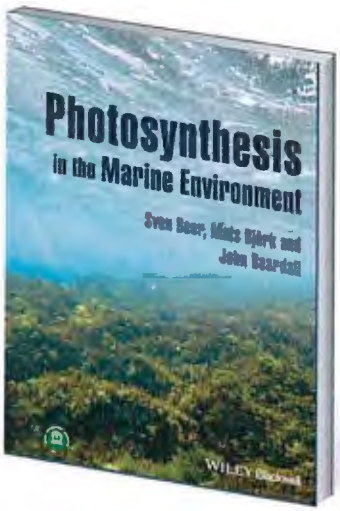
BOOK REVIEWS



PHOTOSYNTHESIS IN THE MARINE ENVIRONMENT

By Sven Beer, Mats Björk, and John Beardall, 2014, Wiley-Blackwell, 224 pages, ISBN 978-1-119-97957-9, Hardcover: $149.95 US, Paperback: $89.95 US, e-book: $71.99 US

Reviewed by Arthur Grossman

Photosynthesis in the Marine Environment was written by three experienced marine biologists, Sven Beer, Mats Björk, and John Beardall, who have all worked for many years on photosynthesis and the utilization of inorganic carbon in the marine environment. They have published numerous papers dealing with photosynthesis and the fixation of inorganic carbon by various marine organisms, including seagrasses, macroalgae, and microalgae, and how the environment impacts their photosynthetic activity. This book emphasizes how marine photosynthetic processes differ from those of terrestrial plants, and while it has sections that might be valuable for specialists, its strength is that it serves as an excellent introduction to photosynthesis in the ocean for graduate students and undergraduates, and even for advanced high school students. When describing photosynthesis in the ocean, the authors place it into the context of the evolutionary history of the planet/atmosphere and the massive changes in O_2, CO_2, and UV light that have occurred over the last three billion years. The book also provides a glimpse into the various types of photosynthetic organisms, from the macrophytic algae such as Porphyra and Ulva, to the coccolithophore-producing algae responsible for creating the calcium carbonate deposits of the white cliffs of Dover, to diatoms and their silica frustules, model green algae such as Chlamydomonas, and prokaryotic cyanobacteria with their ability to fix nitrogen and synthesize photoprotective UV absorbing compounds.

The text provides a menu of topics, stories, and thoughts that communicate scope and insights that will interest the young and the curious reader, and it provides new possibilities for research directions for scientist at all levels. Furthermore, the book benefits from a number of contributors who convey ideas and lessons they have learned by working with marine photosynthetic organisms (contained within boxed sections of the text) that add both depth and personality to the discussion. For example, John Raven muses on life on other planets and the possibility of the transfer of that life to Earth, Laura Steindler discusses the understudied photosymbiotic association that supports the growth of sponges, Stuart Larsen describes the measurement of ocean chlorophyll levels from satellites and how it may be used to monitor changes in the global ocean environment, and Lennart Axelsson discusses carbon utilization in macrophytic algae.

The illustrations are clearly presented, providing the reader with images of important oceanic organisms and primary data, graphs, and charts that emphasize many of the points being made in the text. Indeed, the figures and tables, which would be very useful props when teaching a class or a section of a class on photosynthesis (or on algae), are provided with the book as downloads obtained from the Wiley-Blackwell website.

There are some sections of the text that do not provide a lot of detail on specific aspects of photosynthetic activities in the ocean (light use and the various mechanisms used by the photosynthetic organisms for quenching excess absorbed light energy), and the book doesn't really deal with molecular aspects of photosynthetic processes, including new data obtained using genomics, transcriptomes (both chloroplast and nuclear gene), and recombinant DNA technology. Although some of these areas are covered in other books in the field (e.g., Falkowski and Raven's *Aquatic Photosynthesis* and Blankenship's *Molecular Mechanisms of Photosynthesis*), many molecular breakthroughs are relatively new, and the information is rapidly changing; these molecular subjects would benefit from a separate, more focused volume.

A major strength of *Photosynthesis in the Marine Environment* is found in the many sections that deal with the utilization of inorganic carbon, a subject on which the authors have spent much of their working lives. This area is explained in significant detail with discussions of the equilibrium of the different forms of inorganic carbon (in closed and open systems), the role of carbonic anhydrase in bringing those forms to equilibrium, and the strong impact that carbonic anhydrase has on the ways in which organisms concentrate inorganic carbon (both bicarbonate and CO_2) to overcome the poor affinity of the ribulose 1,5-bisphosphate carboxylase (initial activity involved in the fixation of inorganic carbon) for CO_2 and the low level of soluble CO_2 in the ocean (and the much higher concentration of bicarbonate).

Various mechanisms/models are presented that describe how inorganic carbon

is concentrated in both marine organisms and land plants. The authors also provide important insights into the symbiotic associations critical for life in the oligotrophic oceans, the physiological characteristics of seagrasses and how they evolved to be different from land plants once they migrated from the terrestrial environment back into the ocean 90 million years ago, the growth of epiphytes on algae, the rugged life that occurs in the intertidal zone, and the calcification of many of the algae and how that will be impacted by elevated atmospheric CO_2. A very valuable chapter describes many of the basic photosynthetic parameters that researchers measure and the various instruments and technologies they use, including Pulse Amplitude Modulated (PAM) Fluorometry, Fast Repetition Rate (FRR) Fluorometry, and $^{14}CO_2$ isotope labeling.

Overall, the book provides a concise and very readable excursion into the habitat of marine photosynthetic organisms, guided by the extensive research, teaching experience, and thoughtfulness of the three authors. It conveys the scope of many of the issues concerning photosynthesis, the degrading health of the marine environment, and our impact on that health ("We mess with the oceans at our own peril"), and provides practical insights into the ways in which photosynthesis in the ocean is measured (and the advantages and limitations associated with the different procedures). Extensive images of marine organisms and graphs and figures showing real data help clarify the discussions for both students and teachers, while the text also provides some lighter moments and highlights areas that would immediately benefit from additional work. This attempt to give direction to young scientists is evident in various sections of the text and enunciated when the authors say, in a somewhat wry statement, "Since we, the authors of this book are aging out of science (but still remain good hearted) we will try to point out where progress can be made by others, and possibly how." When speaking of desiccation and our lack of understanding of mechanisms by which intertidal macroalgae survive desiccation and rapidly regain their ability to photosynthesize upon rehydration, they simply recommend "Young scientists: go for it!" I think that the same exclamation could be applied to the purchase of this book.

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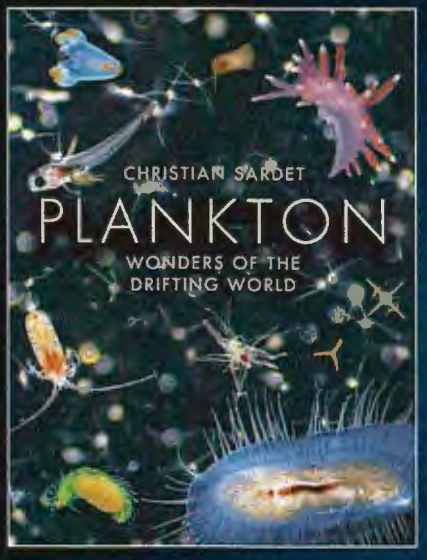

NEW AND NOTEWORTHY

PLANKTON: WONDERS OF THE DRIFTING WORLD BY CHRISTIAN SARDET, 2015, THE UNIVERSITY OF CHICAGO PRESS, 224 PAGES, 550 COLOR PLATES, ISBN 978-0-226-18871-3, $45US HARDCOVER, $27US E-BOOK. Written by Christian Sardet, cofounder and scientific coordinator of the Tara Oceans Expedition, *Plankton: Wonders of the Drifting World* assembles hundreds of stunning color photographs and concise descriptions of the ocean's fascinating and important floating organisms. One of the most wondrous is the dinoflagellate *Ceratium ranipes*. At sunrise, this plankton grows fingers filled with chloroplasts to optimize its surface area for photosynthesis, which retract at nightfall. An attention-grabbing series of seven photos shows two *Liriope tetraphylla* capture and ingest a fish hatchling, expelling the residue once the jellyfish had sucked out all of the juices of the tiny fish. A page with three large photographs of pteropods clearly display the different orange, yellow, and green colors of the organisms' hepatic glands and digestive organs, which the text tells us reflect what these mollusks ate.

Beautiful and informative, and written for a broad audience, *Plankton: Wonders of the Drifting World* should be on everyone's gift list this year. While older readers may still prefer flipping through a hard copy of this large-format book, the e-book version may be more appealing to the mobile-nimble generation.

– Ellen S. Kappel, Editor