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Book review

Environmental Photochemistry, Pierre Boule (Ed.), Springer-Verlag, Berlin, 1999, 359+xiv pp., £114.50, ISBN 3-540-62913-0

The environment that permitted the evolution of life on Earth, and the ultimate emergence of Man, was possible only because of the presence of solar radiation of the appropriate intensity and wavelength distribution. An extraordinary thermodynamic disequilibrium exists in our environment, and it is a consequence of the utilization of solar energy. The biota mediate an enormous entropy reduction, but photochemical processes bring it about. Photochemistry is thus the key to the origins of life, and photochemistry remains an essential element in the continued survival of life on our planet. Pierre Boule has brought together a group of colleagues to write about a selection of the processes, as seen as we near the new millennium. The choice of topics is perforce limited, but those presented are quite wide-ranging and representative. The volume is, in fact, part of a wider project entitled *The Handbook of Environmental Chemistry*, with Otto Hutzinger as its Editor-in-Chief. The series has been running for nearly 20 years, the present *Environmental Photochemistry* being categorized as Volume 2, Part L, and apparently running as roughly number 30 in the complete opus. Regardless of its place in this wider scheme, the volume under review consists of an entirely self-contained and fascinating set of chapters that explore specifically photochemical issues. One striking observation is that, despite the diversity of interests represented, a satisfyingly large number of the primary references cited are to papers published in the *Journal of Photochemistry and Photobiology.*

There are 11 chapters in all, and they start, very appositely, with an examination of the role of solar radiation in atmospheric chemistry. In this chapter, Madronich and Flocke discuss how the photodissociation of relatively stable molecules into radical fragments drives the entire chemistry of the atmosphere. These authors give a detailed and authoritative account of the determination of the rate coefficients for photodissociation, the knowledge of which is crucial to quantitative interpretation of atmospheric behaviour. If this chapter is regarded as 'upstream' environmental photochemistry, then 'downstream' activities are well represented by the contribution from Bahnemann on the photocatalytic detoxification of polluted waters. Man has, of course, greatly altered the chemical and physical behaviour of oceans, land and atmosphere as a consequence of his activities, and the chemical species that he releases. It is thus especially satisfying to photochemists to see their science employed in the service of remedying some of the worst excesses of Man's impact on his environment. The *Journal of Photochemistry and Photobiology* has, in fact, been publishing recently an increasing number of papers in the general area of what might be called 'photochemistry in the service of a cleaner environment', so that Bahnemann's chapter fits very well into one of the developing interests of our readership.

The two chapters just described are the first and the last of the book. Most other chapters fit in between these two not only in the order of the contents, but also in concept, concerned as several are with the photochemistry of anthropogenic pollutants. Typical amongst these contributions is that of Wallington and Nielsen, who present a review of the atmospheric degradation of anthropogenic molecules. An example of their interest is afforded by the search for environmentally acceptable replacements for the CFCs. Although the initial thrust was to discover compounds with the requisite properties than would not reach the stratosphere, and there destroy ozone, the very fact of the tropospheric chemical consumption of these alternative compounds means that entirely different environmental issues must be faced, and these latter include the impacts of the degradation products. Other chapters of this kind are directed largely at aquatic systems, including influences on oxidant formation and pollutant degradation (Faust); transformations photoinduced by the NO_3^-/NO_2^- system, by Fe^{III}, and by humic substances (Boule, Bolte and Richard); phototransformation of pesticides (Méallier); photodegradation of lipidic compounds during the senescence of phytoplankton (Rontani); and the phototransformation of phenol and its derivatives (Richard and Grabner). Photochemistry both in water and on solids is the topic of the contribution from Pagni and Sigman on polycyclic aromatic compounds (PAHs) and polychlorobiphenyls (PCBs). Schemes for the photochemically assisted destruction of these notorious compounds have been developed, and this chapter provides the photochemical background. PAH photochemistry is dominated by oxidation, either by singlet molecular oxygen or by superoxide.

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Singlet molecular oxygen in the environment is the explicit interest of another chapter, this time written by Larson and Marley. The present reviewer is bound to take special note of a subject that has been an interest throughout his scientific career, and the chapter indeed presents much to fascinate the reader. In the atmosphere, O_2 ($^1\triangle_g$) is produced in the photolysis of ozone, and possibly in the polluted lower atmosphere by energy transfer from excited organic molecules. Singlet oxygen certainly contributes, through its optical emission, to the atmospheric airglow, but it is still not established if its chemical reactions are of atmospheric significance. In natural surface waters, it is formed from humic substances, but rapid quenching probably prevents the participation of O_2 ($^1\triangle_g$) in other chemical reactions. In water polluted by light-absorbing species, or in non-aqueous media and on solid phases, the environmental impact of the excited species may be more significant.

The second chapter of the book, on emission and flash techniques (Brown), stands rather apart in concept from the other contributions. Although the title of the chapter includes the phrase 'in environmental photochemistry', much of the material is about the fundamental aspects of photochemistry and photochemical techniques, perhaps at a rather elementary level for the professional photochemists who will read the book (and who are likely to be the readers of this review), but nevertheless valuable for others who wish to find out how and why photochemistry can be pressed into service in tackling environmental problems. The consequence of Brown's approach is that there is rather little space left for examples of the applications of the techniques to genuine environmental systems.

It is, of course, almost impossible to provide a review of a multi-author book of this kind that is at the same time both compact and critical. Each chapter has its own approach, its merits, and its defects, and each would require a detailed analysis to do it critical justice. There is no single approach, or quality of presentation, or depth of coverage that allows a short overview. Nevertheless, the component chapters of the book to seem to have been written by experts, presenting their ideas with conviction and authority, and there is a coherence – often lacking in such volumes – that is the evidence of the guiding hand of a strong and perceptive editor. As a contribution to environmental studies, this book will make its mark, and I recommend it.

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