# Floral Diagrams

*Second Edition*

Floral morphology is key for understanding floral evolution and plant identification. Floral diagrams are two-dimensional representations of flowers that replace extensive descriptions or elaborate drawings to convey information in a clear and unbiased way. Following the same outline as the first edition, this comprehensive guide includes updated and relevant literature, represents the latest phylogeny, and features twenty-eight new diagrams. Diagrams are presented in the context of the most recent classifications, covering a variety of families and illustrating the floral diversity of major groups of plants. A strong didactic tool for observing and understanding floral structures, these diagrams are the obvious counterpart to any genetic study in flowering plants and a contribution to the discussion of major adaptations and evolutionary trends of flowers. This book is invaluable for researchers and students working on plant structure, development and systematics, as well as an important resource for plant ecologists, evolutionary botanists and horticulturists.

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## *An Aid to Understanding Flower Morphology and Evolution*

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To Catherine, Camille and Alexandre, with love

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# *Preface*

Flowers are extremely attractive to us as a source of inspiration and happiness. It is no wonder that various technical textbooks in plant science tend to enhance their front pages with glamorous illustrations of flowers. Despite this wide interest, our knowledge about the diversity of floral structures is still limited and often relies on research carried out more than 100 years ago.

Technically a floral diagram is a schematic cross-sectional drawing of a flower. However, a floral diagram is more than just a two-dimensional representation. There are more than 250,000 species of angiosperms, and their flowers vary in many ways. The arrangement of flowers in inflorescences, the number, position, identity and shape of floral organs, and the symmetry of the flower as a whole are rarely identical between different families, genera or even species, and even when they look superficially similar, important details differentiate them. Floral diagrams create a rich source of data for identification purposes and for understanding structures, but also to express a hypothesis of evolution. The information contained in floral diagrams is potentially immense and replaces complex descriptions.

Students often struggle with the identification of flowers, mainly because they fail to look at the structures hidden in the bud. However, comparable to the plan of a house created by an architect, the *Bauplan* of a flower – that is, the spatial arrangements of organs in the flower – is essential to understanding systematic relationships. This information is particularly important for identifying plants in the field and tells us much about the key characters of a specific group of plants. The educational merits of floral diagrams in the classroom are obvious for all ages. Used together with floral formulae, they convey information in a clear and rigorous way. They are important for systematists or evolutionary botanists in providing information for databases dealing with morphological data (e.g. Morphbank: www.morphbank.net) or for clarifying phylogenetic questions. In paleobotanical research floral diagrams are a useful resource in reconstructing the shape of fossilized flowers. Researchers in evolutionary developmental genetics will find

appropriate questions about the nature of floral organs to investigate. Horticulturists or amateur botanists will find this book valuable to understand general patterns of flower construction and floral diversity. Finally, artists will find inspiration in the floral diagrams in creating various aesthetic interpretations of flowers (Keto Logua, 2020. Exhibition Studio Berghain Berlin).

It has been more than 140 years since August Wilhelm Eichler (1839–87), then a professor of botany in Kiel, produced a book on floral diagrams in two parts, the first published in 1875 and the second published in 1878. This book, entitled *Blüthendiagramme construirt und erlaütert*, is a major reference work concentrating the information about flowers known at that time. As such, it represents a treasure trove, detailed and often accurate, and even today extremely valuable as a source of data. Eichler's work was an inspiration for later generations of morphologists, such as Arthur H. Church (1865–1937) and Agnes Arber (1879–1960). A particularly fine example of a book using floral diagrams is *Types of Floral Mechanism* published by Church (1908) and intended as a series, but limited to a single volume by lack of interest and funds (Mabberley, 2000). Since Eichler's book was published, much progress has been made in documenting flower morphology, especially from the last decades of the twentieth century, when there was a renewed interest in floral morphology coupled with the use of the scanning electron microscope. This approach has increased tremendously in recent years.

However, information about flowers is often scattered in scientific papers that are not readily accessible, providing little scope for a broad overview of the flowering plants. Alternatively, it dates from important work carried out in the nineteenth century that is in danger of being forgotten. Floral diagrams were used sparingly in different textbooks as illustrative material (e.g. Baillon, 1867–95; Engler and Prantl, 1887–1909), but never to the extent of Eichler's book. More recent examples include Melchior (1964), Sattler (1973), Graf (1975), Stützel (2006), Leins and Erbar (2010) and Simpson (2016). The more recent major textbooks on angiosperm phylogeny (e.g. Soltis et al., 2005, 2018; Simpson, 2006) lack any floral diagrams. Spichiger et al. (2002) did include diagrams for major families, but the diagrams are oversimplified and riddled with mistakes.

The system of classification Eichler used is outdated, as it is based on the Englerian concept that simple, unisexual, catkin-like flowers are ancestral and that more elaborate bisexual flowers are derived. Recent changes in the phylogeny of flowering plants based mainly on molecular evidence have created the need for a better understanding of morphology and its relation to any molecular phylogeny. This new edition of *Floral Diagrams* based on the most recent synopsis of Soltis et al. (2018) should fulfil this purpose.

# *Acknowledgements*

It is now more than ten years since the first edition of *Floral Diagrams* was published. I have taken much pride in this achievement, which has extended my understanding of the world of plants and has allowed me to meet many new colleagues and friends. Studying and understanding flowers is my great passion, and I think that floral diagrams are the best tool to express the wonderful intricacies of flowers. It is a real pleasure to see my book cited in many publications and to hear from colleagues that they keep it close to their desks as reference material for their teaching. I also use *Floral Diagrams* as the backbone for my teaching of angiosperm biodiversity at the Royal Botanic Garden Edinburgh.

However, I think that now is the time for revisiting the book. As with any first edition of a textbook, one finds tiny mistakes and imperfections that disappear with maturity. During the past ten years, botanical science has progressed tremendously, with much more emphasis on flower morphology, and important new information has become available that could be incorporated in this book. Lastly, I realized that adding a few diagrams would make the book more complete.

Several colleagues were inspirational and encouraging, such as Julien Bachelier, Richard Bateman, Peter Endress, Gabriele Galasso, Greg Kenicer, Alex Kocyan, Peter Linder, Michael Müller, Darin Penneys, Gerhard Prenner, Margarita Remizowa, Paula Rudall, Rolf Rutishauser, Rolf Sattler, Dmitry Sokoloff, Dennis Stevenson, Wolfgang Stuppy and Livia Wanntorp, among others. I had the pleasure of meeting new friends and colleagues and collaborating with them, including Arne Anderberg, Catherine Damerval, Thierry Deroin, Xu Fengxia, Karina Gagliardi, Wang Hengyang, Florian Jabbour, Bruce Kirchoff, Wei Lai, Zhao Liang, Cao Limin, Mariana Monteiro, Sophie Nadot, Ioan Negrutiu, Fernanda Pérez, Dietmar Quandt and Andrey Sinjushin, among others, and also to develop research projects with my students, Celina Barroca, Mauricio Cano, Jia Dong, Wang Junru,

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