Green Plants

Their Origin and Diversity

The central theme of *Green Plants* is the astonishing diversity of forms found in the plant kingdom, from the simplicity of prokaryotic algae to the myriad complexities of flowering plants. To help the reader appreciate this remarkable diversity, the book is arranged according to generally accepted classification schemes, beginning with algae (both prokaryotic and eukaryotic) and moving through liverworts, hornworts, mosses, fern allies, ferns and gymnosperms to flowering plants. Copiously illustrated throughout with clear line diagrams and instructive photographs, *Green Plants* provides a concise account of all algae and land plants, with information on topics from cellular structure to life cycles and reproduction. The authors maintain a refreshingly cautious and objective approach in discussions of possible phylogenetic relationships. Newly emerging information on features of plants known only as fossils is included, providing as complete a history as possible of the plant kingdom. Throughout the book there are many references to ultrastructural and physiological features which relate growth and form to current concepts in the study of plant development. This new edition has been completely updated to reflect current views on the origin of the major groups of plants and includes information arising from more recently developed techniques such as cladistic analyses. As such, it provides an up-to-date and timely resource for students of botany, and also for researchers needing a comprehensive reference to the plant kingdom.

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Second edition

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Preface to the first edition

Green Plants is a thoroughly revised edition of the earlier *Diversity of Green Plants* by P. R. Bell and C. L. F. Woodcock (3rd edition, London, 1983). The continuing demand for a concise account of the algae and land plants from the point of view of their natural relationships and biology reflects the buoyant state of botanical science. Exciting advances remain a feature of all its aspects. The biophysically minded are revealing in impressive detail the electron pathways in the thylakoid membrane while paleobotanists expand significantly our knowledge of the earliest angiosperms of the Cretaceous and geneticists explore the molecular aspects of plant development. The theme of *Green Plants* is the astonishing diversity of forms which evolution has provided from the atmospheric carbon fixed by photosynthesis, the remarkable phenomenon which is basic to plant life. The treatment of the Plant Kingdom correspondingly extends from the simplest cellular organisms capable of phototrophy, the prokaryotic algae, to the complexities of the flowering plants, not omitting (so far as they are known) the essential features of the plants represented only by fossils.

The record of plant life provides a striking instance of both genetic conservation and variation. The photochemistry of the thylakoid membrane is presumably basically the same today as it was at the dawn of plant life in pre-Cambrian times, and the genetical system controlling its development likewise essentially unchanged. Variations in subsequent biochemical pathways, leading, for example, to C_3 and C_4 plants, may also be of considerable antiquity. Accompanying these stable mechanisms of phototrophy are innumerable variations in morphology, a consequence of the mutability of DNA. Natural selection has offered, and continues to offer, the principal constraint. In lush conditions, even selection, provided essential physiological and reproductive features remain unimpaired, may do little to limit diversity.

Classifications of the algae and land plants facilitate the ordered treatment of diversity. Those adopted here follow schemes in general use. The "blue-greens" (together with the Prochlorophyta) are regarded as algae. To maintain a sharp division between prokaryotic and eukaryotic organisms is to fall into the error of attributing undue weight to one character. The concept of Algae, phototrophs with a wide range of morphological, biochemical and ecological features in common, comprehends both karyotic conditions.

The preparation of the present work has involved the help, willingly given, of experts in many fields. The writer must accept responsibility for any errors remaining. In addition to the authors and publishers cited, the following kindly agreed to the reproduction of figures: The Council of the Linnean Society of London (Figs 5.7, 8.46, 9.14, 9.15); the Trustees of the British Museum (Natural History) (Figs 2.12, 3.20, 3.23, 3.24, 4.15, 4.16, 9.5); and the University of Michigan Press (Figs 3.25, 3.26, 3.27).

Nothing would have been possible without the invaluable technical assistance of John Mackey and the skilled secretarial work of Elizabeth Bell. To both my sincere gratitude.

P. R. Bell
London, 1990

Preface to the second edition

New techniques, such as nucleic acid sequencing and refined methods of spectrographic analysis of plant products, have contributed to the continuing vitality of botanical science, and correspondingly the need for a second edition of *Green Plants*. Sequence analyses have indicated, for example, the evolutionary distance between the mosses and liverworts, the latter appearing closer to the green algae, and presumably to the early colonists of the land. Chemical analyses have revealed surprisingly that the material thought to be sporopollenin coating the membranes of certain green algae, unlike sporopollenin, is largely aliphatic in nature. The evolutionary significance of this discovery is not yet clear, but it is noteworthy that a chemically similar, acetolysis-resistant, material has been found coating the female gamete in archegoniate plants.

Advances in comparative morphology and paleobotany have also been notable. Penetrating studies of sexual reproduction in the Gnetales have thrown fresh light on the origin of double fertilization as it is seen in flowering plants, and has strengthened the view that the endosperm, unique to the angiosperms, is in origin a second embryo, but remains a tissue in which embryogenesis is normally permanently suppressed. The firm evidence, now available, for certain lowly plants from the Rhynie Chert (Lower Devonian) being gametophytes of the rhyniophytes has confirmed the existence of an archegoniate life cycle in these early colonists of the land. Expanding knowledge of the flowering plants of the Cretaceous, particularly of the small-flowered "paleoherbs", has revolutionized thinking about the nature of the earliest angiosperms. Most interestingly, the general affinity (so far as known) of the earliest flowering plants points to self-incompatibility being one of their features, in line with arguments previously advanced on theoretical grounds.

It is becoming increasingly accepted that a basic knowledge of the diversity of plants, of their morphology and of their reproduction is an essential prerequisite for productive research into plant growth and morphogenesis, including the novel use of homoeotic mutants in the analysis of the genetic control of ordered development. The wealth of new techniques and instrumentation now available promises an exciting future for the young investigator of plant life. The aim of *Green Plants* continues to be to foster this endeavor. The order of earlier editions of this work has been largely followed, except that the Psilotales, in keeping with current views, are now associated with the ferns, and the subclasses of the flowering plants are referred to as the Liliopsida and Magnoliopsida.

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P. R. Bell — *London*

A. R. Hemsley — *Cardiff*

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