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Book reviews

Dynamics of leaf photosynthesis: rapid-response measurements and their interpretations. By A. LAISK and V. OJA. 25 × 17.5 cm. Pp. xiii + 160 with 76 text-figures. Collingwood, Victoria, Australia: CSIRO Publishing. Price p/b: $59.95. ISBN 0 643 06378 1.

The process of photosynthesis is probably the best understood and well characterized biochemical pathway. This wealth of knowledge can sometimes be a frustration to researchers. A common response to an admission that you work in this field is 'Isn't photosynthesis solved already?' On the other hand the refinement with which we can measure individual steps in a complex system means that we can investigate photosynthesis as a dynamic process in a way that can only be dreamt of in other experimental systems. Photosynthesis can be characterized over time scales that vary by 24 orders of magnitude. Light absorption can be resolved down to femtoseconds; net carbon gain can be measured over seasons or even decades (mega- to giga-seconds). *Dynamics of leaf photosynthesis* by Agu Laisk and Vello Oja is concerned with the middle of this range, presenting an overview of techniques that can be applied in the seconds to minutes time range and focusing in particular on measurements in intact leaves. The first in a series entitled 'Techniques in Plant Science', it aims to provide a practical users guide for researchers that is relevant not only in photosynthesis but also those with more general interests in plant stress, ecophysiology or in plant metabolism.

This volume comes over as very much a personal account and as a lesson in the triumph of ingenuity in the face of adversity. The authors come from Estonia and spent much of their careers in the Soviet system, largely isolated from the wider scientific world. This point is made by the authors in the preface but also comes over in the first two chapters of the book, describing the rapid response gas exchange systems that they have developed. This part of the work could be subtitled 'photosynthesis research on a budget' and is interesting in the thoroughness with which it describes the development of a gas exchange apparatus, starting from the basic physics of gas flow and working up. For a biologist, the algebra presented can be somewhat daunting and it was not clear to me that it was absolutely necessary, however, it is perhaps useful in making the point that the design of a gas exchange system is not a trivial problem. The second chapter describes in some detail the gas exchange system designed by (and now marketed by) the authors. This reads in places like a mixture between a users manual and marketing information for their product, however it does offer some interesting practical tips for anyone wanting to save some money and build their own.

The theory of gas exchange measurements is presented in some detail, including an explanation of the effects of complicating factors such as stomatal patchiness and light gradients through the leaf. Again, this bears the mark of the physicist, though here the relevance of the theory to the general user is clearer. Modern analysers, with in-built software, tend to isolate users from the theory by doing the calculations for them and the presentation of this will be good as a learning experience to inflict on students. The following chapter then goes on to show how such measurements can be applied in understanding transient processes, for example during photosynthetic induction or following step changes in gas concentration. The authors give a convincing presentation on how gas exchange data can be used to find out far more about a leaf than its rate of photosynthesis.

The final two chapters introduce the potential for using optical techniques in combination with gas exchange measurements, to understand the processes of photosynthesis. The chapter on fluorescence provides a fairly lucid (if somewhat simplified) account of the theory behind fluorescence analysis and will be useful to the beginners in this field. The limitation of this is that the terminology used reflects the preferences of the authors, making life difficult for readers already familiar with this topic. This is a general problem with all accounts of fluorescence analysis – why are we still unable to agree on the terminology? The chapter on using 800 nm absorbance changes to monitor P700 is of particular interest as few reviews exist for this technique.

The stated aim of this series is to present the detailed accounts of methods that are normally missing from the materials and methods section of a paper in a manner that would be suitable for a 'beginning researcher'. This first volume certainly presents such a detailed account, though I am unsure how suitable it is for the beginning researcher. For me, having the theoretical background to the measurements but lacking the first hand experience in the gas exchange techniques described, the volume was useful. I handed the volume to my first-year PhD student, who claimed to find it really helpful but, notably, hasn't asked to borrow it again. The parts of the book where the physics dominate maybe too daunting, but read selectively, this volume is both interesting and instructive. For the non-expert it should provide ample justification for continuing to study the complexities of photosynthesis.

G. JOHNSON

The shoot apical meristem. Its growth and development. By R. F. LYNDON. 24 × 14 cm. Pp. x + 277 with 62 text-figures. Cambridge, UK: Cambridge University Press, 1st edn, 1998. Price h/b: £55.00. ISBN 0 521 40457 6.

The shoot apical meristem (SAM) of the higher plant enveloped in many leaf primordia, with its seemingly

horrendous complexity, has been the obsession of many notable plant scientists, from C. W. Wardlaw, I. M. Sussex and P. B. Green to the author of this book, to name but a few. Perhaps it is because the SAM is so small and innocuous and yet exhibits such extraordinary morphogenetic potential that has prompted so many plant scientists to keep asking 'how does it make stems, leaves and flowers?' With the never ending range of molecular tools now available, the SAM is undoubtedly in vogue. However, despite its star billing, it may come as some surprise to the uninitiated that many undergraduates find the SAM about as exciting as watching paint dry. Or is it just some of my students? In my view, this jaundiced view stems partly from a school memory of plants as those boring funny green things with the strange anatomy, coupled with a lack of good undergraduate text books, Steeves & Sussex *Patterns in plant development*, Lyndon's *Plant development* and the very colourful chapter in Wolpert's *Development* the most obvious exceptions. Does Lyndon's new book help to stave off that impression and how much does it capture the excitement of SAM research? In effect, the book represents a lifetime's experience of studying, asking awkward questions and scrutinizing hypotheses about the SAM. In my view, it is an excellent read. Since I have worked with Lyndon and made comments on some of the draft chapters, the reader must decide about the extent of bias in my assessment.

The book is divided into 10 chapters, prefaced by what the SAM is and what it does. Chapter 1 takes a step back evolutionarily by considering apical cells of pteridophytes. In effect, Lyndon asks us to understand the origin and behaviour of the apical cell during development, because by so doing we can learn much about plane of division and cell fate in SAM. Chapter 2 then describes the SAM in terms of a source of cells. Clonal analysis and L1, L2 and L3 layers feature strongly. The very mention of the latter three layers raises the pulse of most arabidopsists, but Lyndon is quick to point out the flexibility of cells in those layers as shown by Tilney-Bassett through studies of variegated leaves and by Sussex through elegant probability fate maps. This in turn fits with the plasticity of the Tunica and Corpus during plastochron both within and between species. In this chapter, Lyndon also grapples with one of his pet hobby horses, the origin of the node and internode. Remarkably, the fate of axillary buds, internodes, and nodes is governed by a slither of cells sandwiched somewhere towards the base of the pith rib meristem. However, Lyndon notes that the potential now exists to identify genes which specify fates and they probably impose pattern remarkably early during the inception of various tissues. The origin of the SAM is also given an airing, and through the elegant work of Kathy Barton on shoot meristemless (*stm*) mutants we are now beginning to understand the action of master genes regulating cascades of tissue-forming genes.

Chapters 3 and 4 deal with growth rates and cell cycles, features of the SAM that are intrinsically linked. During the vegetative phase, basipetal gradients of cell size, of cell cycles and of growth rates exist within the SAM and many examples of this are given. The arrival of the floral stimulus in the SAM disrupts this order as cell cycles shorten and growth rates increase; Lyndon gives his views on how growth rate and cell cycle control in the SAM may be linked.

Chapter 5 describes the cytochemical make-up of the SAM and how gradients of nucleic acids (notably RNA) link with structural gradients mentioned in Chapters 3 and 4. Knowing about biochemical changes in the SAM (e.g. respiratory enzymes) for their own sake would tend to suggest a purely descriptive chapter, yet questions are posed about the nature of genes which encode proteins for specific functions of the SAM. This in turn tends to highlight what we don't know as opposed to what we do know and points to useful future areas of research.

Chapters 6–8 deal with primordium initiation, the positioning of primordia and the dynamic relationship between the SAM and leaf primordia. Much of what is written reflects the extent to which Lyndon's views have been influenced by the ideas of the late Paul Green. Indeed, sitting between the two of them at conferences was an ultimate challenge to get a word in sideways. These chapters begin with some explanation of the morphology of SAMs initiating leaf primordia and how changes in the plane of cell division are important in this alteration in directional growth leading to a bulge on the side of the SAM. However, these observations are tempered with the view that changes in surface microstructure represent another important component of leaf initiation. Here, Lyndon highlights the work of Green and colleagues that showed how changes in the orientation of cellulose microfibrils on the outer surface of epidermal cells have an important part of play in leaf morphogenesis. It seems that these various observations are consistent with the idea that leaf initiation depends on changes in the rate of cell division, coupled with an increased frequency of periclinal cell divisions in the peripheral zone and with changes in surface microstructure, which facilitates the outward primordial growth from the SAM. Positioning of leaves in phyllotactic patterns is then given a thorough airing. Hence we get an important historial perspective through consideration, among others, of the work of M. Snow & R. Snow, F. J. Richards and J. H. M. Thornley and their various theories of packing and diffusion reactions mechanisms, which try to underpin the regulation of primordium positioning. Biophysical considerations of microfibril orientation on the surface of both vegetative and inflorescence meristems again feature strongly (e.g. the work of Paul Green, Jean Selker and latterly Lyndon himself).

In Chapter 8, special attention is given to partitioning of the apex during vegetative floral growth. Much information if supplied about growth rates in the apex, changes in growth rate during primordium inception and the dynamic relationships between the apex and the primordium. The chapter is wrapped in a model in which auxin features as a localized signalling agent for leaf initiation. Given the backdrop of how to measure growth rates in meristems and what those measurements tell you, the availability of auxin-insensitive mutants now represent a valuable tool to test such models.

The final chapters (9 and 10) are devoted to flowering and they begin with phase change. Here, the operational terms, competence and determination are explained clearly and a neat overview of Carl McDaniel's experiments on determination is presented. A particularly interesting model of determination at the molecular level is given (Fig. 10.2) based on the time taken for homeotic gene products to lock in and reinforce a cascade of transcription factors

that could commit cells to specific developmental pathways. Floral evocation is explained but more importantly, Lyndon emphasizes the significant changes that occur in the evoked SAM that lead to flowering as opposed to changes that can be limited solely to growth. Finally, Chapter 10 deals with the new floral meristem and the cascade of genes that regulate organ position. An overview of LFY/FLO is given together with how these meristem identity genes regulate other downstream homeotic genes. Such a hot topic need not be rehashed here. Read the chapter, it's all there. Lyndon concludes that homeotic genes are the switches. What activates them and what they activate are posed as vital questions of future research.

So, who would buy this book as opposed to who should buy this book? Well, Lyndon's *The SAM* may not feature in an undergraduate's shopping list alongside the latest from *Stereophonics* or *Oasis*. However, it will represent a challenging read for intermediate to advanced students. Hence, libraries would do well to acquire copies. I emphasize the plural to prevent a mad scramble for one copy. Postgraduates, post docs and staff, teaching and researching the SAM, should buy it. It is a rich source of valuable teaching information, and a remarkable source of literature (BA (Before Arabidopsis)). However, most importantly, it is the presentation of a philosophy about development. Lyndon has always tried to challenge us to think about the validity of hypotheses rather than their faithful adoption. Hence, if plant development is your obsession, buy this book and read it.

D. Francis

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Responses of plant metabolism to air pollution and global change. (Ed. by LUIT J. DE KOK and INEKE STULEN.) 24 × 16 cm. Pp. xix + 538 with 128 text-figures. Leiden, The Netherlands: Backhuys Publishers, 1998. Price h/b: NLG 240.00/US$126.00. ISBN 90 73348 95 1.

This book arose from an international symposium held in Egmond aan Zee, The Netherlands, in April 1997. There are 18 major contributions, mostly from authors or teams recognized as leading authorities in their fields, but in addition there are no less than 61 'contributed papers' averaging only 4 pages in length. Volumes constructed in this way are often seen as opportunities for depositing preliminary statements about ongoing research which have little enduring value in the literature. This is the case here, for there is little material in the 61 papers that is novel and exciting, and one must question the rationale for putting so much that is ephemeral into a hardback volume. Strangely, these short papers are not assembled according to topic, but with first authors' names in alphabetical order, which produces discontinuities proving very irritating for the reader, particularly when papers from the same research group dealing with related topics, such as two on ozone resistance in *Plantago major*, are separated by more than 100 pages. Fortunately, there is quite a comprehensive index which does help the reader to navigate through the diverse subject matter.

The 18 invited contributions are of much higher calibre, and they succeed in making this a very desirable volume for researchers and for advanced students. Most are substantial reviews providing important perspectives on many of the impacts of individual air pollutants at metabolic and physiological levels, and there is broad coverage of some of the consequences of global change. Many of these topics have been covered elsewhere in the last few years, in some cases by the authors included here, but the strong focus on plant metabolism gives a special quality to this volume which can, in consequence, be strongly recommended despite the caveats about the lasting value of many of the shorter contributions.

T. A. Mansfield

The diversity of living organisms. Ed. by R. S. K. BARNES. 24 × 17 cm. Pp. xiv + 345 with 249 text-figures. Cambridge, UK: Blackwell Science, 1998. Price: £19.50. ISBN 0 632 04917 0.

This is a profusely and well illustrated text with clear and uncluttered drawings throughout. The book has an ambitious aim, to provide a quick reference guide to all types of living organism. Leafing through, it is easy to gain a quick impression of the range of living organisms from the pictures. The emphasis is on the major body-plan of the organism, but life-styles and ecology are also mentioned where they help to distinguish related groups.

However, the text adopts what is called a sensible, practical classification, in other words, a rather traditional taxonomic scheme based on similarity, rather than on evolutionary relationship. It misses the opportunity to do something really different and hence useful; to present a current view of the 'tree of life'. Of course, there would be many difficulties in adopting a more modern phylogenetic approach derived from molecular data. There are uncertainties about the relationships of some groups. However, there are many areas of agreement and, time and again, molecular data have led to the suggestions of a phylogeny which is more useful, because it is predictive, and also more interesting.

Three glaring examples illustrate this. In this classification the Archaea are treated as a Subkingdom, along with Subkingdom Eubacteria in a Superkingdom Prokarya, yet the text states that they are 'as unrelated to the Eubacteria as they are to the Eukarya'. A 'molecular phylogeny of living organisms' (actually an unrooted tree) which is presented in Fig. 2.1 emphasizes their distinctness.

The classification of land plants resurrects outmoded taxa such as the bryophytes (Phylum Bryophyta), representing at least three distinct and unrelated lineages (mosses, liverworts and hornworts), pteridophytes (Subphylum Pteridophytina), a paraphyletic group of ferns, clubmosses and horsetails, and gymnosperms (Subphylum Coniferophytina), long recognized as paraphyletic. It is

perhaps unfortunate that the book was published only shortly before the publication of a radically new and interesting classification of flowering plants (Angiosperm Phylogeny Group, 1998). However, even in 1998 it was clear that the classification adopted here was wrong, and what the likely new groups were going to be.

The classification of vertebrates maintains Class Reptilia, which here includes turtles but excludes birds!

Older taxonomic categories used here which have since been replaced, such as reptile, bacteria or gymnosperm, are useful colloquially to represent a grade of organization, or a type of body-plan, but their use in a formal taxonomic hierarchy is misleading. I do not know enough about many of the other taxa presented to know whether I am being mislead but the three examples I have cited make me wary. The author might have been better advised to adopt an informal system of categories for this kind of book.

In addition, there are many occasions where the text is concise to the point of terseness, and the drawings are so simplified and lacking in labelling to the point of being obscure. Many of the diagrams seem familiar. Are they all new or what were the sources? It may be quibbling to want more from a book of this scale. The text and diagrams do get to the nub of the differences between the major groups, but so do texts such as Purves *et al*. (1998) or Campbell (1999), both works which place the diversity of living organisms into a much wider context, for very little extra cost.

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