100 FAMILIES OF FLOWERING PLANTS

M. HICKEY
& C. J. KING

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MICHAEL HICKEY & CLIVE KING

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CAMBRIDGE UNIVERSITY PRESS
Cambridge
London New York New Rochelle
Melbourne Sydney

Published by the Press Syndicate of the University of Cambridge
The Pitt Building, Trumpington Street, Cambridge CB2 1RP
32 East 57th Street, New York, NY 10022, USA
296 Beaconsfield Parade, Middle Park, Melbourne 3206, Australia

First published 1981

Set by Ward Partnership and printed in Great Britain
at the Alden Press, Oxford

British Library cataloguing in publication data

Hickey, Michael
One hundred families of flowering plants.
1. Angiosperms – Dictionaries
I. Title II. King, Clive John
582'.13'03 QK495.A1 79-42670

ISBN 0 521 23283 X hard covers
ISBN 0 521 29891 1 paperback

FOREWORD

I am very pleased to see this book completed, for several reasons. Firstly, I really believe that it will provide teachers and students of Angiosperm systematics with a body of information which it is difficult, if not impossible, to find in the existing literature, and I look forward to using it in my own teaching. Secondly, it represents what seems to me an ideal collaboration between two 'Cambridge Botanic Garden men' – if I may so describe the authors – whose talents are impressively complementary, and such collaboration is the natural outcome of a Garden which has a long tradition of practical horticulture allied to scientific scholarship. Thirdly, and perhaps most importantly, I see the book as a small but significant contribution to the very necessary task of interesting a much wider public in the classification of the Flowering Plants, by encouraging people to look carefully for themselves, as Michael Hickey has done, to see the remarkable detail of floral structure on which the classification is based. Careful observation lies at the root of all worthwhile scientific enquiry, and biology is *par excellence* the science of careful observation.

Having witnessed the various stages in the production, I can record my warm admiration of the authors' tenacity of purpose and meticulous attention to detail, qualities which have in my opinion produced a far more valuable text than might at first sight be realised. Descriptions and statements in the literature have been checked against the living plant – a process all too rarely undertaken – and much detailed clarification has resulted. Undoubtedly errors and ambiguities remain, but they must be greatly reduced by the scrupulous checking which the authors have carried out. Generations of students will, I hope, test the value of the book, and come to appreciate its worth.

S.M. Walters
Director
University Botanic Garden
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PREFACE

According to various authorities there are some 300–400 families of flowering plants in the world today. To understand fully the relationships between these families and to appreciate the diversity of their floral structure would require research into a wider range of plants than time and available facilities normally permit. However, a basic knowledge can be obtained by the study of a selected group of families, and therefore we decided to restrict the number dealt with in this book to one hundred. We thought that this number would be sufficiently large to enable students at schools and universities to gain a reasonable general knowledge of this aspect of botany.

In selecting the hundred families the following points were borne in mind: (1) The range of families should be sufficiently wide to illustrate adequately the similarities and differences existing in floral structure. (2) The typical representative(s) of a family should, as far as possible, be readily available, either as members of the native flora, or as introduced plants commonly grown in gardens or glasshouses.

In limiting ourselves to a maximum of one hundred families we have had to omit many which are both large and important, especially some which are prominent in tropical or subtropical regions.

In general, the descriptions of the families have been based on information given in Willis's *Dictionary of the Flowering Plants and Ferns*, revised by H.K. Airy Shaw, and published by Cambridge University Press in 1973. In cases where long-established families have been divided up, however, this course has not always been followed, the broader view of the family being considered to be of more value to the students for whom this book is designed. The families are arranged in the same order as that of the second edition of *The Identification of Flowering Plant Families* by P.H. Davis and J. Cullen, published by Cambridge University Press in 1979.

The text for each family is in two parts. The first part treats the family as a whole and gives its world distribution, general characteristics, principal economic and ornamental plants, and a classification which includes the mention of some of the larger or more important genera together with their distribution and the number of species they contain. The second part is devoted to the detailed description of a plant chosen as a typical representative of the family – in a few cases it was considered that more than one plant was necessary to show the variation in floral structure existing within the family. This part gives the dis-

tribution of the plant, its vegetative characteristics, floral formula, details of the flower and inflorescence, pollination mechanism, and suggestions for alternatives if the plant described proves to be unobtainable.

The pen and ink drawings which show, in detail, the floral structure of the plant(s) representing each family are an essential part of the book, and all of them have been made from living material. The drawings are accompanied by extended captions which in most cases include measurements of the floral parts. Since many of the drawings are larger than life-size in order to show more clearly the parts concerned, it was felt desirable to provide these measurements so that students, when examining a flower or fruit, should have a clear mental picture of the actual size of the part in question. It must be emphasised that the measurements were taken from the specimens used for the drawings, and that care was taken to ensure that these were typical in form. However, variation within a species or developmental factors may mean that a student will sometimes find that a certain part does not agree exactly with the description or dimensions given. The abbreviations L.S. and T.S. (for longitudinal and transverse sections respectively) have been found convenient to indicate what is seen when a part has been cut lengthwise or across at any point. Their use has therefore not been restricted to describing thin slices of material such as those normally used in microscopic work.

It is hoped that this book will be useful, not only to students, but also to professional botanists and interested amateurs of natural history and horticulture.

We would be grateful if users of the book would notify us of any errors or omissions that may come to their notice.

M.H.
C.J.K.

ACKNOWLEDGEMENTS

We would like to express our appreciation and gratitude to Dr S.M. Walters, Director of the University Botanic Garden, Cambridge, for acting as adviser and for his encouragement in the writing and illustrating of this book. We would also like to thank him and his staff for providing much of the plant material required for the illustrations. A generous amount of material was also supplied by Mr Philip Butler, Curator of the Birmingham Botanical Garden, and by J.K. Barry, R. and C. Draper, W.G. Hennessy, M. Newland and E.W. Pymont. To all these we give our thanks. We are grateful also to J. and H. Blackwood, R.E. Edwards, R. Gregory, T.V. and J. Ireland, S.W. Smith (formerly Head of Science, St Paul's College, Cheltenham), A. Tandy, D. Tullis and Dr P.F. Yeo (Taxonomist, University Botanic Garden, Cambridge) for giving us information and assistance in various ways. We are greatly indebted to Dr Margaret Bradshaw of the University of Durham for her valuable comments on the Introduction, and to Mrs Ann Hill for her sustained effort in producing the typescript. Finally, we wish to thank Dr Alan Winter and others at the Cambridge University Press for their advice and help throughout the production of this book.

SIGNS AND ABBREVIATIONS

Note. Throughout the text the numbers given in parentheses after the genera listed for each family indicate the number of species known throughout the world.

♂	male
♀	female
☿	hermaphrodite
∞	indefinite number
×	hybrid
( )	united
A	androecium
C	corolla
$\overline{G}$	gynoecium (ovary inferior)
$\underline{G}$	gynoecium (ovary superior)
K	calyx
P	perianth
L.S.	longitudinal section
T.S.	transverse section

c.	(circa) about, approximately
cm	centimetre(s)
m	metre(s)
mm	millimetre(s)
2-merous	dimerous
3-merous	trimerous
4-merous	tetramerous
5-merous	pentamerous
6-merous	hexamerous
adj.	adjective
plur.	plural

A measurement given without qualification refers to length. Two measurements connected by × indicate length followed by width. Further measurements in parentheses indicate exceptional cases outside the normal range.

FLORAL FORMULA

Some of the above signs and abbreviations occur in the Floral Formula, which is a convenient form of 'shorthand' for representing the structure of a flower. The letters K, C, A, and G are used to indicate the whorls of floral parts, beginning with the outermost whorl and working inwards towards the centre of the flower. Where there is no separation into calyx and corolla the letter P is used in place of K and C.

Each letter is followed by one or more figures showing the number of parts comprising each whorl, e.g., A5 indicates an androecium consisting of 5 stamens, and A5+5 shows that there are 2 whorls of stamens with 5 in each whorl. Where the number of parts is large and imprecise the sign '∞' is used. If the number of parts in a whorl is variable, a dash joining 2 figures indicates the range of variation, e.g., A12–20 (in *Reseda lutea*) means that from 12 to 20 stamens may be found in a flower of this species.

The parts forming a whorl are sometimes connate, e.g., G(3) denotes a gynoecium of 3 united carpels. (A bracket may be placed above the letters concerned to indicate that 2 whorls are joined together, e.g., $\overbrace{\text{C(5) A5}}$, but this practice has not been adopted here.)

The position of the ovary is shown by a line above or below the letter G, representing an inferior or superior ovary respectively. In rare instances of dioecious plants lacking a perianth, e.g., female flowers in *Betula pendula*, it is not possible to show the relationship of the ovary to the other floral parts and the line is therefore omitted.

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INTRODUCTION

CLASSIFICATION AND EVOLUTION

The classification of the flowering plants or Angiosperms is based upon comparative study of the structure of their flowers and fruits. Thus, one of the most obvious differences between plants, namely whether they are trees, shrubs or herbs, is not a character used in the main classification into different families, and indeed many important families of flowering plants, such as Rosaceae and Compositae, contain both woody and herbaceous representatives. But it is significant, and also useful in identification, that certain families, such as those comprising the catkin-bearing group or Amentiferae, are wholly or very largely composed of woody plants, whilst others are entirely herbaceous.

It is generally assumed that the change from woody to herbaceous forms, and vice versa, has occurred many times within different evolutionary lines of flowering plants. Many botanists also hold the view that the primitive Angiosperm was a dicotyledon with woody stems and large, terminal flowers like the modern *Magnolia*, but this theory has not been proved to the satisfaction of all. Neither is it certain how the monocotyledons originated, though it may be that the common ancestor of both monocotyledons and dicotyledons was some shrubby Angiosperm with primitive floral structure belonging to a group which is now completely extinct. Although the form of the earliest flowering plants is still unknown, it seems clear from the fossil record that they arose in the early Cretaceous period (120 million years ago) and that by the end of that period (80–90 million years ago) they had ousted the conifers and cycads from their position of dominance and established themselves in their stead as the characteristic form of land plant, a place they have continued to hold to the present day.

THE FLOWERING PLANT

With very few exceptions, growth in the flowering plants is maintained underground by a **root** system and above ground by a **shoot** system. The shoot system consists of one or more stems bearing leaves which are arranged spirally or in pairs, or more rarely in whorls of three or more, along each stem. The point from which a leaf arises is called a **node**, and the portion of the stem between two nodes is described as an **internode**. The angle formed by a leaf and its parent stem is known as an **axil**, and buds appearing in this position are called **axillary**. A bud may also be found at the apex of the stem, in which case it is described as **terminal**. Each bud is, in fact, a shoot with very short internodes

and immature leaves. Some buds do not develop further but, if they do so, the internodes lengthen and the leaves enlarge, forming a typical shoot.

A flower may be regarded as a bud which is modified for the purpose of reproduction of the parent plant. The outermost leaves have changed little, retaining their leaf-like appearance and protective function. The inner leaves, on the other hand, have in many cases undergone considerable modification in shape and colour, and have become highly specialised in order to perform a variety of functions necessary for the successful propagation of the plant concerned. These modified leaves are now referred to as floral parts.

In the more primitive families such as Magnoliaceae, the floral parts are many or **indefinite** in number and are arranged on an elongated axis. In more advanced families there is a reduction in the number of parts which then arise from a much shortened axis. In either case, the production of a flower means that growth of the stem concerned is now limited, although it may continue to elongate sufficiently in order to allow the flower-cluster or **inflorescence** to develop fully.

Growth of a stem by apical extension is termed **monopodial** and results in an inflorescence known as a **raceme**. In contrast to this, the main stem may cease to lengthen owing to a flower being formed at its apex. If this occurs, side or **lateral** branches may arise from buds below this flower. This is called **sympodial** growth and results in an inflorescence known as a **cyme**. Determining whether an inflorescence is racemose or cymose may sometimes be difficult but they are usually distinguishable by the order of flower development. In a raceme the youngest flower is situated at the apex of the stem, while in a cyme the oldest flower occupies this position. Grouping the flowers together into an inflorescence, of whatever kind, renders them more conspicuous and is an important aid to pollination.

The term inflorescence is often used solely for a cluster of individual flowers, but, correctly employed, it includes the stem from which the flowers arise which is termed the **peduncle**. Sometimes, however, the flowers are solitary on a stem as in *Galanthus*, Snowdrop. If an individual flower is unstalked it is said to be sessile, but if stalked this stalk is known as a **pedicel**. There may often be scale or leaf-like structures arising from the peduncle or pedicel. These are termed **bracts** or **bracteoles**, and are usually simple in shape compared with the foliage leaves. Where bracteoles are present in dicotyledons, there are usually two situated opposite each other on the pedicel, but only a single bracteole may be present in monocotyledons. In many inflorescences each pedicel arises from the axil of a bract on the peduncle. In the Compositae and Dipsacaceae the inflorescence is condensed to a head of sessile flowers known as a **capitulum** which is borne on the thickened and flattened apex of the peduncle. The bracts of these flowers are crowded into one or more whorls round the capitulum, and together form an **involucre**.

FLORAL STRUCTURE

The flower is a specialised structure evolved for the process of seed for-

mation, which is normally the result of a sexual union. Some plants, however, have the ability to form seeds without the aid of fertilisation. This form of reproduction, which is found in several common genera of Rosaceae (e.g., *Alchemilla*, *Rosa* and *Rubus*) and Compositae (e.g., *Hieracium* and *Taraxacum*) is known as **apomixis** (more strictly **agamospermy**).

The floral axis on which the flower-parts are arranged is termed the **receptacle** or **torus**. The parts are divided into accessory organs which are non-reproductive,

Fig. I. Aestivation.