

Book Reviews

Brooks RR. 1998. *Plants that hyperaccumulate heavy metals.* 384 pp. Wallingford: CAB International. £55 (hardback).

The ability of a few plants to accumulate some metals to extraordinarily high levels has attracted increasing interest over the past few years. From soil science through plant physiology to evolution these plants pose a fascinating problem in how and why a species can concentrate 100 times more of a toxic metal in its aerial parts than normal plants. But it is their potential use in the green clean-up of metal contaminated soils (phytoremediation) that has probably generated most excitement and applied and basic research.

This book is therefore very timely. Brooks has been one of the major workers in this field for many years, long before it attracted the current level of interest, and he has used his experience to put together a wide-ranging overview of the phenomenology, biology and applications of hyperaccumulation.

Over half the chapters are authored by Brooks, either as sole or joint author. After a review of the phytochemistry of hyperaccumulation, he contributes chapters on the use of hyperaccumulators in Geobotany, Biogeochemistry and Phytoarchaeology. I found some of these the most interesting in the book, reflecting as they do much of the experience of the author. Another very good chapter is contributed by Boyd, on the adaptive value of hyperaccumulation. This exposes how little we know about why this character has evolved, though the front runner appears to be as an anti-feedant.

The latter half of the book is devoted to the use of hyperaccumulators in phytoremediation and phytomining. These sections are topical, but equally there are a number of books 'on stream' that will cover these aspects rather more comprehensively than here. These chapters tend to be rather repetitive (for instance the role of plants in the volatilisation of selenium is covered twice), and of course much of current phytoremediation technology does not use hyperaccumulators—so the authors tend sometimes to be rather apologetic about including some of the examples they use.

I have a number of reservations. Brooks has included two chapters—on seaweeds and microbes—that fit rather uncomfortably in the theme of the book. In contrast, there is very little about mechanisms of hyperaccumulation, except as part of the phytochemistry chapter. Perhaps it is my prejudice, but I feel that this aspect of the phenomenon deserved more attention. I was also disappointed, in a book that could have aimed to be the definitive text on the biology of this class of plants, that Brooks has not critically evaluated what is meant by this title. Perhaps, given his role in describing so many hyperaccumulating species, he is too close to the concept to be objectively critical. For instance, how should a hyperaccumulator be defined? Does a single specimen of a plant with an unusual concentration categorise

a species as a hyperaccumulator? Particularly in the case of copper, many of the reported species are highly variable, with only a minority of wild collected specimens having concentrations above the magic threshold. And how were these thresholds determined? The original threshold for nickel (1000 ppm) was arrived at following a widespread survey of *Alyssum* species, which showed that the distribution of metal concentrations was bimodal, with 1000 ppm differentiating the two modes. But most of the other thresholds seem much more arbitrary, and vary from publication to publication. Is hyperaccumulation a genuine phenomenon, involving novel physiology or biochemistry, or simply the tail of a normal distribution, in which hyperaccumulators are not qualitatively different from normal plants?

However, these criticisms do not seriously detract from this book, which will be a very valuable addition to the library of anyone interested in this exciting and fast-moving field.

Mark R. Macnair

Greenland DJ. 1997. *The sustainability of rice farming.* 279 pp. Wallingford: CAB International. £49 (hardback).

With an ever increasing global population, a book on the sustainability of producing rice, the world's most important crop, is highly relevant to today's concerns. At present there are 2700 million people, almost half the world population, whose diet depends on rice. By 2015, a 50% increase in production is required to maintain present nutritional standards in the projected 4000 million people whose major staple food will be rice. To raise nutritional levels to satisfactory standards, increases in production would have to be as high as 70%. With these figures in mind, who can doubt the necessity of maintaining present rice production, but more importantly, sustaining the *increases* in production made in the last three decades. The introductory chapter concisely appraises the scale of the problem, and includes informative historical background that intimates the dire consequences if the problem is not rectified. Although the data itself is quite frightening, the author presents the facts and figures and discusses the problem and solutions in a calm, well-thought out manner.

A brief look at the book's contents indicates the well laid out approach the author takes in discussing this problem. After the introduction there follows an instructive chronicle on the domestication of rice and the rise of its importance in Asia and subsequent spread into other parts of the world. Neatly following on, the third chapter brings us up to date with a description of the four major production systems: floodprone, rainfed lowland, upland and irrigated, where rice farming occurs today. One criticism is the lack of clarity

on the two types of mechanisms determining survival in flood-prone areas. Although the author includes a figure accurately describing the four types of rice grown in flood-prone areas, in the text he more than once clouds the difference between the escapist strategy of fast elongating deepwater and floating rice with true submergence tolerance of some short-statured rice varieties.

The next four chapters deal systematically with the complex interactions of socio-economic, pedological, biological, climatic and hydrological factors which constrain rice yields. Chapter four discusses the 'biophysical sustainability' of rice growing. One minor criticism is the over use of this jingoistic phrase throughout the book. Simply put this chapter is divided into two parts, the first describing many of the physical and chemical properties and processes special to paddy soils and the second dealing with biodiversity and the control of pests and diseases within the rice field. The next two chapters continue in a similar vein describing the nutrient and water requirements of rice. After discussing the needs of rice, the next chapter deals with the socio-economic factors influencing the rice farmer and rice producing governments, with some interesting insights into the management of land and people. These four chapters bring together a lot of information, and the reader could get rather 'swamped' with too many 'dry' facts and figures. However, the author incorporates several interesting historical records and tidbits of folklore preventing the text from becoming too turgid, and good, clear graphs and pictorial illustrations help further to break up potentially heavier-going sections.

A major criticism of this book is that although the introduction dwells mainly on the need to produce at least 50% more rice in the near future than is currently grown, most of the book is exclusively about rice production in the present and past. On this subject, the author reviews the current and past knowledge clearly and in a well-laid out approach, revealing an effective depth of knowledge amassed from his former colleagues at IRRI (International Rice Research Institute). However, it is only in the last 34 pages that the historical and environmental contextual information from the rest of the book is pulled together to discuss concerns about future rice production. As first argued in the introductory chapter, it is not only the frightening increases in population and concomitant increases in rice production that we must worry about, but also the downward trend in current yields. The crux of the problem lies in establishing and closing yield gaps—the difference between potential and actual yields. Farmers are already utilising knowledge disseminated by IRRI, and the gap between the yield attained at the research station and that from favoured sites using established best practice techniques is closing. Thus, a new ultimate potential yield plateau needs to be established and until the gap between this and yields currently obtained is reopened, it is difficult to see how the demand for a 50–70% increase in global rice production can be achieved. The author could have used the space in these last two chapters to include a lot more information on the use of modern technological advances in molecular biology and plant tissue culture which could help to establish new yield potentials. Embryo rescue and anther

culture techniques have already made important contributions to accelerating traditional rice breeding programmes and biotechnology's most novel and controversial contribution to plant breeding—the use of transgenic plants—is already a part of IRRI's research. However, the possibilities arising from the use of these powerful tools were either not discussed or only briefly mentioned, and instead the author really just summarises the previous chapters.

Despite these criticisms, this book is a welcome addition to the vast, although not necessarily readily obtainable, literature already available on rice. Those looking for a more challenging read and with a more specific interest in rice may find a lack of detail and depth on any one subject area. However, there is a good amount of general information on a whole range of factors determining the sustainability of rice production, and overall, I would recommend this book to anyone with a broad interest in this area from undergraduate level onwards.

J. E. Summers

Hill J, Becker HC, Tigerstedt PMA. 1997. *Quantitative and ecological aspects of plant breeding*. 275 pp. London: Chapman & Hall. £65.00 (hardback).

This is the fourth book in the plant breeding series that has been published under the editorship of Professor Peter Caligari. The earlier volumes covered the principles and prospects of plant breeding, selection methods in plant breeding and statistical methods for variety evaluation. The present text is intended to underline the philosophy and modelling of genetical variation and deal with some important ecological and conservation aspects of plant breeding. It is aimed primarily at undergraduate students although plant breeders who are not trained in quantitative and ecological genetics may also find it useful for their work.

The book has eight chapters which are organized conveniently into two parts under the titles 'Quantitative variation: its detection, estimation and utilization' and 'Genotype and environment: their interrelationships'. The introduction provides a very interesting account of the historical developments of biometrical genetics as a science. It starts with Mendel's work which is presented lucidly, and the pioneering contributions of Johannsen, Ehle, Fisher and Huxley are described in detail. However, that is where the historical setting ends and post 40s developments of the subject are not mentioned at all. Further, little is said about the ecological and conservation aspects even though a substantial part of the book is devoted to these topics.

The four chapters in part one largely describe the quantitative methods for detecting and estimating various types of gene effects and their interactions and some effort is made to explain how such information can be used in practical breeding. The first half of chapter 2 elaborates tests for the additive, dominance and epistatic effects among the generation means and the authors explain diligently how these effects can be separated and measured in practice. The examples used to describe the methodology are highly relevant and analytical details are adequate. The section on variances, however, starts with randomly mating popu-

lations and goes on to describe relationships between relatives before variances of the F_2 , F_3 etc. generations are tackled. This is clearly a diversion which the readers could do without, because the rest of the chapter is dedicated to the extraction of information from single crosses, including the genetics of hybrid vigour and the prediction of recombinant inbred lines derivable from such crosses.

Chapter 3 skims through a whole range of mating schemes (BIPs, North Carolina I, II and III designs, TTC and the polycross) while chapter 4 is devoted exclusively to the diallels. The diallel is presented as the ultimate design and there is some truth in it because it allows the most sophisticated dissection of the genetic variability. However, breeders use diallels to produce crosses and assess their performance but not to carry out any genetical analysis. Diallel is in fact the least efficient design for detecting and partitioning genetic variation and the relationships described on page 115 concerning the extent of information provided by each design are grossly misleading because diallel analysis rarely provides reliable tests of any type of variation. To obtain consistent results one needs to use diallels of at least 20×20 dimension and such diallels are rarely conducted in practice.

The last chapter in part one describes the principles of selection theory, the predicted and observed response to selection, some description of correlations between traits, multiple trait selection and selection in the presence of competition. A limited coverage is also given to marker assisted selection and QTL mapping which in my view is not enough, assuming that linkage maps and molecular markers are the future tools of plant breeding.

Chapters 6 and 7 (part two) provide excellent accounts of genotype \times environment analysis and the concepts of stability and adaptability, and fit well into the theme of the book. Chapters on breeding for biotic and abiotic stresses, and genetic resources (chapters 8 and 9), on the other hand, seem to be out of place in the present text even though they are written succinctly and provide useful reference material.

Finally, one has to question what this book offers to the reader which others don't. While I must admit that it provides more information on diallels and ecological and conservation aspects compared to other books, it falls far short on molecular markers and correlation analysis. Further, for £65, the cost of the book is bound to be prohibitive and I am not sure if many copies will be sold for personal use, particularly when readers can buy two books (e.g. *The genetical analysis of quantitative traits* by Kearsley and Pooni and *Plant genetic resources: the in situ approach* by Maxted, Ford-Lloyd and Hawkes) for this price which would provide coverage of both quantitative genetic theory and genetic resources.

Harpal S. Pooni

Mattheck C. 1998. *Design in nature—learning from trees.* 276 pp. Berlin Heidelberg: Springer-Verlag. £30 (softback).

Claus Mattheck has a background in physics and solid mechanics and heads the Biomechanics Department at the Research Centre in Karlsruhe, Germany. His most recent

book is concerned with biological shape optimization due to mechanical loads, with trees providing the majority of case-studies. Interesting examples of tree shape issues which are discussed and illustrated include trunk shape, branch junctions, tree forks, roots, wound healing and tree welds (grafts). At the scale of annual rings, subjects such as reaction wood, frost ribs and wood fibre orientation are discussed. In addition, tree breakage is covered and shape optimization principles are generalized and applied to bones, claws and shells.

Many of the tree examples were also discussed in Dr Mattheck's previous book (1991) *Trees—the mechanical design* also published by Springer-Verlag. However, in the present book, an impressive number of examples are accompanied by results from computer-based calculations using the finite element method (FEM). In addition, simple FEM-schemes for structural optimization are suggested and applied. The results stem from work over many years comparing real life structural shapes with computer model predictions. Although one has to argue with some of the FEM assumptions and aims (the material is modelled as isotropic; no quantitative predictions are made), the results are still interesting and the intention to explain tree shapes and inspire the design engineer is fulfilled. The book is richly illustrated with 205 figures, about half of which are colour representations of stress distributions.

The book is intended for biologists and engineers as well as the general reader. The result is entertaining and pleasant to read, as a popular account of the influence of mechanical loads on biological shapes should be. To qualify as a more in-depth coverage of the subject, more frequent references to studies in other labs would have been desirable.

As an engineer, I found the case-studies interesting and they stimulated my curiosity. The book will have a similar effect on biologists interested in mechanical loading effects on trees. FEM, especially quantitative FEM, is a powerful tool in our effort to understand structural shapes in nature, and Mattheck's account is likely to stimulate its further use in the biology community.

Lars A. Berglund

Michaelis W. 1997. *Air pollution—dimensions, trends and interactions with a forest ecosystem.* 177 pp. Berlin: Springer-Verlag. £49 (hardback).

This book describes part of a major experiment in northern Germany between 1986 and 1992, to study the interaction of air pollutants with a Norway spruce forest. As very little of the research presented in this book has been published in journals in English, this summary volume is invaluable in introducing the enormous quantity of high-quality data produced during the 5 full years of the experiment.

After introducing the background to the experiment, the author summarizes the methods used for sampling and analysing rain and throughfall water, aerosols and gases, and the theoretical framework that was used to derive fluxes of gases and aerosols from concentration gradient measurements above the forest. The following four chapters cover the results and provide a summary of the concentration and deposition of major and trace elements in precipitation and

particulate form over the 5 years. These results are extended in the next chapter to include data on the pools of elements in the soil and biomass, and the fluxes through the ecosystem. The final two chapters deal with gas fluxes of SO_2 , NH_3 , NO_x , O_3 and their relationship to CO_2 fluxes.

There are some peculiar omissions for a book describing interactions between air pollution and forests—for example, although wet deposition of 24 trace elements is recorded, nitrogen is not included. In the chapter on ‘total deposition’, no mention is made of the deposition of trace gases, yet SO_2 must have contributed a significant fraction of the total deposited sulphur, and the data exist to calculate its contribution. Similarly, in calculating element fluxes through different compartments, no contribution of dry-deposited SO_2 or the other gases is included in the flux of hydrogen ions.

Nevertheless, the book is packed with detailed measurements to intrigue the reader, whether it be the trace element and biomass measurements reported for 29 different compartments in 30 sampled trees (from needles to fine roots), or the upward fluxes of CO_2 observed in response to SO_2 or O_3 pollution events. The text is well referenced to original publications in the project reports (mostly in German).

This is a book for research students and professionals studying air pollution, trace gas and particle exchange, and forest ecology. Although there is little detailed interpretation of the data, the descriptive analysis, graphical presentation and tables are clear, and provide much food for thought. It is to be hoped that the results of this major research project will eventually be published in the peer-reviewed literature. Until then, this book at least records that such data exist, and does so in a clearly readable fashion.

J. Neil Cape

Williams JE, Woinarski JCZ, eds. 1997. *Eucalypt ecology: Individuals to ecosystems*. 430 pp. Cambridge: Cambridge University Press. A\$130 (hardback).

About 700 species of the genus *Eucalyptus* cover a large part of the Australian continent but, except for four species to the north of Australia, they do not occur naturally anywhere else. Charles Darwin found them of interest because eucalypts shed their bark and retain their leaves, contrary to the pattern he was familiar with in British trees—a truly antipodean genus for him. From the time that the first species was described by a Frenchman in 1788, an extensive literature has accumulated on this variable and large genus. The species which produce lots of harvestable hardwood and wood for pulp have been planted extensively outside Australia and are now a major component of world forestry. Australia even imports eucalypt oil from Brazil! The genus has been aptly referred to as ‘the universal Australian’ and, although species of the genus *Acacia* cover a wider geographic range in Australia and are more numerous, eucalypts remain the quintessential Australian genus.

This book aims to present what is known about the ecology of the genus in Australia. Fourteen chapters from a number of different authors cover topics such as classification, the relationship of eucalypts to fires, their eco-

physiology and the associations between eucalypts and other groups of organisms (especially shrubs, fungi, invertebrates and vertebrates), as well as the conservation of plant communities dominated by eucalypts. The introduction emphasizes variability in the genus and this is a constant theme throughout the book, whilst the concluding chapter by the editors brings together some themes developed in earlier chapters.

I found this an attractive, well-edited book with many illustrations, including a beautifully designed cover. The quality of production is high, although the two-column per page layout leads to some strange splitting of figures—as in Figures 1.1 and 1.2 cf. Figure 1.5. Some figures are too small and were poorly reproduced in my copy, e.g. Figs 5.2, 5.4, 5.5 and 10.4, which seems a pity in an otherwise good production. There is a comprehensive index and, very usefully, a taxonomic index as well. Not only is *Eucalypt ecology* well produced, but it is well edited too.

Inevitably in such a multi-authored publication, some chapters are of more interest than others. Several chapters especially interested me. Eucalypt classification has been a vexed area for taxonomists for years, but Chapter 2 includes macrofossil characteristics and molecular data, as well as the more traditional taxonomy, to derive the different groups within the genera *Angophora* and *Eucalyptus* and their most plausible inter-relationships. There is general agreement between taxonomists on the groupings but the status of those groups still remains unresolved. Much more could be done on the ecology and relationships of these different groups, despite several earlier attempts (see Florence, 1981, 1996; Noble, 1989), and sections of Chapters 3 and 9 in this book. Heterophylly and its ecophysiological implications, discussed briefly in Chapter 8, are intriguing aspects of eucalypt ecology that have received too little research attention up to now. Considerations of nitrogen cycling in eucalypt communities depends on the ability of understorey species to fix N (Chapter 9) and lead in to a comprehensive account of vascular plant-eucalypt interactions in Chapter 10 that I found stimulating; the latter considers understorey species and searches for associations between the two. The author of this particular chapter concludes that eucalypt species may have distributions that are largely independent of the distributions of the understorey species at both the tree- and landscape-scales—an interesting conclusion that should challenge Australian ecologists. One aspect of eucalypt ecology not discussed is the inability of eucalypts to become invasive outside Australia, relative to the pines, for instance. Despite extensive plantings, eucalypts are rarely major weeds, although they may severely modify their ‘new’ environments, especially with respect to the flammability and water use of those altered environments. The book ends appropriately and strongly in Chapter 15 with some challenges and opportunities for the conservation and management of eucalypt-dominated communities.

This book adds significantly to our knowledge of the genus *Eucalyptus* and thereby to Australian ecology and to functional ecology of sclerophyll vegetation in general. It reflects the recent exponential growth in studies of all eucalypt-dominated communities (a point made very nicely

for the historically-minded reader in Figure 16.1), including managed forests and plantations. *Eucalypt ecology* is primarily a researcher's book and should be read by all those with interests in the genus. The book is good value for money but is probably too highly priced at A\$130 for graduate students, though the latter group could benefit enormously from using a library copy. Professional ecologists and land managers in Australia should buy the book and read it; furthermore, the book should be on the essential reading list for all foresters and intending foresters to show them what variable and fascinating material they have to manage, both in Australia and also in all those countries in which eucalypts are planted. If the latter groups read this book and that of Florence (1996), eucalypt forests should be better managed in terms of ecological sustain-

ability and their special qualities maintained for future generations. And don't bother too much with the taxonomic niceties of *Eucalyptus* classification—read Chapter 2 in this book instead!

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R. H. Groves