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Volume 1

Series Editors: Donat-Peter Häder and Giulio Jori

Photomovement

Volume Editors: Donat-Peter Häder and Michael Lebert

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COMPREHENSIVE SERIES IN PHOTOSCIENCES

Series Editors

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and

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European Society for Photobiology

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COMPREHENSIVE SERIES IN PHOTOSCIENCES – VOLUME 1

PHOTOMOVEMENT

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SERIES EDITORS' PREFACE

"Its not the substance, it's the dose which makes something poisonous!" When Paracelsius, a German physician of the 14th century made this statement he probably did not think about light as one of the most obvious environmental stress factors. But his statement applies as well to light. While we need light for example for vitamin D production too much light might cause skin cancer. The dose makes the difference. These diverse findings of light effects attracted the attention of scientists for centuries. The photosciences represent a dynamic multidisciplinary field which includes such diverse subjects as behavioral responses of single cells, cures for certain types of cancer and protective potential of tanning lotions. It includes photobiology and photochemistry, photomedicine as well as the technology for light production, filtering and measurement. Light is a common theme in all these areas. In the last decades a more molecular centered approach changed both, the depth and the quality of the theoretical as well as the experimental foundation of photosciences.

An example for the relationship between global environment and the biosphere is the recent discovery of ozone depletion and the resulting increase in high energy ultraviolet radiation. The hazardous effects of high energy ultraviolet radiation on all living systems is now well established. This discovery of the result of ozone depletion put photosciences in the center of public interest with the result that in an unparalleled effort scientists and politicians worked closely together to come to international agreements to stop the pollution of the atmosphere.

The changed recreational behavior and the correlation with several diseases in which sunlight or artificial light sources play a major role in the causation of clinical conditions (e.g. porphyrias, polymorphic photodermatoses, Xeroderma pigmentosum and skin cancers) have been well documented. As a result in some countries (i.e. Australia) public services inform people about the potential risk of extended periods of sun exposure for every day. The problems are often aggravated by the phototoxic or photoallergic reactions produced by a variety of environmental pollutants, food additives or therapeutic and cosmetic drugs. On the other hand, if properly used, light-stimulated processes can induce important beneficial effects in biological systems, such as the elucidation of several aspects of cell structure and function. Novel developments are centered around photodiagnostic and phototherapeutic modalities for the treatment of cancer, arteriosclerosis, several autoimmune diseases, neonatal jaundice and others. In addition, classic research areas like vision and photosynthesis are still very active. Some out of these developments are unique to photobiology, since the peculiar physico-chemical properties of electronically excited biomolecules often lead to the promotion of reactions which are characterized by high levels of selectivity in space and time.

Besides the biologically centered areas, technical developments have paved the way for the harnessing of solar energy to produce warm water and electricity or the development of environmentally friendly techniques for addressing problems of large social impact (e.g. the decontamination of polluted waters). While also in use in Western countries, these techniques are of great interest for developing countries.

The European Society for Photobiology (ESP) is an organization for developing and coordinating the very different fields of photosciences in terms of public knowledge and scientific interests. Due to the ever increasing demand for a comprehensive overview over the photosciences the ESP decided to initiate an encyclopedic series, the 'Comprehensive Series of Photosciences'. This series is intended to give an in-depth coverage over all the very different fields related to light effects. It will allow investigators, physicians, students, industry and laypersons to obtain an updated record of the state-of-the-art in specific fields, including a ready access to the recent literature. Most importantly, such reviews give a critical evaluation of the directions that the field is taking, outline hotly debated or innovative topics and even suggest a redirection if appropriate. It is our intention to produce the monographs at a sufficiently high rate to generate a timely coverage of both well established and emerging topics. As a rule, the individual volumes are commissioned; however, comments, suggestions or proposals for new subjects are welcome. We are proud to present this first volume of the series which covers the field of 'Photomovement'.

Donat-P. Häder and Giulio Jori
Summer 2000

VOLUME PREFACE

The last comprehensive volume on the physiology of movement was published 1979, more than 20 years ago in the context of the 'Encyclopedia of Plant Physiology'. In the preface of that volume the editors stated "... against the background of the rapidly evolving field of molecular biology, plant movements were considered, by some scientists, as 'classical' (= old-fashioned) topics which might not contribute much to 'modern' biology." When the original decision was taken to try to assemble a new volume centered around photomovement of plants, the editors were confronted with the same type of hesitations. We consider the volume in your hands as the best argument that light-controlled signal transduction chains are by no means old-fashioned but on the contrary are in the center of modern biology.

This volume emphasizes the involvement of all facets of biology in the analysis of environmentally controlled movement responses. This includes biophysics, biochemistry, molecular biology and as an integral part of any approach to a closer understanding, physiology. The initial euphoria about molecular biology as the final solution for any problem has dwindled and the field agrees now that only the combined efforts of all facets of biology will at some day answer the question posed more than hundred years ago: "How can plants see?" One conclusion can be drawn from the current knowledge as summarized in this volume: The answer will most likely not be the same for all systems.

However, progress in the molecular understanding of photoresponses is naturally not on the same level for all systems. While in some systems the photoreceptor and the main components of the signal transduction chains were identified, in many other systems the knowledge is far from complete. The editors strongly believe that this volume will intensify and stimulate further research based on the comprehensive summary of results and findings in every article and the potential application of methods, hypotheses and ideas to other systems.

Finally the editors would like to thank all the authors for their work, their cooperation and their gracious acceptance of editorial comments. Specifically, we would like to thank all authors who agreed to write chapters on very short notice which resulted from last minute changes in the outlining. U. Trenz is acknowledged for skillful and very patient final preparation of the manuscripts. Last but not least we would like to thank Elsevier for the efficient production and excellent layout.

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Professor Häder has worked on the photomovement of microorganisms, the effect of solar ultraviolet radiation on phytoplankton and is involved in space biology studying the effect of microgravity on motility in flagellates. He is a member of a Committee on Ecology for the German ministry for science and technology, expert for an Enquete commission of the German Parliament and a member of a UNEP commission on the effects of the ozone destruction.

One of the tools for his research activities is a real time image analysis system developed over the last fifteen years. He has published over 380 original papers and has been involved in eleven books as author, translator or editor.

Michael Lebert, Dr. rer. nat., is a senior scientist at the Department of Botany and Pharmaceutical Biology at the Friedrich-Alexander University at Erlangen, Germany. He received his doctoral degree from the University of Munich. He was a postdoctoral fellow at the WSU, Pullman, U.S.A.

Dr. Lebert has worked on environmentally controlled signal transduction chains in microorganisms for 15 years. This includes the relevance of light and gravity on the behavioral reactions of motile protists and bacteria. In addition, he is interested in the effect of ultraviolet radiation on aquatic ecosystems. His special interest is in the interface between biology, electronics and computers.

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Chapter 1

Photomovement: past and future

Wolfgang Haupt

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