

**Photoreception and
Sensory Transduction
in Aneural Organisms**

NATO ADVANCED STUDY INSTITUTES SERIES

A series of edited volumes comprising multifaceted studies of contemporary scientific issues by some of the best scientific minds in the world, assembled in cooperation with NATO Scientific Affairs Division.

Series A: Life Sciences

Recent Volumes in this Series

- Volume 22* – Plant Regulation and World Agriculture
edited by Tom K. Scott
- Volume 23* – The Molecular Biology of Picornaviruses
edited by R. Pérez-Bercoff
- Volume 24* – Humoral Immunity in Neurological Diseases
edited by D. Karcher, A. Lowenthal, and A. D. Strosberg
- Volume 25* – Synchrotron Radiation Applied to
Biophysical and Biochemical Research
edited by A. Castellani and I. F. Quercia
- Volume 26* – Nucleoside Analogues: Chemistry, Biology, and Medical Applications
edited by Richard T. Walker, Erik De Clercq, and Fritz Eckstein
- Volume 27* – Developmental Neurobiology of Vision
edited by Ralph D. Freeman
- Volume 28* – Animal Sonar Systems
edited by René-Guy Busnel and James F. Fish
- Volume 29* – Genome Organization and Expression in Plants
edited by C. J. Leaver
- Volume 30* – Human Physical Growth and Maturation
edited by Francis E. Johnston, Alex F. Roche, and Charles Susanne
- Volume 31* – Transfer of Cell Constituents into Eukaryotic Cells
edited by J. E. Celis, A. Graessmann, and A. Loyter
- Volume 32* – The Blood–Retinal Barriers
edited by Jose G. Cunha-Vaz
- Volume 33* – Photoreception and Sensory Transduction in Aneural Organisms
edited by Francesco Lenci and Giuliano Colombetti



The series is published by an international board of publishers in conjunction with NATO Scientific Affairs Division

A Life Sciences

B Physics

C Mathematical and
Physical Sciences

D Behavioral and
Social Sciences

E Applied Sciences

Plenum Publishing Corporation

London and New York

D. Reidel Publishing Company
Dordrecht, Boston and London

Sijthoff & Noordhoff International
Publishers

Alphen aan den Rijn, The Netherlands, and Germantown
U.S.A.

Photoreception and Sensory Transduction in Aneural Organisms

Edited by
Francesco Lenci
and
Giuliano Colombetti

*Consiglio Nazionale delle Ricerche
Pisa, Italy*

PLENUM PRESS • NEW YORK AND LONDON
Published in cooperation with NATO Scientific Affairs Division

Library of Congress Cataloging in Publication Data

Nato Advanced Study Institute on the Photoreception and Sensory Transduction in Aneural Organisms, Versilia, Italy, 1979.

Photoreception and sensory transduction in aneural organisms.

(Nato advanced study institute series: Series A, Life sciences; v. 33)

“Lectures presented at the NATO Advanced Study Institute on the Photoreception and Sensory Transduction in Aneural Organisms, held in Versilia, Italy, September 3–14, 1979.”

Includes index.

1. Photobiology—Congresses. 2. Photoreceptors—Congresses. 3. Senses and sensation—Congresses. I. Lenci, F. II. Colombetti, Giuliano. III. Title. IV. Series.

QH515.N22 1979

574.19'153

80-12426

ISBN 978-1-4615-9166-5

ISBN 978-1-4615-9164-1 (eBook)

DOI 10.1007/978-1-4615-9164-1

Lectures presented at the NATO Advanced Study Institute on the
Photoreception and Sensory Transduction in Aneural Organisms, held in
Versilia, Italy, September 3–14, 1979.

© 1980 Plenum Press, New York

Softcover reprint of the hardcover 1st edition 1980

A Division of Plenum Publishing Corporation
227 West 17th Street, New York, N.Y. 10011

All rights reserved

No part of this book may be reproduced, stored in a retrieval system, or transmitted,
in any form or by any means, electronic, mechanical, photocopying, microfilming,
recording, or otherwise, without written permission from the Publisher

PREFACE

This book collects all the lectures presented during the NATO Advanced Study Institute on "Photoreception and Sensory Transduction in Aneural Organisms," held in Villa Le Pianore (Versilia, Italy), September 3-14, 1979.

In order to publish the lectures in the shortest possible time, we had to make the decision not to include the free communications, the informal seminars, and the panel discussions, notwithstanding their very high scientific level and interest. Only the final panel discussion has been summarized by Prof. W. Haupt (whose effort we gratefully acknowledge), because it gives a comprehensive view of the state of the art in this field.

The ASI was intended to be a high-level course, characterized by an interdisciplinary approach to the problem of photoreception and photosensory physiology in aneural organisms, bringing together scientists from different fields and specializations. We hope that these characteristics are reflected in the content of the book, which is meant to be both an advanced textbook for researchers and students entering the field and a critical overview of the problems of photosensory transduction in aneural organisms. The topics presented range from a phenomenological description of the different photomotile responses in various microorganisms to a discussion of the molecular processes involved in the primary events of photoreception as well as in the subsequent steps of the transduction chain.

We owe a deep debt of gratitude to Maria Antonia Baldocchi and Graziella Baldeschi, whose organizational and typing expertise proved invaluable. Thanks are also due to Vincenzo Passarelli, who helped us in the final preparation of the book.

Finally, we gratefully acknowledge the generous financial sponsorship of the Scientific Affairs Division of the NATO (Brussels), which has made this ASI (and this book) possible.

Francesco Lenzi and Giuliano Colombetti
C.N.R.-Lab. Studio Proprietà Fisiche
Biomolecole e Cellule -
56100 PISA (Italy)

Pisa, November 27, 1979

CONTENTS

Sensory Transduction in Aneural Organisms	1
M. J. Carlile	
Introduction to Optical Stimuli: Physical Properties of the Light Beam	23
G. Montagnoli	
Phototile Responses in Flagellates.	45
M. E. Feinleib	
Phototile Responses in Gliding Organisms and Bacteria	69
W. Nultsch	
Phototropism of Lower Plants	89
R. Hertel	
Experimental Determination and Measurement of Photoresponses	107
B. Diehn	
The Photoreceptive Apparatus of Flagellated Algal Cells: Comparative Morphology and Some Hypotheses on Functioning	127
P. Omodeo	
Localization and Orientation of Photoreceptor Pigments	155
W. Haupt	
Identification and Spectroscopic Characteriza- tion of Photoreceptor Pigments	173
G. Colombetti and F. Lenci	

Primary Photophysical and Photochemical Reactions: Theoretical Background and General Introduction	189
P. S. Song	
Molecular Aspects of Photoreceptor Function: Carotenoids and Rhodopsins	211
R. V. Bensasson	
Molecular Aspects of Photoreceptor Function: Phytochrome	235
P. S. Song	
Molecular Aspects of Photoreceptor Function in <i>Stentor Coeruleus</i>	241
P. S. Song, E. B. Walker and M. J. Yoon	
Possible Photoregulation by Flavoproteins	253
V. Massey	
Bluelight Reception and Flavin Photochemistry	271
P. Hemmerich and W. Schmidt	
Basic Concepts in Bioenergetics	285
B. A. Melandri and G. Venturoli	
Properties of the Photosynthetic Membrane	303
J. Amesz	
Comparative Discussion of Photoreception in Lower and Higher Organisms. Structural and Functional Aspects	319
E. Hildebrand	
Photosensory Transduction Chains in Eucaryotes	341
G. Colombetti and F. Lenci	
Photosensory Transduction Chain in Procaryotes	355
D.-P. Häder	
Sensory Transduction in Phototropism: Genetic and Physiological Analysis in Phycomyces	373
V. A. Russo	

CONTENTS

ix

Panel Discussion "Sensory Transduction and Photobehaviors: Final Considerations and Emerging Themes"	397
W. Haupt	

PARTICIPANTS

INDEX