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BOOK REVIEW

DE NETTANCOURT, D.: *Incompatibility in Angiosperms*. — Springer-Verlag, Berlin—Heidelberg—New York 1977, 230 pp., 24.20 US \$.

This third volume of *Monographs on Theoretical and Applied Genetics* treats the physiological, biochemical, genetic, structural and evolutionary aspects of sexual self- and interspecific incompatibility in angiosperms.

Self-incompatibility is examined essentially in the meaning of Lundqvist's attitude as "the inability of a fertile hermaphrodite seed-plant to produce zygotes after self-pollination". The introductory chapter points out the existence of a number of incompatibility systems which can be classified according to the time of gene action during microsporogenesis, to the site of gene expression in the pistil and in relation to the association with floral morphology, pollen cytology and the presence or absence of polyallelic series. It further shows how the basic systems are distributed among various families and economically important genera and examines the origin, transformations and importance of this outbreeding mechanism in evolution of angiosperms. The section covering genetic aspects of the phenomenon describes the structure, linkage and location of self-incompatibility loci in chromosome and reviews the modes of inheritance of the most important self-incompatibility systems together with the mechanisms through which the S-locus controls the breeding character of plants and of entire populations. The basic literature offers great body of data on physiology, biochemistry and structural aspects of self-incompatibility, but their interpretation is difficult for various reasons. The main problem is to distinguish between specific manifestations of self-rejection reaction and metabolic changes occurring as a consequence of differences in growth rate of compatible and incompatible pollen tubes. The greater part of the data and theories derived from them is brought together and critically examined in the third chapter and an attempt is made to conciliate the known features of incompatibility reaction into one general model. The suggestion that the constitution of a callose barrier to communication could be considered as the primary result of reaction of recognition in gametophytic systems is, however, complicated by the fact that abnormal callose depositions do also occur in pollen tubes grown *in vitro*. There is a number of methods for by-passing incompatibility barriers to fertilization and for modification of breeding character of plants. Both physiological methods and possibilities of genetic breakdown of self-incompatibility are reviewed in detail.

The examination of interspecific incompatibility is limited, like in the case of self-incompatibility, to the interactions between pollen and pistil preventing zygote formation. Chapter 5 presents and discusses all aspects of the phenomenon with special emphasis on its relationships with and divergence from self-incompatibility systems.

The concluding chapter clearly summarizes the present state of investigation and presents valuable suggestions and ideas for basic and applied research of incompatibility.

This volume is an excellent and presently the most detailed monograph on the theme it covers and will be certainly of great help especially to research workers interested in incompatibility and related fields and to plant breeders.

J. TUPÝ (Praha)

J. BARBER (ed.): **The Intact Chloroplast**. Topics in Photosynthesis, Volume 1. Elsevier Scientific Publishing Company, Amsterdam, New York, Oxford, 1976. 476 pp. US \$ 57.25.

The flood of highly specialized information characteristic of the hectic development in the progressive fields of modern science afflicts photosynthesis research. It is almost impossible for a worker in one particular area to keep abreast with progress in other parts of the field. Invaluable help can be furnished in this situation by well designed monographs edited, with the aim to provide an up to date, authoritative, clear and well balanced picture of the most important facts and interpretations in a given field. Editing of and contributing to such monographs is a hard work. Jim Barber and the team of contributors to the volume being reviewed are to be congratulated to have produced a model of high standard.

The use of isolated chloroplasts in experiments marks the beginning of the modern era in photosynthesis research. The concept of the intact chloroplast characterizes one of its most important present phases. The fully functional isolated chloroplast capable of high rates of CO₂ fixation provides an ideal material for bridging the gap between photosynthesis studies performed with conventional broken chloroplasts and those accomplished with intact cells and tissues. All the more so, as the removal of the outer membrane by osmotic shock can be compensated for by finding defined suspending media to mimic the function of the stroma. The broken chloroplast and its various fractions have furnished us with a wealth of data concerning the nature of various elementary reactions of photosynthesis. Putting these elements back to their place in the intact chloroplast and bringing the latter back into context of a functional phototrophic cell is one of the most fascinating tasks of present research in photosynthesis.

The monograph is introduced by a chapter (J. Coombs and D. Greenwood) concerned with the functional aspects of chloroplast structure. The authors are to be given special credit for not only dealing in detail with the highly invariable structure of a typical higher plant chloroplast (including its modifications in C₄ plants) but also for providing an extensive account of the most diverse structural designs of chloroplasts in various taxonomic groups of algae (including the oxygenic photosynthetic apparatus of prokaryotic *Cyanophyta*). This provides a background for considering evolutionary aspects but, at the same time, the reader gets a clear idea how much work will be still required before the extent of our knowledge on the function and structure of all chloroplast types will approach that attained presently with the higher plant chloroplast.

In recent years it has been gradually cleared up that ionic fluxes between the thylakoid lumen and the chloroplast stroma and ion gradients established across the thylakoid membrane play a crucial role in the control of elementary processes in either of the two chloroplast compartments. In the second chapter W. J. Vredenberg concentrates on coupling of ion movements in the chloroplast with the generation of potential difference across the thylakoid membrane. He discusses first the general background of the electrical potentials involved and then reports the results obtained by direct measurements of potential kinetics upon illumination with micro-electrodes. In the special case of *Peperomia* chloroplast he believes that in a great number of cases the response of the electrode actually represents the situation in an intrathylakoidal space or at least within one stack of grana. The comparison of results thus obtained with evidence derived from the (supposedly) electrochromic absorbance changes provides interesting material for discussion and further experiment planning.

Most diverse aspects of ionic regulation of primary photosynthetic processes are successfully reviewed by J. Barber. By necessity a large part of this chapter is devoted to the classification and discussion of the available information concerning broken chloroplasts. Structural and functional changes in thylakoids (stacking and other conformational changes, electron transport control by the energized state, state 1-state 2 phenomenon), produced by varying the ionic environment are analysed in detail. Since fluorescence measurements represent a most important source of information a reader not familiar with this aspect of photosynthesis will appreciate the concise explanation of basic concepts concerning fluorescence kinetics, yield and lifetime. In the final sections of the chapter first attempts to understand the extent and purpose of ionic regulations within intact chloroplast are summarized.

The coupling of photophosphorylation to electron transport, particularly the stoichiometry of ATP formed and electrons transported, varies considerably with the structural state of the isolated chloroplast and with the conditions of assay. This is, no doubt, an important cause of the uncertainty which still exists as to the exact number of ATP molecules produced when two electrons are transferred through the noncyclic electron transport chain. In chapter 4 D. O. Hall convincingly documents his view that this number is greater than 1.5 and in the fully functional chloroplast approaches the value of 2.0. Apart from analysing results obtained in his laboratory and explaining how these were obtained, D. O. Hall presents also, in the form of extensive tables, most of the data published by other groups on ATP/2e stoichiometries for noncyclic photo-

phosphorylation and for phosphorylations connected with each photosystem separately, as well as for the H^+/e and H^+/ATP ratios reported in the literature. In addition, a great number of basic data from various sources relevant for the calculation of phosphate potential have been collected, tabulated and used for evaluation of ΔG for ATP synthesis. A tentative conclusion is drawn that the value for $\Delta G = 11.5$ Kcal mole⁻¹ may represent a reasonable upper limit at conditions under which efficient ATP synthesis occurs in the chloroplast, and that the corresponding value of ΔE can be built up in the working thylakoid as the sum of ΔpH and ψ . In Hall's view available evidence supports the idea that the amount of ATP produced in non-cyclic phosphorylation is sufficient for driving CO_2 fixation and reduction in the Calvin cycle and that the ATP/2e ratio is a comparatively stable value for a given preparation of chloroplasts. It is stimulating to read forcible arguments to the contrary in the chapter entitled "Energetics of intact chloroplasts" by G. H. Krause and U. Heber. Heber's concept of the considerable flexibility of the ratio in which ATP and NADPH can be supplied by the photochemical apparatus for biochemical work in the stroma is based mainly on three types of observations: (i) external substrates requiring widely different ATP/NADPH ratios (from 0 to 2.0) are reduced by intact chloroplasts at comparable and high rates; (ii) when CO_2 is added to illuminated intact chloroplasts the ATP level decreases while NADPH level remains constant; (iii) quantum requirements for reduction of external substrates by intact chloroplasts surpass the value of 8 if the value of the ratio ATP/NADPH is greater than 1. Many additional lines of evidence are discussed demonstrating that the ratio of ATP/NADPH supplied by the thylakoids adjusts to the demanded value. The greater and equally important part of the chapter, however, describes various shuttle mechanisms which have been proved to secure transport of reduced pyridine nucleotides and ATP from and into the intact chloroplast. Reading this part of the paper one cannot but admire both the variety of ingenious tricks developed in the chloroplast to solve difficult tasks and the skill of the experimenter in disclosing them.

An operation of a certain shuttle mechanism is often demonstrated and quantitatively evaluated by Krause and Heber on the basis of its consequences, such as oxygen evolution, NAD^+ reduction, etc. Direct measurements of the rate of transport across the chloroplast envelope with different compounds of interest have been systematically undertaken in recent years by Heldt and his colleagues. Their results obtained by the ingenious method of silicon layer centrifugation are discussed by Heldt in the next chapter. Most ions and metabolites which act in the important shuttles appear to be transported across the chloroplast inner membrane mainly by two types of translocators, i.e., the phosphate and the dicarboxylate translocator. Their affinities for various compounds have been established and are reported in terms of K_m or K_t .

A good deal of original work by the author is also included in the discussion by D. A. Walker of photosynthetic induction and its relation to transport phenomena and control mechanisms in chapter 7. The treatment is based mainly on the results of experiments with intact chloroplasts. The possibility to control the kinetics of induction by increasing or reducing the level of various Calvin cycle intermediates in intact chloroplast preparations provides a very valuable tool for the analysis of the nature of the induction period. Inversely, the effect of various compounds on the induction can be used to specify their possible role not only in the carbon reduction cycle but also in the chloroplast cytoplasm relationships. In this way the crucial role of inorganic phosphate concentration in the control of photosynthate export from the chloroplast has been thoroughly defined. The activation of Calvin cycle enzymes by light and cations has been also examined in some detail. The general conclusion from this chapter is that induction is due primarily to the autocatalytic build-up of the Calvin cycle whereas activation of enzymes makes only a minor contribution.

The chapter on chloroplast — cytoplasm relations in C 4 plants by J. Coombs brings a detailed critical evaluation of the evidence on which the various schemes of different variants of C 4 photosynthesis rest. An alternative hypothesis is also presented based on Coomb's belief that the level of RBP carboxylase activity in the mesophyll chloroplasts of some C 4 plants is high enough to substantiate the operation of the Calvin type carbon reduction cycle along with the CO_2 fixation by PEP carboxylase in the cytoplasm. Part of Coombs criticism of the commonly accepted schemes of C 4 photosynthesis becomes presently smoothed down by latest results, some of which have been obtained by novel approaches. Even so his chapter presents a very useful recapitulation of all the objections which have to be taken into account before one starts to believe an appealing scheme.

Next three chapters emphasize the fact that biosynthetic activities of the chloroplast comprise much more than a "sugar factory" engaged with CO_2 assimilation. In chapter 9 J. D. Schwenn and A. Trebst deal with the wealth of data on photosynthetic sulfate reduction which accumulated during the last ten years. Although a good deal of the results were obtained with *Chlorella* cells, isolated intact chloroplasts were also shown to contain the complete sulfate

reducing mechanism from sulfate to cysteine. ATP, reduced ferredoxin and NADPH for its operation are provided by the photochemical activity of thylakoids.

Sulfate reduction in intact chloroplasts shows significant similarity to photochemical nitrate reduction since the six electron reduction of both sulfite and nitrite is directly coupled to the electron transport chain of chloroplasts via ferredoxin. The chapter entitled "The cooperative function of chloroplasts in the biosynthesis of small molecules" by R. M. Leech and D. J. Murphy starts with consideration of nitrate reduction and then follows the fate of NH_4^+ produced by it in the intact chloroplast. The enzymes and intermediate steps involved in the synthesis of various aminoacids in the chloroplast are discussed as well as the steps for which cooperation with cytoplasmic reactions is needed. The present views are summarized in an instructive diagram. The second part of this chapter follows the intrachloroplastic synthesis of lipids again with the emphasis on the chloroplast — cytoplasm collaboration in the construction of a complete molecule of various lipids. It is to be regretted that other small molecules (partially) synthesised in the chloroplast could not be treated in a similar manner in the present volume.

Synthesis of macromolecular chloroplast components *i.e.* their proteins and nucleic acids is most competently treated by R. J. Ellis. His contribution starts with a most valuable analysis of the frequently misunderstood concept of chloroplast autonomy pointing correctly to its severe limitation. The properties and functions of chloroplast DNA and the nature of chloroplast DNA and RNA polymerases are then described. In the extensive section on protein synthesis *in vitro* experiments are emphasized which yield unambiguous results compared with the often misleading inhibitor studies. In conclusion the cooperation of the nuclear and chloroplast genomes is considered on the model of RBP carboxylase synthesis and assembly from its two types of subunits. To find this chapter completely covering the subject one would appreciate a report on the extensive work on thylakoid polypeptide synthesis accomplished in recent years in various laboratories.

The concluding chapter represents a worthy culmination of the leading idea of the whole volume. J. A. Raven presents in it a most comprehensive analysis available in the literature of the energetical aspects of division of labor between chloroplast and cytoplasm. The merit of this contribution is both in the elaborate compilation of data spread in papers of diverse nature and in the unambiguous way of drawing from them important consequences. On the basis of all available evidence the author concludes that ATP and reductant generated in the light reactions of photosynthesis can be used *in vivo* for the synthetic growth processes outside the chloroplast and that this contribution is quantitatively important and significant for the life of the cell.

I. ŠETLÍK (Třeboň)

Efficiency of Water and Fertilizer Use in Semi-Arid Regions. Proceedings of an Advisory Group Meeting held at Bambey, Senegal, 10—14 November 1975, Organized by the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture. A Technical Document Issued by the International Atomic Energy Agency, Vienna, 1976. 278 pp. Microfilm copies US \$ 0.65.

The International Atomic Energy Agency and the Food and Agriculture Organization of the United Nations support research contracts, symposia, panels and other activities concerned with a wide agricultural research involving the use of radiation and radioisotopes to bring agriculture to its goal — the optimum production of food. Research programmes are planned by advisory groups of leading scientists and for separate programmes contracts are awarded to about 10 well qualified institutes in developing countries. Coordinated research programmes continue for about 5 years. The subject of the Soil Fertility, Irrigation and Crop Production Section programmes is the efficiency of water and fertilizer use on various crops. Current water programme of this section "Use of Radiation and Isotope Techniques in Studies on Soil Water Regimes" was initiated in 1972; it should contribute to a better understanding of water movement in unsaturated soils and through the development of techniques obtain a reliable estimate of the drainage percolation of soil profiles in the field. Information thus gained would lead to appreciable saving in water for more efficient use of fertilizers by crop.

The purpose of the meeting held at "The National Centre for Agricultural Research" at Bambey, was to identify specific areas for the research programmes aiming at reducing the crop hazards and/or increasing production under dry farming conditions. At this meeting were presented 14 papers, which dealt with soil moisture, soil water movement, fertilizer, irrigation and water use efficiency in semi-arid conditions, and with possibilities of simulating this processes. All papers were provided by figures, diagrams, tables, lists of references, and by an essential part of the discussion, which followed the presentation of papers. The book is concluded by formal recommendations made by the advisory group.

JARMILA SOLÁROVÁ (Praha)

GUDERIAN, R.: **Air Pollution**. Phytotoxicity of Acidic Gases and Its Significance in Air Pollution Control. — BILLINGS, W. D., GOLLEY, F., LANGE, O. L., OLSON, J. S. (ed.): *Ecological Studies. Analysis and Synthesis*. Vol. 22. Springer Verlag, Berlin—Heidelberg—New York 1977. 127 pp., DM 58,— US \$ 25.60.

The emission of gaseous pollutants has been rising from year to year and despite the endeavour of many international organizations and governments to reduce further increase of air pollution, predictions for the future are rather pessimistic. Although the control of air pollutants, especially of those from small sources, is technically and economically impossible, it is necessary to maintain the level of pollutants in atmosphere within the limit which is not hazardous for man and his environment, especially for plants. To evaluate this limit, the knowledge of the quantitative relationship between ambient pollutant concentrations and their effect on plant are necessary.

This eminently readable book is a very welcomed addition to the comprehensive literature on this problem. The first of its four chapters — Material and Methods — critically reviews and compares the efficiency and practical possibilities of the study of the effect of pollutants (a) in the field in adjacency to their source, (b) at fumigation experiments in the field, and (c) under controlled environment conditions, as well as the utilization of the apparatuses and methods for air analyses and methods for the objective evaluation of plant responses. The second chapter — Experimental Analysis of the Effects of Gaseous Pollutants — deals with criteria of the evaluation of air pollution effects, the influence of pollutant concentrations and exposure time, continuity and intermittency of pollutant action, combination of different types of pollutant and the significance of external and internal factors of plant growth. The third chapter — Comparisons of the Phytotoxic Characteristics of Sulphur Dioxide, Hydrogen Fluoride, and Hydrogen Chloride — involves the functions of these gases and their elements in plant metabolism, accumulation in plant organs and latent injury to single plants and to the ecosystem on different structural levels. The last chapter — Discussion of the Suitability of Plant Responses as a Basis for Air Pollution Control Measures — deals with criteria of air quality, applicability of different plants as indicators of the level of pollutants in air and possibilities to reduce the action of pollutants in plant stands.

This book contains much valuable information for agronomists, botanists, plant physiologists, ecologists and foresters, which is often difficult to find. The detailed presentation is well documented with 26 tables and 40 figures, the useful list of 378 references facilitates further study. The book is well indexed by a Subject index which contains plant species and the subjects dealt with are discussed in sufficient detail.

JARMILA SOLÁROVÁ (*Praha*)

Manual on Mutation Breeding. Second edition. Technical reports series No. 119, IAEA, Vienna 1977, 288 pp. US \$ 20.00.

More than 200 new cultivars of crop plants and ornamentals (information received by 1975) are a proof of the success of the induced-mutation technique in plant breeding. Data on mutation methods were scattered in different journals and proceedings of symposiums held on this topic. A concise and comprehensible Manual appeared first in 1970. It was edited and compiled by the Plant Breeding and Genetics Section of the Joint FAO/IAEA Division of the Atomic Energy in Food and Agriculture. This second edition is considerably revised and updated. The introductory chapter presents a survey of the possibilities of using mutagens for plant breeding purposes, e.g. for the induction of mutants used directly as improved crops or for cross-breeding, for the induction of male sterility, sports, production of haploids etc. This chapter is followed by a section describing two main types of mutagens a) ionizing radiation (X-rays, gamma, beta, neutron radiation) and b) chemicals (mainly alkylating agents, sodium azide etc.). For the substantial mutagens applied in mutation breeding, the treatment and post-treatment procedures, health hazards and safety measures are presented. Plant breeders will appreciate the description of methods for handling the M_1 and following generations for the selection of mutants of seed propagated species (barley, wheat, rice, soybean etc.) and mutant techniques in breeding asexually propagated plants. A new chapter deals with the modern methods of genetics, which with further perfection can strongly reduce the time and cost of plant breeding in the future: fusion of protoplasts, introduction of externally supplied molecules, haploids from anther pollen culture, etc.

This Manual is a "must" for all those introducing mutation techniques in plant breeding.

T. GICHNER (*Praha*)

FRANKEL, R., GALUN, E.: **Pollination Mechanisms, Reproduction and Plant Breeding.** — Springer-Verlag, Berlin—Heidelberg—New York 1977, 281 pp., 26.40 US \$.

This second volume of Monographs on Theoretical and Applied Genetics is dedicated to reproductive biology of spermatophytes — mainly angiosperms.

The introductory chapter briefly examines the importance of pollination mechanisms in breeding and crop production and reviews the modes of sexual reproduction in higher plants. More attention is paid to pollination ecology and dynamics, especially to the description of pollen vectors and of factors affecting their activity and to discussion of methods for determination of the natural cross-pollination rate. The second chapter entitled "Autogamy" deals with evolutionary aspects of this mode of reproduction, with biological mechanisms of autogamy and describes in detail breeding techniques of controlled pollination in autogamous crops, including the generally important methods of pollen collection, storage and transfer on receptive structures. Nearly two thirds of the book are devoted to the chapter "Allogamy". Besides specific problems of allogamous plants, this section includes a brief survey of the formation and function of reproductory structures. The main topics of the chapter are concerned with sex determination, incompatibility and male sterility. Genetic and environmental factors controlling sex expression are examined with special emphasis on breeding and productivity of crop plants. Concerning the complex theme of incompatibility a brief review is presented dealing essentially with genetics and physiology of self-incompatibility. The discussion of applied aspects of this phenomenon is focused on genetic and physiological breakdown of self-incompatibility and on possible utilization of self-incompatibility in hybrid seed production. This theme is treated in detail in the third volume of this Series. The last part of the chapter deals with structural, developmental and biochemical characterization of male sterility, and with occurrence and genetics of various types of sterility in natural and artificial populations. The practical use of male sterility is discussed above all in relation to the production of hybrid seeds.

The importance of the book consists in that it brings together information on biology of reproduction from various fields of botany. Especially valuable is the breeding-methodological treatment of the theme. It can be recommended above all to postgraduate students in biology and agriculture and to research workers interested in plant breeding and related fields.

J. TURÝ (Praha)

GRUNEWALDT-STÖCKER, G., NIENHAUS, F.: **Mycoplasma-ähnliche Organismen als Krankheitserreger in Pflanzen.** — P. Parey, Berlin, Hamburg, 1977. (Acta Phytomedica, Heft 5.) 115 pp., 36 Figs. 8 Tab. DM 44,—.

Eleven years ago procaryotic microorganisms resembling *Mycoplasmatales* in many properties were demonstrated within phloem tissues of plants infected with diseases called mostly yellows, witches' broom and phyllody; other characteristic symptoms are proliferation, stunting, dwarfing etc. Recent knowledge does not enable these organisms to be given scientific names; thus they are named mycoplasma-like organisms (MLO), but investigation of the supposed function of MLO in etiology of yellows diseases still lacks some evidence. A similar situation arose with rickettsia-like microorganisms (RLO) discovered within vessel tissues of plants infected with some other transmissible diseases. (There is only one case in which *Spiroplasma citri* has been proved to be the agent of the citrus stubborn disease). Vectors (mostly leafhoppers), transmission and many properties of yellows diseases supposed to be caused by MLO were described a long time ago, when they were considered to be virus diseases.

MLO were observed by means of electron microscopy in more than 200 plant species and also their sensitivity to tetracyclines was ascertained in many cases. Recently, relationships of MLO to virus-like particles attached to MLO surface, or discovered in their vicinity, and even within MLO bodies have attracted attention of scientists.

The authors of the publication summarized the up-to-date knowledge of MLO by selecting important information from many papers published all over the world. Of course, the review is not fully exhaustive; nevertheless, they also cite some doubtful conclusions, but usually keeping enough of their own criticism. Individual chapters deal with classification and properties of *Mycoplasmatales*, properties of MLO (morphology, reproduction, cultivation trials, pathogenicity, evidence of MLO and their spread in plants, transmission, multiplication and localization in animal vectors), and plant hosts of MLO (symptoms and host ranges). Some important data are summarized in tables; there are also critical notes e.g. on terminology. The chapter on diagnostic possibilities and control measures (prospects of chemotherapy, heat therapy, and maintenance of healthy plants) contains the most important information. The chapter on relationships of MLO, RLO and viruses (including mixed infection) also includes discussion on the etiological function of individual presumed pathogens.

The book represents a good review suitable for a wide range of readers.

J. BRČÁK (Praha)