Early Events in Monocot Evolution

Tracing the evolution of one of the most ancient major branches of flowering plants, this is a wide-ranging survey of state-of-the-art research on the early clades of the monocot phylogenetic tree. It explores a series of broad but linked themes, providing for the first time a detailed and coherent view of the taxa of the early monocot lineages, how they diversified and their importance in monocots as a whole.

Featuring contributions from leaders in the field, the chapters trace the evolution of the monocots from largely aquatic ancestors. Topics covered include the rapidly advancing field of monocot fossils, aquatic adaptations in pollen and anther structure and pollination strategies, and floral developmental morphology. The book also presents a new phylogenetic tree of early monocots based on sequence data from 17 plastid regions, and a review of monocot phylogeny as a whole, placing in an evolutionary context a plant group of major ecological, economic and horticultural importance.

Abstracts and key words for each chapter are available for download at www.cambridge.org/9781107012769.

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The Systematics Association promotes all aspects of systematic biology by organizing conferences and workshops on key themes in systematics, running annual lecture series, publishing books and a newsletter, and awarding grants in support of systematics research. Membership of the Association is open globally to professionals and amateurs with an interest in any branch of biology, including palaeobiology. Members are entitled to attend conferences at discounted rates, to apply for grants and to receive the newsletter and mailed information; they also receive a generous discount on the purchase of all volumes produced by the Association.

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Preface

The monocotyledons represent a major subgroup of flowering plants, with many species of economic and ecological significance. They include food crops such as cereal grasses, palms, bananas, taro, yams and onions, and also many plants important for ornamental horticulture, such as lilies, orchids, aroids, bromeliads and sedges, some of which are critically endangered in the wild. Since monocots form *c.* 20% of the angiosperms they are of significance to all those working with or studying the biology and evolution of flowering plants. There is now a community of at least 300 researchers pursuing monocot systematic and evolutionary research, as evidenced by attendance at the most recent of the quinquennial Monocots Conferences (Monocots IV) held in Copenhagen in 2008.

Recent new research on both extant and fossil monocots has significantly increased our knowledge of their biology and evolution. Despite these advances, several questions remain, especially regarding aspects of early-divergent monocots and higher-level ordinal relationships. At the Monocots IV Conference there was relatively little focus on the deep branches of the monocot tree or ordinal relationships, or the early-branching taxa themselves, particularly outside the major alismatid radiation, Araceae. Since 2008, new comparative data on monocot evolution and systematics have emerged on an unprecedented scale, addressing whole-genome phylogenetics and character trait evolution in relation to global patterns of dispersal and diversification.

The papers published here were originally presented at the three-day conference *Early Events in Monocot Evolution*, organized to bring together scientists with a special interest in early-divergent monocots and held in London (at the Linnean Society and the Royal Botanic Gardens Kew) on 20–22 July 2010. Although not intended to be equivalent to a quinquennial Monocots Conference, this meeting commemorated the first one, originally conceived by Paula Rudall and Simon Mayo and hosted at the Royal Botanic Gardens Kew in 1993 (Rudall et al. 1995). The 2010 meeting was also planned to coincide with the official retirement of Simon Mayo and to celebrate his career after 37 years working on Araceae and monocot systematics at Kew and in Brazil.

Although first planned to take place in April 2010, the conference had to be postponed until July due to the travel problems arising from the eruption of the volcano Eyjafjallajökull in Iceland, which unfortunately prevented the attendance in July of some monocot scientists. The meeting was nevertheless attended by over 80 participants, with oral presentations by 19 speakers and their collaborators from Brazil, Canada, Denmark, France, Germany, Japan, Mexico, Russia, UK and the USA, as well as posters by authors from a similarly diverse range of nations. The scientific programme had three main themes: monocot origins and relationships, including fossils, evolution and systematics of early-divergent monocots (including Acorales and Alismatales) and deep monocot relationships: early divergence of lilioid monocots, especially pandans and yams (Pandanales and Dioscoreales). Papers presented at the meeting but not published here include contributions by Dennis Stevenson on alismatids, Sabine von Mering and Joachim Kadereit on Juncaginaceae, Mark Chase, Lídia Cabrera and Gerardo Salazar on Araceae phylogeny, Marc Gibernau on floral character evolution in Araceae, and Ana Maria Giulietti Harley on the contribution of Brazilian researchers to monocot taxonomy and phylogenetic research, in recognition of Simon Mayo's contributions to Brazilian botany.

In the present volume the first few chapters focus on general topics. Iles et al. (Chapter 1) set the scene of early monocot phylogeny in a study of the Alismatales, the largest early clade of the monocot phylogeny. They use plastid sequence data in a new analysis which results in more robust support than obtained by previous studies for the key internal nodes of the alismatalean phylogenetic tree. Smith (Chapter 2) provides a fascinating survey of monocot fossils, an area which has advanced rapidly in recent years. She focusses especially on fossils known from Cretaceous times and describes modern techniques which greatly enhance data gathering from fossils. The clear need for continuing morphological research on extant monocots to complement fossil studies is highlighted. Sokoloff et al. (Chapter 3) target the evolution of syncarpy in early-divergent lineages of monocots and eudicots, a classic issue in angiosperm evolution, and conclude that intercarpellary fusion is ancestral for monocots. Furness (Chapter 4) surveys pollen and anther characters in the Alismatales and concludes that aquatic and semi-aquatic environments are likely to have had an important influence in their evolution in comparison to other early-branching monocot lineages. Jones et al. (Chapter 5) move the focus towards future prediction of monocot diversity in a macroecological study. They compare species richness in all accepted monocot genera with data on their geographical distribution and ecological (biome) associations. Among other things they find differences between the major monocot orders in their diversification in relation to climate, and highlight the importance of understanding the role of niche conservatism in the response of species to environmental change.

The following chapters move the focus to more detailed studies of families and orders. Les and Tippery (Chapter 6) present a comprehensive and detailed review of molecular phylogenetic studies in the alismatid monocots, a taxon of particular interest since it includes the marine angiosperms and most water-pollinated species. They confirm the monophyly of the core elements of alismatids and note that some genera, including *Sagittaria*, remain poorly understood systematically. Tanaka et al. (Chapter 7) studied pollen and stigma morphology of Hydrocharitaceae and discuss these fascinating and unusual structures in relation to pollination mechanisms and molecular phylogeny. In a developmental study, Remizowa et al. (Chapter 8) investigated floral bract reduction in genera of early-divergent monocots (*Potamogeton*, *Tofieldia*, *Triglochin*) and propose the evolution of two different patterns of reduction, although both may occur within the same genus.

Three chapters follow on Araceae, the largest family of early-divergent monocots. Mayo et al. (Chapter 9) review molecular phylogenetic work in Araceae since 1995, and in Chapter 10 Mayo and Bogner discuss the interpretation of the first evolution-based classification of the family by A. Engler, tracing in its conception the influence of the orthogenetic ideas of C.W. Nägeli. Barabé (Chapter 11) reviews work on floral morphogenesis in Araceae in relation to recently published phylogenies, highlighting the great diversity of developmental features that have been observed to date.

The next two chapters shift attention to developmental studies on groups in later-emergent clades of the monocots. Scotland (Chapter 12) reviews an old controversy concerning the homological relationships of the corona of daffodil flowers and reports on work using ABC developmental genes to investigate the genetic basis of this structure. A study of the Velloziaceae by Sajo et al. (Chapter 13) focusses on the contribution of embryology to assessing relationships within the order Pandanales and reveals considerable complexity both at family and ordinal levels.

Finally, Davis et al. (Chapter 14) conclude the volume by presenting the general picture of the monocots as a whole. They using novel data from the ongoing monocot tree-of-life project (MonAToL) to address the origins of the diversity of the lilioid and commelinid monocot lineages, based on a set of 600 representative taxa.

Early Events in Monocot Evolution presents a range of papers which explore a series of broad but linked themes and provides for the first time a more detailed and coherent view of the taxa of the early monocot lineages, how they diversified and their importance in monocots as a whole. As with Monocot Conference volumes that have already appeared, we are confident that this volume will stimulate further research and discussion of early monocot plants as well as demonstrate the vitality and rapid progress of this area of scientific research.

It is a great pleasure to acknowledge the following people and organizations for their help and support in bringing this project to its conclusion: The Systematics

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