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Book Reviews

Methods for Risk Assessment of Transgenic Plants. II Pollination, Gene Transfer, and Population Impacts. By GÖSTA KJELLSSON, VIBEKE SIMONSEN and KLAUS AMMANN. Birkhauser Verlag. 1997. 308 + ix pages. Price DM98. ISBN 3-7643-5696-0 (Basel), 0-8176-5696-0 (Boston).

The Southern Corn Leaf Blight (SCLB) Epidemic of 1970 put a warning shot across the bows of the plant breeding industry. The introduction to the report of the US National Research Council (1972) contains the following:

'In 1917 Donald F. Jones, a graduate student, discovered an aspect of hybrid corn whereby it could be produced commercially.... Looking back on the stages of the development of Jones' principle, one wonders about the technology assessment at each stage. Who assessed it? Who approved further development? How important was the role of science? How important that of economics?' (p. 9).

By the mid-1980s it had become clear that producing genetically engineered crops was, in principle, a commercial proposition. The lessons of the SCLB epidemic had, however, been learnt – that the consequences of the introduction of a novel technology into an industry of the strategic importance of agriculture could have dramatic political and economic consequences and that it might be prudent to assess the safety of genetic engineering of crops before marketing of transgenics occurred. Thus we see throughout the industrialized world, i.e. those countries with the industrial capability of developing the technology, the production of guidelines and codes of practice, for testing transgenic crop plants. During the latter half of the 1980s we see this precautionary approach becoming more codified, for example the OECD's 'Recombinant DNA Safety Considerations' in 1986 (the 'Blue Book') and, in 1989, the NRC's 'Field testing of Genetically Modified Organisms' (the 'Green Book'). Eventually, in some countries, these guides to best practice became incorporated into legislation, e.g. within the EC, the issue of directive 90/220/EEC on the deliberate release into the environment of genetically modified organisms, later incorporated into national legislation of the member countries. The environmental requirements of these regulations created a problem for the plant breeding industry. The procedures for testing the performance of new varieties are well established and standards for seed production legally enforceable. But, here we had, in part, a novel agricultural problem, not the perspective of 'how good is a variety?', and 'how can we minimise contamination of seed crops?', but 'what is the environmental impact of a crop?' and 'how can gene transfer **from** the crop be minimised?'

These were problems that agricultural experimental design had not had to face before, but ones that were familiar to ecologists and population/ecological geneticists. Since the form of field assessment of transgenic crops would have to be qualitatively different from that previously adopted, a synthesis between agriculture and ecology/population genetics had to be forged. The major problem here was that the two groups of scientists mostly came from different traditions and the added layer of bureaucracy meant that civil servants also had to be familiar with the sorts of techniques involved in the reports of 'environmental impacts' that industry might submit.

In response to this, several countries, and international agencies, embarked on collating descriptions of the techniques that might be involved in such assessments. This volume represents the efforts of the Danes, the Swiss and DG XI of the CEC. It has all the literary appeal of the 'Yellow Pages', but, then, the 'Yellow Pages' is extremely useful when you need it. The meat of the book consists of a list of methods that could be used in investigating 'pollination, gene transfer and population impacts' from a field, laboratory or analytical perspective. Each method is subjected to a common format which consists of a 'description' (with assumptions, restrictions, and advantages), its applications and an assessment of its practicability (i.e. sensitivity, requirements, time and cost) on an arbitrary, but logical, scale.

To supplement the 'methods' section there are sections on genetic engineering methods, the sorts of traits that might be incorporated, techniques for carrying out a risk assessment, and, thankfully, 60 pages of references. A great beauty of the structure is that just about every form of cross-referencing between the different sections has been incorporated, so in many ways (although I am not happy with the analogy), the effect is the same as having all of this information in a database and carrying out a

'keyword' search. But, at whom is the volume aimed?

Anyone reasonably familiar with these aspects of plant biology will probably find the potted descriptions a bit irritating, but the references for less familiar approaches useful. Someone, without this sort of background, looking for a best solution for tackling a problem, say, for an environmental impact experiment, will find it frustrating, and should not be looking here, anyway. No, I think that the strength of this volume is that it sits on a shelf alongside dictionaries, guides to grammar, etc., as a useful reference book. Nobody knows everything in this field, and inevitably one will come across aspects, where one's knowledge is somewhat lacking, whether in industry, regulation, consultancy or academia. In this case, having a 'pocket' description and the relevant source references will be invaluable.

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Mutants of Maize. By M. Gerald Neuffer, Edward H. Coe and Susan R. Wessler. Cold Spring Harbor Laboratory Press, 1996. 468 pages. Price $250 (cloth), $100 (paper). ISBN 0 87969-443-2 (cloth), 0 87969 444 0 (paper).

Mutants of Maize is the second edition of a guide to maize mutants and maize genetics originally published in 1968. Clearly it was time for a new edition, but this book goes far beyond an updating of the first and aims to provide a very complete guide to maize, its mutants and its unique genetic and cytogenetic tools. It is packed full of useful data, presented, by and large, with clarity and with effective design. The information presented focuses on photographs of the best characterized mutants of maize including well over 300 colour plates with accompanying detailed gene descriptions. First encounters with the book do not make the photographs of the mutant phenotypes particularly easy to find because they are arranged according to chromosomal position. However, early reference to the gene descriptions (which are arranged alphabetically) will provide the page references for the photographs of mutant phenotypes. The combination of notes attached to the photographs and those constituting the gene descriptions is very informative. The facts are generally short, clearly explained and have been well edited from the original descriptions provided.

There are a few minor shortcomings. Annotation of the photographs has generally been avoided but would, on occasion, have been useful, as in the case of the appearance of some high chlorophyll fluorescence mutants under UV light. In the case of *hcf3* it is unclear even to a non-colour blind reader exactly which plants are 'red' and which 'blue'. Similarly, on sections such as that of an embryo of a *dek1* mutant, annotation of the different parts of the embryo would have aided interpretation. In the photograph of the *sh6* mutant an indication of the 'navajo spot' would also have served to clarify the commentary on the photograph. Some of the pictures of mutants lack comparable wildtypes for comparison. I found this problem most acute in the description of the *opaque2* mutant. In this case, the problem was compounded by the figure legend claiming that the plant was 'segregating for O2', although all the kernels appeared the same phenotypically. Generally, however, the photographs and descriptions are excellent and very informative. Clearly one photograph is rarely 'definitive' for the appearance of a mutant phenotype, but the cross referencing of figures is very good so that if a picture of another mutant also includes the phenotype of the mutation of interest it can be found quickly thereby aiding comparison.

I think the real strength of *Mutants of Maize* is the combination of mutant descriptions with all the additional data on molecular analysis, mapping and biochemistry, together with the details descriptions for use of speciality maize tools such as BA translocations and Ds chromosome breakage stocks. The clear descriptions for the use of specialized maize lines will be most useful for those intending to use such lines, and may well provide ideas for innovative research – such as how mutant chimeras might be generated for the examination of gene function, for example. The genetic maps are presented in a reasonably comprehensive manner, considering how rapidly they are changing. Maps for each chromosome compiled in 1993 are augmented by an accompanying map from 1995. The wealth of information in these maps could have been more clearly presented. For example the separate colouring for RFLP and morphological markers used for the 1995 maps would also have been helpful in understanding the 1993 maps. Some additional annotation of the maps would also have been a good idea and some of the explanatory devices, such as underlinings and asterisks, do not seem to have been consistently applied. These problems do cause the reader some initial confusion in understanding the maps, but considering the complexity of the information and its rate of change, the use of the maps becomes relatively easy with a little extra time spent understanding their design.

The molecular descriptions of the different loci are useful, especially the maps of genes with, in some cases, the locations of various mutations. I found the descriptions of *wx1*, for example, a very helpful and concise synopsis of a wealth of published literature. One problem is that this section is likely to become out of date quite quickly, but the majority of

information provided is general enough to prove useful for several years.

Included in the book are additional sections on plant anatomy, kernel anatomy and macro/microsporogenesis. The latter section is very detailed but I felt the description of different parts of the maize was a bit skimpy, especially with respect to leaf form and anatomy. This was obvious in the description of some of the mutants affecting ligule/auricle development which were more difficult to understand because there was no introduction to leaf structure. Inclusion of the details of the specialised anatomy dealing with C_4 photosynthesis would also have been forward looking and relevant.

Finally, groups of mutants affecting similar traits such as flavonoid pigment production, cuticular waxes and lesion mimics are grouped in a useful and informative way in the Tables and Pathways section (chapter 4). Here related mutations and their effects can be compared although clarification of some of the accompanying remarks would be useful. One example of this is with lesion mimics where the mutant phenotype is classified as 'early' or 'late'; it is not clear whether this refers to the age of the leaf or the age of the plant. In a late onset mutant do all leaves show the phenotypic trait but only when the plant is relatively old, or do only the older leaves show the trait? Once again, these are minor criticisms of what is an important and useful section.

The *Mutants of Maize* is not a book to read but one to refer to. It would be a useful addition to most libraries and laboratories working on plant genetics, molecular genetics and physiology. I suspect it will be just as useful to plant biologists not working on maize as to members of the maize community, since this book answers all the naive questions arising from unfamiliarity of the field. It will undoubtedly grow in usefulness as plant science turns from model species to crop species. Maize is the model crop species and I think that this book will prove to be an essential aid for appreciating its genetics and cytogenetics and how these can be used to understand the workings and productivity of the major crop plants of the world.

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Molecular Evolution by WEN-HSIUNG LI. Published by Sinauer Associates, Sunderland, MA, USA. ISBN: 0-87893-463-4 (cloth).

Molecular Evolution by Wen-Hsiung Li is a timely book. Since Masatoshi Nei wrote 'Molecular Evolutionary Genetics' ten years ago, only one other reference text of note has been published in this field, *Fundamentals of Molecular Evolution* by Wen-Hsiung Li and Dan Graur. 'Fundamentals' was an excellent book, but 'Molecular Evolution' looks set to supersede it. Whereas 'Fundamentals' was a good primer, 'Molecular Evolution' is surprisingly comprehensive, tackling more subjects, in far more depth. It is not an excessively large volume at 432 pages of text, but almost all subjects are covered to some degree.

The book is divided into 14 chapters, starting with introductory chapters on the two subjects which underpin molecular evolution; molecular genetics and evolutionary genetics. Both of these chapters are good primers. These are followed by chapters on models of DNA sequence evolution, the estimation of sequence change, and two chapters on the reconstruction of phylogeny. The first of these chapters on phylogeny deals with the methods of phylogenetic reconstruction, and is excellent. All the methods from UPGMA to the method of invariants are covered, along with discussion of their relative merits, and how the reliability of the trees can be tested. The second phylogenetic chapter considers a number of examples where molecular systematics has helped resolve controversies or overturn traditional points of view. Again this is an excellent chapter using several interesting examples, such as the human–chimp–gorilla trichotomy, and the origin of eukaryotes, to illustrate various methods, and pitfalls of phylogenetic reconstruction. It is a shame however, that some of the new uses of molecular phylogeny, in areas such as molecular ecology, are not considered.

The book then moves onto two chapters on the rates and patterns of nucleotide substitution. The first of these chapters is perhaps slightly disappointing; the section on synonymous codon use is rather thin, which is a shame, since this is one of the areas in molecular evolution where I think we have a good chance of understanding molecular evolution, and where the interplay between molecular and evolutionary genetics is beautifully played out. The following chapter on molecular clocks is good with nice discussions of male-driven evolution and overdispersion.

One of the major areas in molecular evolution, the analysis of DNA polymorphism data, is covered in the following chapter. The focus is largely on tests of neutrality, all of which are covered in detail except the test suggested by Sawyer, Dykhuizen and Hartl; they suggested comparing the frequency distributions of different classes of mutations (e.g. synonymous and non-synonymous) segregating in a population. Under neutrality the frequency distributions should be the same. This appears to be a forgotten test, although its utility has been recently demonstrated by Akashi and Schaeffer. Surprisingly in this chapter, there is no mention of the use of polymorphism data in the inference of demographic history, although this is a major industry, and a fascinating area of research, particularly with respect to the origins and history of the human race.

The following three chapters deal with various aspects of gene duplication. The first considers gene

and intra-genic duplication, the second, the concerted evolution of duplicated genes, and the third, evolution by transposition and horizontal transfer. These chapters illustrate one of the major differences between this book and 'Fundamentals'; there are good discussions in each chapter on the evolutionary dynamics of the system. For example in the first of these chapters there is discussion of the rate at which a duplicated gene is likely to be lost; in the third there is discussion of how transposable elements are maintained in a population. This is a welcome improvement.

Overall the book gives a balanced summary in areas of controversy. Unfortunately this is not the case in the last two chapters. The penultimate chapter in the book considers three aspects of genome organisation: the c-value paradox, the evolution of base composition and the origins of introns. The first and last of these topics are covered well; however, the discussion of whether selection or mutation bias is responsible for large scale variation in base composition within a genome, is disappointingly biased.

In the final chapter the author returns to the question of whether evolution at the molecular level is largely driven by selection or genetic drift. This is a rather curious chapter. The author considers a miscellaneous collection of observations and problems, and demonstrates how they are each consistent with mutation and genetic drift as primary determinants of molecular evolution. On the whole they are unconvincing.

Overall this is an excellent book, which I think will serve professionals and students very well. Each chapter is followed by a set of questions which will be useful for teaching purposes. The book is also very reasonably priced at £33. *Fundamentals of Molecular Evolution* has been one of my most useful books over the last six years, *Molecular Evolution* looks set to supersede it.

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Genomic Potential of Differentiated Cells. By MARIE A. DIBERARDINO. Columbia University Press. 1997. 386 pages. Price £52.00/$75.00. ISBN 0-231-06986.

Rarely can a scholarly, academic monograph representing a lifetime's thought and work have been so timely in its publication. Marie di Berardino's book *The Genetic Potential of Differentiated Cells* appeared just as the full rumpus resulting from the announcement of Dolly, the sheep cloned from the nucleus of a cell cultured from an adult sheep, erupted.

Marie Di Berardino, who joined Bob Briggs as a Research Assistant in 1948, was present in the laboratory when Briggs and King were first able to demonstrate (in 1952) the development of a complete frog blastula following nuclear transplantation, and has followed a career in exploration of this phenomenon. The nuclear transfer experiments prior to Dolly have been presented in one or two characteristic ways: the 'cup's half empty' or the 'cup's half full'. The Briggs and King school noted that the success of nuclear transplantation diminished with the increasing development of the donor cell and that, apart from nuclei from early embryos, none gave full development of normal tadpoles. Hence their experiments were viewed as showing loss of totipotency.

The optimists on the other hand (the school of John Gurdon) found similar results but emphasized the best development of which some of the nuclei were capable. Thus the pluripotency of the nuclei of differentiated cells was emphasized by the development of normal adult fertile embryos from nuclear transplantation from a minority of differentiated cells. Fertile adult frogs were developed using transplanted nuclei from intestinal cells of a tadpole, but there was no example of a full development to a fertile adult from an adult cell nucleus. Nuclear transplantation was thus viewed as a test of the genomic equivalence of differentiated cells – now accepted almost as a dogma – but the restrictions in developmental potency remain to be explained.

Marie Di Berardino emphasizes the possibility of a sub-population of cells being responsible, but this merely shifts the problem to definition and understanding of the stem cell state. Personally, I would regard a stem cell as a specifically differentiated state with a particular normal differentiation repertoire and with a suitable, but not necessarily immaculate, genetic composition.

It is the conceptual gap between these two viewpoints which much of Marie Di Berardino's work in frogs has sought to illuminate. She gives us a readable, comprehensive account of research on the potency of cell nuclei from the classical early embryological experiments of Roux and Spemann to the present day. She presents an informative and well balanced review of the analyses of nuclear transplantation potential of amphibian nuclei from early and later embryo cells and differentiated tissues. The book proceeds through chapters on the experiments with Rana renal adenocarcinoma nuclei – experiments which were important in the development of ideas of epigenetic control in cancer – and then on to considerations of nuclear transplantation in insects, ascidians, fish and mammals.

The three following chapters – transdifferentiation, somatic hybrids and tumour cell differentiation, irreversible DNA changes in development and epigenetic controls – seem to me to be the least interesting in the context of this book just because here the personal touch is missing. They do serve to balance the whole picture, but more in the style of a textbook than a monograph.

One of the intriguing aspects of this monograph is that it must now be viewed post-Dolly. Does Dolly change the field? Marie Di Berardino's hypothesis (which is extended in a one page addendum now included with the book) is that the nucleus of a differentiated cells is not totipotent but that stem cells in a tissue might provide the nuclei for occasional success. The alternative possibility is that in most cases the nucleus from a differentiated cell never gets sufficient opportunity to re-programme before being forced into action and that this causes damage which is small but still sufficient to prevent full totipotency. One potentially crucial technical aspect of the successful sheep cloning has been the use of G0 quiescent cells, and with this hindsight, it is most interesting to read the chapter on the re-activation of Rana erythrocyte nuclei – one of the author's own key contributions to the field. Erythrocyte nuclei introduced directly into enucleated eggs support development only to the early gastrula stage, but after cycling through an oocyte these nuclei and their serially cloned derivatives may give fully developed feeding tadpoles. It is not clear whether substantial efforts were ever made to take these through metamorphosis and adulthood or whether the prevailing hypothesis of the inability of differentiated nuclei to allow full development inhibited these experiments. In her final chapter, where she revisits the interpretation of all the information on nuclear transfer, Marie Di Berardino eventually states that 'I favour the idea that we have not yet completely revealed the genetic potential of differentiated nuclei'.

The best history is written by the person who was *there when it happened* and as such this book is at its best as a full and personal account of the experiments on Rana. It is not only timely, but will stand as a thoughtful record and useful sourcebook whatever future developments may bring.

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