosynthesis with special emphasis on lepidopteran pheromones and also covers genetic aspects. The subsequent chapter by C. Keeling et al. describes the hymenopteran semiochemicals (bees and ants), describing pheromones and allelochemicals. The hymenoptera add a certain flavor to the scene, because now the complexity of social insects with their many interactions comes into play, as well as the multi-level (multi-trophic) signals used by parasitoids.

The first volume ends with a chapter by G. Pohnert on chemical defence in the marine environment. Defense compounds, which can be regarded as allomones, are often, but not always, more complex than other semiochemicals and may have unique modes of action. The biological mechanisms are not always easy to unravel, which is shown by some of examples. The reader may be tempted to compare the chemical complexity with that of terrestrial insect defence, which can be found in the second volume chapter by D. Daloze and J.-C. Braekman. Insects thus do not only produce interesting pheromones, but also complex allelochemicals for their own protection.

The second volume starts with biochemistry and new insights into pheromone perception and transport by W. Leal. These findings show that specificity is not only achieved by uniquenss of compounds or blends, but also by the perceiving receptors and transport molecules. The following chapters on bugs

and beetles by J. Millar and W. Francke and K. Dettner also cover methods used for identification besides target-oriented synthetic approaches and discussion on the application of pheromones in insect control. The book will close with two chapters on highly complex and relatively simple organisms, namely mammals and bacteria. B. Burger points out the difficulty in working with behaviorally complex animals for establishing biological activity of certain compounds or mixtures. Furthermore, complexity can also be found in exocrine secretions of mammals which poses specific problems to the analytical chemist. P. Williams et al. explore chemical communication in bacteria. Microbiologists often use different terminology than zoologists, but from my point of view quorum-sensing-factors are still pheromones or at least semiochemicals. This exciting new field shows extensive progress and facilitates the application of biotechnological methods more easily than in more complex animals.

Hopefully the reader will get an overview of the recent work in the field after reading the chapters. Nevertheless, many exciting subjects have not been included, especially when recent reviews exist, as is the case for semiochemistry of arachnids (spiders and mites) or cockroaches. Further interesting subjects are pheromones of fish, reptiles, amphibians, algae, fungi, yeast, insect-plant interactions, etc. The research described here lays the foundation for further progress in the future, which will definitely benefit from the technological advances seen during the last years in chemistry and biology. A better understanding of the role and function of secondary metabolites may hopefully be obtained.

Braunschweig, August 2004 Stefan Schulz