

Preface

We wrote this book because we believed that there was a need for an explanation of plant systematics (or taxonomy) that can be used in undergraduate courses and that incorporates current exciting developments in the field. In the past two decades abundant new systematic data, especially from DNA sequences, have come forth, and a rigorous phylogenetic approach has established novel ways of analyzing data and practicing systematics.

The three earlier editions of this book have been well received by many students and other botanists. The textbook has been translated into Chinese, French, Italian, Korean, and Portuguese, and the authors of the first edition (Walter S. Judd, Christopher S. Campbell, Elizabeth A. Kellogg, and Peter F. Stevens) received the 1999 Engler Silver Award/an annual award of the International Association of Plant Systematists for the most outstanding book or monograph in plant systematics. Encouraged by this positive reception, we have prepared a fourth edition in order to keep the book as up-to-date as possible.

The basis for this book is the tree of life—the idea that all life is interrelated, like branches on a tree. We deal with the part of this tree occupied by the vascular plants or tracheophytes, and focus on the flowering plants, an important group that dominates most of Earth's terrestrial ecosystems and provides us with medicines, beautiful ornamentals, construction materials, fiber for paper and clothing, and most of our food. Historically, information about these and other attributes of vascular plants was essential to the development of human civilization. Survival rested upon knowing which plants were poisonous or were good to eat; which were potential food for animals; which were good for tools and weapons; which might cure ailments; and which might be useful in many other ways. Systematics as a science grew out of such interests in organisms and evolved from systems of information about the uses of different organisms to a broader understanding of biodiversity. To this end, plant systematists ask questions such as, How should the tremendous diversity of legumes be partitioned or classified into genera and then into species? What are the relationships among the major groups of grasses? How do we know whether or not a plant is a member of the orchid family? This text deals with how these and thousands of similar questions are answered; the final two chapters present some current answers to questions about evolutionary relationships among the major groups of tracheophytes.

Charles Darwin led the way in establishing the evolutionary perspective of modern biology. One impact of this view of life was to make it a major goal of systematics to uncover the evolutionary history—or phylogeny—of groups of organisms. Willi Hennig and W. H. Wagner, along with many others, developed explicit methods of hypothesizing and testing phylogenetic relationships and reflecting these in classifications. We follow a phylogenetic approach throughout this book (as opposed to a phenetic or evolutionary taxonomic/eclectic approach). As far as possible, therefore, we recognize monophyletic and avoid paraphyletic or polyphyletic groups. In the few cases in which a nonmonophyletic family or subfamily has not been divided into monophyletic units, we have placed the taxon name in quotation marks. The monophyly of many genera of angiosperms is questionable, but fewer phylogenetic analyses are available at this level, so generally we have not tried to indicate possible or probable paraphyly or polyphyly of genera.

Chapter 1 introduces and explains the concept of phylogeny, and outlines why systematics is important in biological investigations and to society. Chapter 2 explains how phylogenies are reconstructed from systematic evidence, especially molecular data. The process of transforming evidence into a representation of phylogenetic relationships in an evolutionary tree is first presented using simple hypothetical data and then extended to complex real situations. The chapter examines the construction of phylogenetic trees using Neighbor Joining, Parsimony, Maximum Likelihood, and Bayesian methods. This “primer of phylogeny” also incorporates the conversion of phylogenetic hypotheses into a classification, mapping characters onto trees, and dating phylogenies.

The central position of phylogeny in classification has emerged only recently, but many groups of plants, such as legumes, grasses, mustards, and orchids, have long been recognized. Chapter 3 outlines how systematists perceived groups in the past, how higher taxa were formed, and the historical background of phylogeny. It also provides an explanation of plant groupings over the years. The information on which phylogenies and classifications are based comes from a wide array of sources, including structural aspects of organisms, i.e., morphology, anatomy, cytology, and secondary chemistry (Chapter 4), and DNA features, especially nucleotide sequences (covered in Chapter 2, because of their critical importance in

phylogeny construction). These chapters on phylogeny, classification, and taxonomic evidence provide essential information for understanding the vascular plant groups covered in this book.

Diversification and the evolution of plant species—how plant species form, how they interact, and how we define them, including a presentation of the effects of hybridization—are the fascinating and challenging topics of Chapter 5. Chapter 6 presents an overview of the phylogenetic history of green plants, especially tracheophytes, explains the origin of many of the important features used to identify plants, and lays the foundation for the final two chapters, which focus on vascular plant diversity.

Chapter 7 covers tracheophytes that do not have flowers, including lycophytes, monilophytes, and extant gymnosperms (conifers, cycads, ginkgo, and gnetophytes). Although these plants are certainly important, they are far surpassed in terms of number of species and ecological dominance by the flowering plants or angiosperms, the subject of Chapter 8. Chapters 7 and 8 present the diversity of these groups, with descriptions, illustrations, and discussions of phylogenetic relationships. Exceptionally high-quality illustrations from the *Generic Flora of the Southeastern United States*, which show taxonomically useful information for many families of plants, and a series of color photographic plates, are special assets of Chapters 7 and 8.

Chapters 7 and 8 also emphasize characterization of major clades of vascular plants, and provide detailed coverage of 187 plant families. Two appendices provide additional information related to plant identification, including botanical nomenclature (the application of scientific names), collection of scientific plant specimens, an overview of plant identification, information about the plant systematics literature, and some useful sites on the Internet.

The science of plant systematics has a large number of specialized terms. We have tried to minimize use of technical language, and to apply those terms used in a consistent and precise manner. The terms used in this book are not only included in the glossary, but they are also boldfaced and defined in the first five chapters and appendices (and included in the Subject Index).

Scientific names (and common names) are included in the Taxonomic Index.

Our knowledge of plant systematics is growing very rapidly, making this an exciting time to study plant sys-

tematics. We encourage students to get caught up in this excitement, to appreciate the beauty and importance of plants, which constitute one of the great branches of the Tree of Life, "which fills with its dead and broken branches the crust of the earth, and covers the surface with its ever-branching and beautiful ramifications" (Charles Darwin, *On the Origin of Species*, 1859, Chap. IV, page 163).

Photo Gallery

An important tool for plant identification is the website *Photo Gallery of Vascular Plants* that is associated with this book. It contains over 9750 images of flowers, fruits, detailed dissections of flowers and fruits, and other parts of plants. Students can access these images through an alphabetical list of species, an alphabetical list of families (with the species listed alphabetically within each), or a list of orders and families following the arrangement adopted in this text. The *Photo Gallery* is a new feature of the fourth edition, replacing the CD that accompanied earlier editions of this text. This new platform allows for a great expansion in number of images, including those representing diagnostic characters (and variation within) of each of the plant families, floral and fruit dissections, or anatomical structures. An illustrated glossary (a list of defined terms with links to particular images in the *Photo Gallery* illustrating them) is included.

Acknowledgments

This book is a group effort. Although each of us wrote certain chapters, we all benefited from numerous helpful comments from our coauthors. Walter S. Judd had primary responsibility for Chapters 4 and 8, the box covering Hennigian Argumentation in Chapter 2, the two appendices, and the glossary. Christopher S. Campbell was responsible for Chapters 1, 5, and 7; he also contributed the treatment of Rosaceae in Chapter 8, the sections on pollination biology, embryology, chromosomes, and palynology in Chapter 4, and the section on the Internet in Appendix 2. Elizabeth A. Kellogg wrote Chapter 2, a portion of Chapter 1, as well as the treatments for Poaceae, Juncaceae, Cyperaceae, and Santalales in Chapter 8, and the section on arguments against ranks in classifications in Appendix 1. Peter F. Stevens wrote Chapter 3 and Michael J. Donoghue wrote Chapter 6.

The Website Photo Gallery of Vascular Plants is the responsibility of Walter S. Judd, Daniel L. Nickrent, Kenneth R. Robertson, J. Richard Abbott, Barbara S. Carlward, Tanja M. Schuster, Christopher S. Campbell, Kurt M. Neubig, Scott Zona, Michael J. Donoghue, and Elizabeth A. Kellogg; this group also provided nearly all of the photographs.

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IAS	Ihsan Al-Shehbaz
IB	Irene Brady
ADC	Arnold D. Clapman
SD	Sydney B. DeVore
DCJ	Diane C. Johnston
DHM	Dorothy H. Marsh
PK	Patricia Kernan
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RAW	Rachel A. Wheeler
WZ	Wendy B. Zomlefer

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