

**GUIDE TO  
STANDARD FLORAS  
OF THE WORLD**

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**DAVID G. FRODIN**

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**SECOND EDITION**



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## Guide to Standard Floras of the World

*Guide to Standard Floras of the World* is a selective annotated bibliography of the principal floras and related works of inventory for vascular plants. This new edition has been completely revised, updated and expanded to take into account the substantial literature of the late twentieth century, and features a more fully developed review of the history of floristic documentation. The works covered are principally specialist publications, encompassing descriptive floras and checklists, distribution atlases, systematic iconographies, and enumerations or catalogues. A relatively few more popularly oriented books are also included. The *Guide* is organized into 10 geographical divisions, with these successively divided into regions and units. Each geographical unit or larger region is prefaced with a historical review of floristic studies, including references to key literature as well as to more specialized area bibliographies. The bibliography itself is preceded by three general chapters on botanical bibliography, the history of floras, and general principles and current trends, and the book concludes with an appendix on bibliographic searching, a lexicon of serial abbreviations, and author and geographical indices.

DAVID FRODIN is a researcher in the Herbarium at the Royal Botanic Gardens, Kew, having previously held positions in the Department of Biology at the University of Papua New Guinea and the Department of Botany at the Academy of Natural Sciences of Philadelphia. His botanical interests focus on the systematics of the family Araliaceae, particularly the genus *Schefflera*, while his more general interests include tropical biology and the history of biology. He is also an acknowledged authority on botanical bibliography, documentation and informatics, having compiled the first edition of *Guide to Standard Floras of the World* (1984) and co-authored several volumes in the Kew series *World Checklists and Bibliographies of Seed Plants*, including *Magnoliaceae* (1996), *Fagales* (1998), *Euphorbiaceae (with Pandaceae)* (2000), *Sapotaceae* (2000) and *Araceae and Acoraceae* (2000).



# Guide to Standard Floras of the World



An annotated, geographically arranged systematic bibliography of the principal floras, enumerations, checklists and chorological atlases of different areas

SECOND EDITION

**David G. Frodin**

Royal Botanic Gardens, Kew



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To Sidney Fay Blake and Alice Cary Atwood  
authors of *Geographical guide to floras of  
the world*

Phyllis I. Edwards and Rudolf Schmid  
advocates for biological documentation

and E. J. H. Corner  
who eloquently reminded us of what  
Floras are *for*





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## Prologue to the first edition

No branch of botanical literature is more useful, and at the same time more neglected than [floras] . . . For a beginner [the Flora] is the first, and one of the most important aids for obtaining botanical knowledge.

de Candolle and Sprengel, *Elements of the philosophy of plants* (Edinburgh, 1821).

Quatenus bibliotheca in omni scientia primum à studioso evolvi debeat, ita etiam est Botanico *maxime necessaria*, quum multiplex usus inde deducitur ...

Linnaeus, *Bibliotheca botanica* (Amsterdam, 1736; reprinted Halle 1747).

Now, there are two different attitudes towards learning from others. One is the dogmatic attitude of transplanting everything, whether or not it is suited to our conditions. This is no good. The other attitude is to use our heads and learn those things which suit our conditions, that is, to absorb whatever experience is useful to us. That is the attitude we should adopt.

Mao Tse-tung, 27 February 1957, in *Quotations from Chairman Mao Tse-tung* (New York, 1967).

Of all forms of human activity related to plants, that of knowing the kinds, properties and uses of such plants as grow in one's *Landschaft*, or 'parish', is perhaps the longest-established. Most, if not all, 'traditional' cultures centered on the land possess, or once possessed, a comparatively detailed knowledge of the local flora, in many cases recognizing the same species (and sometimes genera) as would a modern professional botanist; and, in like manner to many 'advanced' societies, this knowledge is best developed amongst a comparatively small circle of *savants*.

It is thus not surprising that, in those civilizations which achieved literacy in the pre-Columbian era, this kind of botanical knowledge should have come to be recorded at an early date. However, such works as are now known were largely compilations of what was common knowledge, considerable though this might have been, and for long were conceptually pragmatic. This obtains, for instance, in the oldest known extant geographically oriented botanical works, the treatises of Theophrastus reporting discoveries on Alexander's campaigns in the fourth century B.C.E. and *Nan-fang ts'ao mu chuang* of the fourth century C.E. on south China and Indochina, whose post-Columbian semantic descendants include the Swedish surveys of Linnaeus, the many geographical accounts of distant lands of the nineteenth century containing substantial botanical information, and, with greater impersonality, the Australian and Pacific-area terrain studies by various military and civilian agencies in the mid-twentieth century. Not, however, until the rise of the Western European tradition of independent scientific enquiry and the consequent development of a systematics based on the *nature* of plants *in themselves* rather than on traditionally pragmatic values did the compilation of organized area floristic accounts and plant lists become a distinct activity, which after the Linnean revolution and during the century of European colonial expansion came to constitute a significant proportion of what in

some lands was to be called 'special botany' (*spezieller Pflanzenkunde*, *bijzondere plantkunde*) or, in more modern parlance, systematic botany in a broad sense. Floristic studies and flora- and checklist-writing have ever since constituted an important part of the work of this subdiscipline and the published (and, increasingly, semi-published) results cumulatively contain an immense amount of botanical information. To the non-specialist, these works, along with the provision 'on demand' of identification and information services, perhaps represent the most easily comprehensible aspect of the systematist's work.

The relative importance of area floras and checklists in the world of systematic botany has varied over nearly four centuries, but since the 1930s, and especially since 1945 and the advent of liberal but often short-term state support, floras, checklists, and related area works and contributions thereto have come to predominate. Stafleu<sup>1</sup> has termed the present cycle as 'an age of floras and floristic work', but at the same time notes that this has partly come about at the expense of serious monographic and revisionary work, a trend strongly aggravated by the virtual destruction of the Berlin Herbarium and the German systematics profession by the end of World War II. Current indications are, as Jäger<sup>2</sup> has noted, that this pattern will continue, causing the collective mass of floristic works, especially the more significant ones, to become the single most important source of modern taxonomic knowledge, and thus by default supplanting the great synthetic works of the mid-nineteenth to early-twentieth centuries such as the *Prodromus systematis naturalis regni vegetabilis*, *Monographiae Phanerogamarum*, *Die natürlichen Pflanzenfamilien*, and *Das Pflanzenreich*. Of a verity have floras expanded in scope far beyond what was originally conceived: from simple inventory (and diagnosis) they have successively assumed the roles of identification manual and taxonomic encyclopedia, in the latter case now often also accounting for current notions on the classification of a given group above, as well as at, species level. In too many instances, however, their *effective* role has been lost sight of.

That floras and checklists had a distinctive place in botanical literature was already recognized from late in the eighteenth century and by 1820 had become canonical. Classified lists of those which were independently published appear in general bibliographies from Linnaeus onwards, but by 1879 their importance had become so recognized that a separate list was deemed

necessary. This first list, a slender but closely printed pamphlet of twelve pages, was *The floras of different countries* by G. L. Goodale of Harvard University. Two others have followed since: the Lloyd Library's *Bibliography of the floras* by W. Holden and E. Wycoff (1911–14), rather more comprehensive than Goodale's list but like it compiled 'in-house' and (following traditional practice) limited to independently published works, and the original and critical *Geographical guide to floras of the world* by S. F. Blake and A. C. Atwood (1942–61, not completed). Several regional and national lists have also been produced.

These earlier general guides to floras, however, were produced when the totality of botanical literature, even accounting for that published in periodicals and serials, was far less and overall bibliographical control more satisfactory (particularly before World War I). These conditions no longer existed by the 1960s. Twenty years alone were required by Blake for distillation of volume 2 of the *Geographical Guide* from the vast mass of Western European floristic literature, and by the end of that period, volume 1 was already in need of revision, although the flow of new literature had not yet taken on the proportions of the 1970's flood. Developments since 1960 have been such that, although Blake was said to be well aware of the magnitude of his task,<sup>3</sup> it is likely that in the years after his death, even had the will and the means existed, completion of the work on the original plan would, for a variety of reasons, have been very difficult if not impossible.

At the present time the climate for a revised and completed version of the *Geographical Guide* along its original lines is even less favorable, however much it may be desired in some quarters. The exponential growth of biological literature in the 1980s, and its control, is but one factor: others include the effects of the disruption and fragmentation of the world botanical information system due to two World Wars, trans-Atlantic isolationism in the inter-war period, additional centers of botanical activity and publication, changes in scientific fashions, and political and social developments of recent decades including the currently changing relationship between science and society in a more austere economic climate.<sup>4</sup>

Moreover, much current retrospective bibliographical work has been directed elsewhere: *Index nominum genericorum*, *Taxonomic literature* (and its 2nd edition referred to as *TL-2*), *Bibliographia Huntiana*, etc. With respect to floristic bibliography, the fragmentation

and partial disintegration of the botanical *referat* system alone has posed significant obstacles which only sophisticated organization and large financial expenditure can overcome. A number of the principal sources utilized by Blake and Atwood no longer exist; these include their primary source, the USDA Botany Subject Catalogue, terminated in mid-1952 (fortunately for others, it appeared in book form in 1958) and current literature coverage, especially of independently published items which comprise the majority of significant contributions, is more diffuse and uneven and less complete than in the past, although since 1950 two indexing journals specifically dealing with systematic botany have come into being: *Excerpta Botanica*, A (from 1959) and *Kew Record of Taxonomic Literature* (from 1971). Lately, 'semi-publication' has presented an increasing problem to bibliographers as inexpensive, comparatively permanent modes of offset printing have become widely diffused. Another approach was needed if the heterogeneous flood of floristic literature, which had increased greatly during the 1950s and later came to be considered a key contributor to what Heywood<sup>5</sup> has termed the contemporary 'crisis' in taxonomy, was ever to be mastered and meaningful world-wide coverage once more provided.

The actual stimulus for the present book, from which grew its basic idea, arose from a conversation in the summer of 1962 with a fellow student at the University of Michigan Biological Station in the northernmost part of the state's Lower Peninsula. As an invertebrate zoologist planning to participate in the 1963 International Indian Ocean Expedition, he desired to obtain some basic references on the vascular plants of the islands in the region. A search through the first volume of the *Geographical Guide* revealed a goodly number of titles, but upon reflection it became apparent that many were too specialized or restricted in scope for the kinds of information sought. Ultimately it was found that a comparatively limited selection of floras and enumerations would provide, within a reasonable compass, a proportionately high degree of useful information about the region's vascular plants; in other words, these works could be viewed as 'standard' floras.

From this beginning there developed the idea that such a selective process could, with variations, be applicable world-wide, and that this would in due time enable the preparation of a one-volume annotated general bibliography of 'standard' floristic works on

vascular plants which would cover the entire world, region by region. I also came to believe that such a work would be of particular interest to non-botanists as well as to botanists without a detailed knowledge of regional floristic literature outside their own sphere. Other factors contributing to a decision to prepare such a bibliography were the limited nature of lists of 'useful' floras provided in systematics textbooks as well as the unlikely prospect, noted above, that the *Geographical Guide* would ever be completed, especially considering the death of its senior author in 1959 (as it stands, it does not cover central or eastern Europe or the continent of Asia). Furthermore, in addition to Part I becoming increasingly out of date, the size of Part II appeared likely to daunt all those not having some familiarity with the vast corpus of western European floristic literature.

During 1962–3, various experiments in relation to depth of coverage were attempted, but the main catalyst proved to be in the pair of 'Green Books'<sup>6</sup> published by the Flora Europaea Organization which came to my attention in March 1963 on a visit to the University of Michigan Herbarium. Therein was given a list, with supplement, of 'standard' floras of Europe deemed most significant for the preparation of *Flora Europaea*. (The 'standard' flora concept had itself evidently been formulated by the Organization in the mid-1950s.)<sup>7</sup>

The final result, for which work originally began in a substantial way during the summer of 1963 at the Field Museum of Natural History, Chicago, is represented by the present book. However, lack of experience as well as time suggested that the *Guide* be first written up and distributed in short-title form without annotations or commentary. That effort materialized as the mimeographed booklet written largely at the University of Tennessee, Knoxville, and issued from its Department of Botany in 1964.

The consequent strong and continuing demand for that booklet, even to the time of final revision of this preface, ultimately led me to consider an expanded, more definitive edition. For various reasons, however, no serious research was begun until the end of 1967 when, encouraged by representations from colleagues all over the world as well as a publication proposal from the University of Tennessee Press, I felt compelled to undertake the task, one which would be greatly facilitated by being at the time at the University of Cambridge. Primary compilation of the necessary

material was undertaken largely in Cambridge and London, with additions from Australian libraries in 1971 following my move to an academic position at Port Moresby (Papua New Guinea), but short visits were made to libraries in several other centers.

It was a basic tenet of both the preliminary and the present versions of this book that as far as possible all titles selected for inclusion should be examined and annotated at first hand. To a very large degree, this has been achieved, in a few cases with the aid of photocopied extracts. Where an entry has had to be based upon a secondary source, that source has been indicated.

The original selection of titles was made by systematic browsing along the shelves of the Botany Library in the Field Museum. Additions were made through work in the University of Tennessee (Knoxville) Libraries and short visits to some special botanical libraries in the central and eastern United States. Guidelines for the selection process were also provided by a number of secondary sources as well as advice from colleagues. For the present version, the botanical libraries at Cambridge (England), the Royal Botanical Gardens, Kew, and the British Museum (Natural History) were extensively utilized, along with the working library of the Flora Europaea Secretariat (at Liverpool, later at Reading), the library of the Komarov Botanical Institute, Leningrad, and the libraries of the New York Botanical Garden and the Arnold Arboretum/Gray Herbarium at Harvard University. Small amounts of work were done at additional special botanical libraries as opportunities arose. Advice was also sought from a great number of other botanists, both in person and in writing. It may here be noted that the number of botanical libraries in which a substantial primary search for floras and related works may be carried out efficiently is comparatively small: five in the United States (in four centers) and three in Europe (in two centers). It is in London that the most substantial collections of these works exist, and it has been my good fortune to have been able to make extensive use of them over the years.

As might be expected, the coverage of material in the periodical literature has presented the greatest problems, both in ferreting out references and in seeing the articles concerned. No good cumulative classified index is currently available and extensive searches of the various abstracting and indexing journals would have been tedious and very time-

consuming. Furthermore, floristic material is found in a wide and scattered range of biological, zoological, general scientific, and other periodicals as well as in those more specifically concerned with botany. In more recent years, material published or 'semi-published' in various kinds of technical series or runs of 'occasional papers' emanating from a plethora of university departments, institutes, and other organizations has proliferated to an inordinate degree. A great misfortune has been the above-mentioned discontinuance of the botany subject catalogue in what is now the United States National Agricultural Library; this provides the best classified source for the first half of the twentieth century. Its suspension without an adequate replacement can only be deplored. Fortunately, in more recent decades there has been a marked rise in the number of regional compilations of botanical literature (both bibliographies and indices), and much use was made of them; they are now available over many parts of the world though variable in scope and quality. Some of these provided their own selections of key floristic works. Lists of references in major floras themselves were searched for periodical material. It must be confessed, however, that a goodly number of items were yet found 'by chance'. In all respects, having made a systematic study of a world-wide tropical and subtropical genus, *Schefflera* (Araliaceae), which followed earlier work on *Cytisus* and allied genera (Leguminosae-Genisteae), proved a considerable asset.

Principal secondary sources utilized included, above all, the two volumes of Blake and Atwood's *Geographical Guide*. Another useful but older general source was *Bibliography relating to the Floras* (1911-14) in the *Bibliographical Contributions* series of the Lloyd Library. Other key works were, in the main, regional: among them were the bibliographies in Hultén's *The amphi-Atlantic plants* (1958) and *The circumpolar plants*, II (1971); *Bibliography of eastern Asiatic botany* by Merrill and Walker (1938) and its *Supplement* by Walker (1960); the two volumes of *Island bibliographies* by Sachet and Fosberg (1955, 1971); *Botanical bibliography of the islands of the Pacific* by Merrill, with subject index by Walker (1947); *Vvedenie v botaničeskiju literaturu SSSR* by Lebedev (1956) and *Literaturnye istočniki po flore SSSR* by Lipschitz (1975); the *Guide for contributors to 'Flora Europaea'* and its *Supplement*, both by Heywood (1958, 1960), otherwise known as the 'Green Books'; *History of botanical researches in India, Burma, and Ceylon*, II:

*Systematic botany of angiosperms* by Santapau (1958), and *A guide to selected current literature on vascular plant floristics for the contiguous United States, Alaska, Canada, Greenland, and the US Caribbean and Pacific Islands* by Lawyer, Miller, Morse, and Kartesz (in press). Some individual library or union catalogues were useful, particularly the *Botany Subject Index* (1958), which constitutes the above-mentioned former USDA botany subject catalogue of 1906–52 in book form, the *Catalogue of the Library, Royal Botanic Gardens, Kew* (1974) with both author and classified divisions, the *Catalogue of the Library of the Arnold Arboretum* (1914–33), and, for bibliographic control, the *National Union Catalog [USA]: Pre-1956 imprints* and its retrospective and post 1956 supplements together with the *Botany Subject Index* and *Biological Abstracts*. Major indices used from time to time included *Excerpta Botanica* and *Kew Record of Taxonomic Literature* and, at regional level, *Index to American Botanical Literature* (and the former *Taxonomic Index*), *AETFAT Index*, *Flora Malesiana Bulletin*, and the European and Australasian indices published through the International Association for Plant Taxonomy in the 1960s. For search purposes, however, only occasional use was made of *Biological Abstracts*, however, and with the advent of the many regional botanical bibliographies now in existence there proved relatively little need to consult the older general indices, even had they been readily available. Of general current awareness lists, those extensively utilized included the *referat* sections in *Taxon* and *Progress in Botany* [Fortschritte der Botanik] as well as the ‘semi-published’ accession lists from the New York Botanical Garden (now defunct) and Kew libraries (the latter classified); these were supplemented by a range of dealers’ catalogues (mainly Antiquariat Junk, Koeltz, Krypto, Scientia, Stechert-Hafner, and Wheldon and Wesley) and trade announcements (the latter sometimes providing descriptions). None of these, however, acted as substitutes for examination of the originals save when no other opportunity was available, but nevertheless they prove especially valuable whilst working in a relatively remote country such as Papua New Guinea.

The actual preparation of the *Guide*, although undertaken in 1970, was unfortunately considerably prolonged on account of my many university responsibilities as well as the attractions of a tropical flora, and only in late 1975 could it be terminated. The remote-

ness of Port Moresby was also a handicap, but on account of circumstances perhaps less so than might be imagined. More importantly, it enabled the work to be written from the point of view of a botanist attempting to cope with an imperfectly known tropical flora and actively involved in teaching. Much of the writing was accomplished during spells in remote outstations and camps while ‘on patrol’, often when waiting for air-planes or sitting out the rain. Following submission of the manuscript, a variety of technical difficulties led to a long delay in publication and in January 1979 it was formally transferred to Cambridge University Press. Accumulating additions and other changes as well as ideological refinements necessitated complete revision of the manuscript and this was largely carried out in Papua New Guinea and Australia during study leave from July 1979 to February 1980. Overseas visits in 1973, 1975–6, 1976–7, and 1978–9 enabled coverage of new or overlooked works. As far as possible 1980 is taken as the ‘cut-off’ year, with some indication of likely future developments and publications given in the various regional commentaries.

It is hoped that the *Guide* as now presented will meet the needs of a wide range of users, both botanical and non-botanical. It has been written in the belief that, since a thorough revision and completion of Blake and Atwood’s *Geographical Guide* is not likely in the foreseeable future (and in any case would have to be an institutional project), a simpler one-volume analytical work would serve as a practical and more easily realizable alternative which would yet suffice for a majority of interested persons.

The work as it stands, though, is also intended to draw attention to the need for developments in floristic and other botanical bibliography comparable with what Heywood<sup>8</sup> and some other authors have called for with regard to floras generally. Although the necessity for various kinds of functional articulation and resource redeployment was long ago recognized in bibliographic science through sheer force of circumstances, it has been slow to come to systematic botany: the dream of the definitive, hard-cover, omnibus work has been long-persistent. Yet two (or more) functions are served in both floras and botanical bibliography – chiefly the archival and the practical – which in most cases can no longer usefully be combined within a single work and now require separation in publication. It is here suggested, for instance, that comparable selectivity with articulation is as necessary for flora-bibliography as for

floras themselves, and that this is but part of a continuing process in information handling with implications for all fields of knowledge.<sup>9</sup> A work such as the *Geographical Guide* – considered in its day as ‘selective’ in relation to the general corpus of systematic botanical literature, and representative of the ‘new trend’ of scholarly bibliography which arose out of World War I<sup>10</sup> – is seen here as to a marked extent now archival, whereas the present *Guide*, though less extensive in its coverage, should prove useful at a more practical level whilst still remaining a meaningful indicator. It thus continues to stand for the ‘state of the art’ in Malclès’ sense. Put in another way, it represents a level of selection twice removed from the coverage spread represented by the last of the great retrospective subject bibliographies (Pritzel, 1871–7; Rehder, 1911–18). ‘Standard’ floras may be viewed as having a place in floristic literature comparable to the head of a comet; the rest forms the gradually thinning tail.<sup>11</sup> As with floras themselves, the overall view is that there is room for both kinds of bibliographical works.

Any deliberate abridgement of the kind represented by the present work, though, always involves subjective decisions over inclusion or exclusion of particular titles, even though they be based upon heuristic criteria. Many items inevitably will have a ‘borderline’ status, even given the intuitively recognized ‘point of balance’ which limits this work. Such items may show a ‘shift’ in that they possess rather more importance in a local as opposed to a global context. All that can be said is that all care has been taken in such decisions, using the only computer available. Nonetheless, I shall always welcome any reasonable suggestions for addition (or deletion) of titles (within limits) with appropriate arguments. It should also be noted that the actual preparation of this work has to a considerable extent been carried out at locations remote from large botanical libraries, making quick rechecking or reinterpretation of sources difficult or impossible; unintentional errors may, therefore, have crept in. Any technical omissions or errors or misleading statements should, if possible, be brought to my attention. All changes accepted would be incorporated in a supplement contemplated for publication in the late 1980s.

Finally, it should be noted that whereas earlier bibliographies of floras have been largely empirical or descriptive, the present work attempts as well to be analytical and interpretative, essaying also some integration on historical principles. The belief has, latterly,

grown in my mind that a classified subject bibliography should not only present and describe titles but also reach outwards: to act as a *Spiegelbild der Forschungsergebnisse*, a mirror on the progress of the subject,<sup>12</sup> as well as to guide – in the words of an earlier promotor of bibliographic science – ‘a young man [who], instead of wasting months getting lost in unimportant reading . . . would be [thus] directed toward the best works and more easily and quickly attain a better education’.<sup>13</sup> It is hoped that this *Guide*, at least to some extent, fulfills these ideals, which with variations are of long standing in bibliography. Modern methods of bibliographical analysis moreover, indicate that a literature cross-section of the kind presented here can be about as meaningful as a comprehensive bibliography in revealing patterns of development in the subject, in this case floristic botany. Further research on the themes embodied here might (1) utilize citation analysis of a wide range of floristic articles as a means of quantifying the selection criteria and the ‘point of balance’, and (2) estimate patterns of usage through time by analysis along similar lines of a series of historical cross-sections of the literature. Both could serve as contributions to the history of systematic botany; and other insights might also be obtained in ways not yet suspected.

D. G. Frodin

Port Moresby, Papua New Guinea

August 1980/January 1982

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## Notes

- 1 Stafleu, F. A., 1959. The present status of plant taxonomy. *Syst. Zool.* 8: 59–68.
- 2 Jäger, E. J., 1978. Areal- und Florenkunde (Floristische Geobotanik). *Prog. Bot.* 40: 413–28.
- 3 Schubert, B. G., 1960. Sidney Fay Blake. *Rhodora*, 62: 325–38.
- 4 Drucker, P. F., 1979. Science and industry, challenges of antagonistic interdependence. *Science*, 204: 806–10.
- 5 Heywood, V. H., 1973. Taxonomy in crisis? or taxonomy is the digestive way of biology. *Acta Bot. Acad. Sci. Hung.* 19: 139–46.
- 6 Heywood, V. H., 1958. *The presentation of taxonomic information: a short guide for contributors to Flora Europaea*. 24 pp. Leicester: Leicester University Press; *idem*, 1960. *Supplement*. 20 pp. Coimbra, Portugal.
- 7 Heywood, V. H., 1957. A proposed flora of Europe. *Taxon*, 6: 33–42.



- 8 Heywood, V. H., 1973. Ecological data in practical taxonomy. In *Taxonomy and ecology* (ed. V. H. Heywood), pp. 329–47. London: Academic Press.
- 9 Garfield, E., 1979. *Citation indexing*. New York: Wiley.
- 10 Malclès, L. N., 1961. *Bibliography* (Trans. T. C. Hines). New York: Scarecrow (reprinted 1973). [Originally publ. 1956, Paris, as *La bibliographie*.]
- 11 Garfield, E., 1980. Bradford's Law and related statistical patterns. *Current Contents/Life Sciences* **23** (19): 5–12.
- 12 Simon, H.-R., 1977. *Die Bibliographie der Biologie*, p. 75. Stuttgart: Hiersemann.
- 13 Napoléon I to Finkestein, 19 April 1807; quoted in Maclès, 1961, p. 75 (see n. 10).

## Prologue to the second edition

The reception of this book since its original publication some 15 years ago, and the frequent questions put to the author over the past decade about a revised edition, suggest that it has found a place amongst the tools of working botanists as well as of reference librarians. I hope this revision will find a similar reception, in spite of – inevitably – an increase in bulk.

In the nearly 20 years since coverage was closed for the original edition, floras and related works have continued by and large to gush forth. The need for them remains, although it may be driven more by practical than by academic considerations. The renewal and increasing prominence of the environmental and conservation movements, the associated promulgation of international treaties such as the Convention on International Trade in Endangered Species (CITES) and the Convention on Biological Diversity (CBD), and the consequent requirement to have a better understanding of national biotas have moreover created new ‘markets’ for floristic information. This is all in addition to natural cycles of renewal as scientific knowledge expands and deepens, best expressed in more developed countries. Altogether, many more new floras and enumerations have been published than superseded, improving coverage for many parts of the world – sometimes well beyond what was the case in 1979 (Map I). They retain an important place within the botanical literary warrant, and continue to be one of the most important points of contact between user and producer.

At the same time, however, the nature of floras may undergo change, driven in particular by the increasing power and flexibility of the Internet as an information source over the past five years or so as well as changes in their organization and the way users interact with them. Five points seem apparent: (1) floras should be backed by an information system; (2) manual-floras for identification should become less ‘academic’; (3) enumerations and checklists are

valuable ‘interim’ tools but should be backed as far as possible by specialist advice; (4) the elements of floras should be analyzed and, where possible, the works built up using widely available routines; and (5) the financial and human needs of flora projects should be worked out in such a way that their real costs become more transparent.

That said, what are some of the advances of the past two decades? Among large-scale floras, one may count the launch of *Flora of North America* (1993), *Flora fanerogámica argentina* (1994), *Flora iberica* (1989) and *Flora hellenica* (1996) as well as the progress of *Flora of Australia*, *Flora reipublicae popularis sinicae*, *Flora of Thailand*, *Flora of tropical East Africa* and *Flora Zambesiaca* and the near-completion of *Flora iranica*. Successful large-scale enumerations – all accounting for 15000 species or more – include, in the Americas, *Catalogue of the flowering plants and gymnosperms of Peru* (1993) and *Catalogue of the vascular plants of Ecuador* (1999) and, in Africa, *Énumération des plantes à fleurs d’Afrique tropicale* (1991–97) and the various editions of what is now *Plants of southern Africa: names and distribution* (most recently in 1993). Many floras, manuals and enumerations of lesser extent have been completed or are in progress, some of them – such as *The Jepson Manual: higher plants of California* (1993), *Michigan flora* (1972–86), *Flora of Egypt* (1999–), *Standardliste der Farn- und Blütenpflanzen der Bundesrepublik Deutschland* (1998), *Manual of the flowering plants of Hawai’i* (1990; revised 1999), and *Flora vitiensis nova* (1979–91) – ‘successors’ to earlier works, and others – such as *Flora of the Lesser Antilles* (1974–89), *Flora of Bhutan* (1983–), *Flora of Orissa* (1994–96), *Flore analytique du Togo* (1984), and *Flora of central Australia* (1981) – ‘breaking new ground’, i.e., accounting for areas never previously covered or only by rather older, larger-scale works. There has also been – as suggested in the previous edition of this book – a further growth in floras and enumerations of relatively small ‘target’ areas. Although by their nature ‘local’, they may serve clearly defined areas or needs and, significantly, have come to be seen as realistically feasible in the three- to six-year terms of many project grants (which have largely succeeded the relatively open-ended financial commitments more common in the years after World War II). Four recent examples include *Flora of Pico das Almas* (1995) and *Flora da Reserva Ducke* (1999) in Brazil, *Flórula de las Reservas Biológicas de Iquitos, Perú* (1997) in Peru, and *The plants*

*of Mount Cameroon: a conservation checklist* (1998) in Cameroon; several more could be mentioned. In the *Guide*, I have accounted for such ‘local’ works in areas for which there is little or no larger-scale coverage, or such is significantly out of date.

It is clear from the above that publication of floras and related works has continued apace. As a literary warrant they have continued to be prominent in the literature of plant biodiversity, if perhaps not quite as pervasive as 30–40 years ago when Frans Stafleu spoke of an ‘age of floras’. It is likely that they will survive the advance of the Internet: in time a balance may be reached between traditional and virtual media in a likely larger market; moreover, paper remains a primary symbol of professional achievement. Nevertheless, as in the print world of the past, divergence in the kinds of data stored and presented will occur. The dictionary, manual-key, concise descriptive manual, and enumeration seem most likely to continue in their present forms; larger, more scholarly works will metamorphose into monograph-series or virtual publications (or information systems) on the Web or CD-ROMs or will be presented as differentiated print and virtual products (as have already some works of more limited scope). Large tropical floras can be, and are being, broken down into more manageable units for presentation. Whatever their form of presentation in future, however, floras and related works remain one of the most important forms of interaction between specialist and user; indeed, with respect to botany and other plant sciences in general they would figure prominently in any renewal of the question of the accountability of ‘normal’ science.<sup>1</sup>

The considerable number of floras and related works published since 1980 – along with a felt need to develop a fuller historical perspective – has meant that the *Guide* as presented here is some one-half again as large as its predecessor. I have, however, attempted to maintain its presentation as a practical as well as analytical introduction to the literature of identification and floristic documentation, occupying a level below, though hopefully more comprehensible than, the often title-rich overall, subdisciplinary, or regional bibliographies. It must be said, though, that the *Guide* has about reached the limit of what is feasible in a one-volume work. In future, a re-analysis of its principles may be required, with the possibility of new directions including (1) rendition of historical analyses and detailed descriptions in electronic form, with the printed text

limited to titles and brief annotations, or (2) a bringing forward of the 'base line' from 1840 to 1940, with the possible creation of two temporally limited volumes (though with some overlap where deemed essential). In the latter instance, a differentiation would be made between works still 'standard' for a practising systematist or regional specialist and those of more immediate value for identification, fact-checking or basic documentation. Whatever path is followed, however, it would seem imperative that the present text – now in electronic form as its predecessor was not – is in the first instance converted into a structured database or marked up in XML; this would aid the development of differentiated products encompassing print, the Web and other media.

For it is in a variety of formats that the way forward in botanical information lies. In spite of the staggering growth of the World Wide Web as a source, its content is inevitably very uneven. Moreover, products with serious input and editorial control – whatever the medium – cost money which will have to be identified, allocated, and often recouped. Though the importance of data and information management in the progress of botanical research and dissemination may be undervalued, I remain convinced that there will always be a place for analytical reference works in print of the kind presented here. Indeed, within five years of publication a new edition of the original work was called for. Availability of text in electronic form, with the possibility of new kinds of products, will not only facilitate the process of future revision and dissemination but also enable new kinds of links to current data – including those available only in virtual form – not readily possible in the past. The *Guide* has in its field become, and will hopefully continue to be, a key tool not only for botanists in general but also for what is an increasingly important profession, that of reference librarians.<sup>2</sup>

A few final words should be said about preparation of the present edition. I have by and large followed the scope and methods of its predecessor, though important advantages in recent years have included regular access to the Library of the Royal Botanic Gardens, Kew as well as the advent of searchable remote-access library catalogues – the latter helpful for the checking of holdings as well as bibliographic details. Account was taken of the many additional references given in *Plants in danger: what do we know?* by

S. B. Davis *et al.* (1986, Gland/Cambridge). A number of visits were made to other libraries as opportunities permitted, and extracts from some additional items obtained by post. A slightly more liberal view was taken of partial and local floras, especially where more general works were not available or significantly out of date. The original text – not available in electronic form – was optically scanned in 1990 but then was entirely rewritten as well as checked for errors. Unit areas and vascular or seed plant flora sizes have been incorporated as far as possible, and opening commentaries have been expanded to account, in running form, for references to floras and related works of historical interest. Where possible, works published in 1999 have been included but beyond that a line has been drawn. No attempt was made to create a database at the risk of further delay to what was in the end becoming – in the face of other commitments – a long drawn-out effort. Portions of the text, including the general chapters and Appendix A, were read by others before being worked up in final form.

David G. Frodin

Kew

4 July 2000

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## Notes

- 1 Cf. R. Schmid, 2000. An excellent flora of New York City and its easterly and northerly environs *sensu latissimo* [review]. *Taxon* 49: 353–355. On the general question of science and society, see for example J. R. Ravetz, 1996. *Scientific knowledge and its social problems*. 2nd edn. New Brunswick, N.J.; and Z. Sardar, 2000. *Thomas Kuhn and the science wars*. Duxford, England: Icon Books; New York: Totem Books.
- 2 The growth in electronic sources has not so far displaced books or reference librarians, nor has this been seen by professionals as likely in spite of words to the contrary. See, for example, M. Runkle (then-director of the University of Chicago Libraries) in *University of Chicago Magazine* 77(2): 19 (1985); and S. C. Sutter (acting assistant director for humanities and social sciences, Joseph Regenstein Library, University of Chicago Libraries) in *ibid.*, 92(4): 3–5 (2000). Indeed, Sutter notes that the rise in the variety and complexity of on-line (and other) resources has *increased* the need for reference librarians, with four new posts being created in the library system.

## Acknowledgments for the first edition

The preparation of both the preliminary version and this present edition of the *Guide to standard floras of the world*, especially the latter, has necessitated the consultation over several years of a great many sources, as noted in the Preface, and furthermore has involved the assistance in various ways of numerous individuals and institutions. These latter must now be acknowledged formally, for without their aid this book could not have appeared in its present form, or indeed at all. The author wishes here to express his deep appreciation to all the support and assistance given him over the nearly two decades required for gestation of the work in its present form.

For the original version (1963–4), the author wishes to record his sincere gratitude to all those in charge of library collections for granting him access to them, particularly the late John Millar, then Chief Curator of Botany at the Field Museum of Natural History, Chicago, and those in charge of the University of Tennessee (Knoxville) libraries. Thanks are also due to the authorities of the Biology Library of The University of Chicago; the Lloyd Library, Cincinnati, Ohio; the Missouri Botanical Garden Library, St Louis; the library of the Department of Botany, Smithsonian Institution; the New York Botanical Garden Library; and the libraries of the Arnold Arboretum and Gray Herbarium of Harvard University, Cambridge, Massachusetts.

Advice and assistance was also given by many individuals, but the author is particularly indebted to the following: E. G. Voss, University Herbarium, University of Michigan, for an introduction to the *Flora Europaea* 'Green Books', L. B. Smith, Washington, for assistance with South American references; and above all to A. J. Sharp and other staff and students at the Department of Botany at the University of Tennessee, Knoxville, for their continuing interest in and support of the project. It was Prof. Sharp who made it possible for the preliminary edition to be reproduced and circulated around the world.

The preparation for and writing of the present version has unfortunately extended over a much longer period (late 1967 to mid-1980), owing to the considerably expanded format, changes in the philosophy of the work, publication difficulties, and the author's many other responsibilities while at Cambridge and in Port Moresby. A major contributing factor to the time span was naturally the decision to annotate, as far as possible, all floristic works included in the *Guide*. This made it necessary to examine personally, or obtain full notes upon, the contents, style, and philosophy of each title, and the author considers himself fortunate to have been able to carry out much of the work of compilation in Europe and especially in London. For completeness of world-wide coverage and for convenience of access and usage, the libraries of the Royal Botanic Gardens, Kew, and the Department of Botany, British Museum (Natural History), are perhaps without peer for research on a work of this kind; and it was, as noted in the Prologue, at these two libraries that the greater part of the materials for the present edition was compiled during 1968–70 and in short intervals in the succeeding ten years. Special thanks are therefore due to R. G. C. Desmond and V. T. H. Parry, successively Librarians at the Royal Botanic Gardens, Kew, and their assistants, and to Miss P. I. Edwards, formerly Botany Librarian, Department of Botany, British Museum (Natural History), and her successors, for their help (and patience!) during my extended visits to their libraries.

A significant amount of compilation was also carried out in 1971 and again in 1979–80 at the library of the Royal Botanic Gardens and National Herbarium of Victoria in Melbourne. This resource is perhaps the most extensive of its kind in Australasia, despite past neglect, and proved of great value at a time when substantial work on the general chapters and area commentaries was necessary but owing to circumstances beyond my control could not be done in Europe or the United States. My thanks are due to the director and staff of that institution, but especially to J. H. Ross, Senior Botanist, and Miss Olwyn Evans, assistant in the library. The help of J. Ashworth, Assistant Secretary, Department of Lands and Environment of Victoria, in resolving an unforeseen crisis over access to the facilities is also hereby acknowledged. During the second period in Melbourne, much use was also made of the Baillieu Library and of the branch library in the Department of Botany in the University of Melbourne,

and the opportunity to make use of these well-endowed resources is much appreciated.

Extensive use was naturally made of the University Library, the Scientific Periodicals Library, and the Libraries of the Department of Botany and of the Botanic Garden in the University of Cambridge whilst the author was in residence as a Research Student from 1967 to 1970. As one of the centers for preparation of *Flora Europaea*, the Department of Botany housed a fine collection of major European floras, ably cared for in the Herbarium by P. D. Sell and (at the time) S. M. Walters. It was under the guidance of Prof. E. J. H. Corner, however, that the varying worth of tropical floras came to be appreciated through research into the large genus *Schefflera* (Araliaceae), a stimulus enriched by subsequent personal experience. This augmented earlier experience at Liverpool in 1964–5 when a study was made of *Cytisus* and its allies (including preparation of an account for *Flora Europaea*) under the direction of Prof. V. H. Heywood.

Other resources substantively utilized include the libraries of the Royal Botanic Gardens, Sydney, and the Commonwealth Scientific and Industrial Research Organization, Black Mountain, Canberra; the library of the Komarov Botanical Institute, Academy of Sciences of the USSR, Leningrad; the library of the Conservatoire et Jardin Botaniques, City of Geneva; the libraries of the Institut für systematische Botanik, Universität Zürich, the Botanische Staatssammlung, München, the Rijksherbarium, Leiden University, and the Botaniska Afdeling, Naturhistoriska Riksmuseet, Stockholm; the library of the New York Botanical Garden; the libraries of the Arnold Arboretum and Gray Herbarium of Harvard University, Cambridge, Massachusetts; and the libraries of the Linnean Society of London and the Commonwealth Forestry Institute, Oxford. Use was also made of the library of the *Flora Europaea* Secretariat, both in Liverpool and in Reading, and of a number of private collections. The author is much indebted to all those persons in charge of institutional libraries as well as private owners for permission to consult the collections in their care and for their assistance in locating needed references.

As with the earlier version of this work, the author is indebted to all those who freely gave assistance during the various stages of preparation and writing of the present edition. The difficult task of searching out, selecting, and locating the various

European floras and manuals occupied a goodly amount of attention in the early stages; in this connection, particular thanks are due to the Flora Europaea Organization (and especially to S. M. Walters) for arranging to have a draft of the bibliographic text of Division 6 (Europe) typed, mimeographed, and sent from Reading to all regional advisers for comment. To all those who replied, many thanks. Thanks are also due to Prof. V. H. Heywood, now at Reading, for advice on European Floras generally, and especially A. O. Chater, London (formerly Leicester), for assistance over several years (mainly before 1977) in locating and annotating obscure works and for arranging contacts with Soviet botanists.

The very exacting and time-consuming task of selecting titles and preparing text for those sections of the book covering the Soviet Union was considerably eased through the generous assistance of M. E. Kirpicznikov of the Komarov Botanical Institute, Leningrad. Not only did he prepare extracts and sample pages from a goodly number of works scarcely available outside the Soviet Union but he also sent a copy of S. J. Lipschitz' *Literaturnye istočniki po flore SSSR*, mentioned above, by air post to New Guinea immediately upon its publication. Moreover, during my visit to Leningrad in the summer of 1975, he graciously read through the completed manuscript for those portions covering the USSR and made many valuable suggestions. In addition, V. I. Grubov of the same Institute gave advice on his special region, central Asia (i.e., from Tibet to Mongolia). The author is also indebted to Prof. Al. A. Fëdorov, Director of the Institute, for permission to make use of the Institute library as well as the collections for a period of several days following the International Botanical Congress, as well as during the Congress itself.

Other botanists in Europe who gave assistance in various forms and to whom the author is likewise indebted include K. Browicz, Zakład Dendrologii, PAN, Kórnik, Poland (Poland and adjacent countries); H. M. Burdet, Geneva (Corsica and other parts of the Mediterranean, as well as general advice); Prof. E. Hultén, Stockholm (Eurasia in general); L. A. Lauener, Edinburgh (China); Prof. C. G. J. van Steenis and other staff members of the Rijksherbarium, Leiden (Malesia and adjacent regions); F. White, Oxford, and Prof. J. Léonard, Brussels (Africa); and especially Prof. F. A. Stafleu, Utrecht, for his general advice, criticism, and support.

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In Australia, advice was received from J. H. Ross, Melbourne (Africa and Australia) and H. J. Eichler and A. Kanis as well as the late Nancy Burbidge, Canberra (Australia, Europe, and in general). Casual comments were advanced by many other colleagues on that continent in the course of a number of visits over the past decade while pursuing this and other, perhaps too ambitious, projects.

Assistance from Africa was received from E. A. C. L. E. Schelpe, Cape Town, and Prof. H. P. van der Schijff, Pretoria (southern Africa). Some pointers regarding the Tethyan side of that continent were suggested by Marie-Thérèse Misset, Oran, Algeria.

As with Europe and the Soviet Union, sifting through the mass of more recent floristic literature on North America was a not inconsiderable task. Special thanks accrue to E. L. Little, Jr., Washington, DC, for his general advice and for information on woody floras and on the Americas in general, and to L. E. Morse, New York, for general advice and for sending a copy, in advance of publication, of the typewritten manuscript of *A guide to selected current literature* by Lawyer and others, mentioned in the Prologue. Other advice was received from A. Cronquist and N. Holmgren, New York; P. F. Stevens, Cambridge, Mass.; and S. G. Shetler and C. R. Gunn, Washington.

Botanists in the United States who gave advice for other parts of the world included L. B. Smith, Washington, DC (Brazil); In-cho Chung, Mansfield, Pa. (Korea); Prof. A. Löve, formerly of Boulder, Colo. (miscellaneous, but especially the Arctic regions); E. H. Walker, formerly of Washington (China); and especially F. R. Fosberg, Washington (general advice and support, and for steering me through the scattered shoals of the insular literature).

During the years the author was resident in England and on subsequent visits, many staff members of both the Royal Botanic Gardens, Kew, and the Department of Botany, British Museum (Natural History), gave freely of their time and knowledge to answer my questions regarding the floristic literature of

many different parts of the world, thus enabling a kind of collective picture to be formed. My 1970 sojourn at Kew furthermore coincided with a series of staff briefings related to an internal reorganization of responsibilities in the Herbarium; I am indebted to Prof. J. P. M. Brenan, then Keeper, for copies of the area circulars produced for these briefings.

Special assistance on China and Korea was received from J. Needham, Cambridge, and E. Wu, Harvard-Yenching Institute, Cambridge, Mass. Advice on bibliographic matters was given by W. T. Stearn, London, and by the staffs of the University of Tennessee Press and Cambridge University Press.

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The author also owes much to the late J. L. Gressitt, and to his associates H. Sakulas and A. Allison for enabling accommodation to be made available at Wau Ecology Institute, in the mountains south of Lae in Papua New Guinea, for an extended period in 1979. This meant that much of the final revision of this book could be accomplished in comparative comfort. Some chapters were rewritten at their nearby Mt Kaindi branch house, where near-total isolation at 2362 m in a diurnal temperature range of 9 to 23 degrees C acted as strong incentives! All associated with the Institute gave support and encouragement to the work. In Melbourne over a two-month period from December 1979 to February 1980, residence at Graduate House, University of Melbourne, was kindly granted by the Warden, W. E. F. Berry. Several residents, botanists and otherwise, provided conversation and moral support over this period; particular thanks are due to P. Bernhardt and D. Fleming. A further short visit to Melbourne and Canberra was made just before completion of the manuscript, which had been unavoidably delayed; at this time A. Kanis, H. J. Eichler and P. Bernhardt kindly undertook to go through the general chapters. A debt of gratitude is also owed to the University of Papua New Guinea and to its

Department of Biology for the grant of six months' study leave to carry out the task of thorough revision of the manuscript which, as noted in the Preface, had originally been completed in 1975 but owing to technical and other difficulties was not published as intended.

Finally, I wish to thank my father, Reuben Frodin, for advice and encouragement at all times and for assistance in locating some obscure references and arranging for notes and copies of sample pages to be sent; to the late L. T. Iglehart, of The University of Tennessee Press, for early financial assistance, much advice and encouragement, and above all patience with the long drawn-out initial period of preparation of this book and sympathy when publication arrangements had to be terminated; to A. Winter and M. Walters at Cambridge University Press for advice, encouragement, and gentle nagging; to D. J. Mabberley, Oxford, for assistance at a critical stage in 1978, at a time when the author also suffered severe losses in an office and herbarium fire; to the Society of the Sigma Xi, USA, for a grant-in-aid in 1970 to enable visits to botanical libraries in Australia and elsewhere; to the Research Committee, the University of Papua New Guinea, for a grant-in-aid towards expenses associated with replication of the manuscript and carriage of two copies by air to the United Kingdom; to A. Butler, Librarian, and his staff in the University of Papua New Guinea Library, for the opportunity to utilize their extensive general bibliographical resources during final corrections to the manuscript in November and December 1981; to Prof. E. J. H. Corner, Cambridge and Great Shelford, for general encouragement over many years; to C. J. Humphries, British Museum (Natural History), London, and to R. Wetherbee in Melbourne, G. J. Leach in Port Moresby, and M. Heads, formerly in Bulolo, for real support during the final stages of the project; and lastly (but no less importantly) to the staff of CUP for a thorough editing of a manuscript written under unconventional circumstances to say the least. Full responsibility for the text, including the onerous task of typing and retyping some 1800 pages of manuscript is, nevertheless, mine and mine alone.

Chapter 3 of the general introduction to this book is based upon the author's essay of the same title which appeared in *Gardens' Bulletin, Singapore* 29: 239–50 (1976 (1977)). Acknowledgment is hereby made to the Government of Singapore for permission to reuse this material.



The map on p. 20 in Chapter 2 of the General introduction, depicting the relative state of present floristic knowledge for different parts of the world, was kindly supplied by E. J. Jäger, Halle/Saale, German Democratic Republic. It is a revised version of that which appeared in *Progress in Botany*, 38: 317 (1976).

The not inconsiderable task of proofreading, carried out at Port Moresby, was assisted by Nancy Birge, G. J. and Amanda Leach, P. Osborne, and N. V. C. Polunin. Preparation of the indices was much facilitated by the use of 'Profile II', a Radio Shack (Tandy Corporation) proprietary file management package run on a Tandy TRS-80 Model II microcomputer; access to this machine was kindly granted by E. D'Sa and J. C. Renaud of the Mathematics Department, University of Papua New Guinea.

## Acknowledgments for the second edition

As with the first edition, I am indebted to many bodies and individuals for their interest and assistance during the preparation of this book.

Firstly, I would like to thank the Royal Botanic Gardens, Kew, its successive Directors, Sir Ghilleen Prance and Peter Crane, successive Keepers of the Herbarium, Grenville Lucas and Simon Owens, as well as David Hunt, Keith Ferguson, R. K. Brummitt and Alan Paton for leave to include this project amongst my official duties while on the Herbarium staff from 1993 onwards. I am very grateful for their interest and support. I would also like to thank my many other colleagues at that institution for questions answered, assistance rendered and general discussions over the years, and particularly Sylvia Fitzgerald, John Flanagan and other staff of the Library for their unstinting help in the face of many other demands on their time.

Elsewhere, I would like particularly to thank Malcolm Beasley and his staff (Natural History Museum), Gina Douglas (Linnean Society of London), John Reed (New York Botanical Garden), Connie Wolf (Missouri Botanical Garden), Ruth Schallert (Botany Library, Smithsonian Institution), Bernadette Callery (now Carnegie Museum, Pittsburgh), Judy Warnement and other staff of the botanical libraries at Harvard University, Kees Lut (National Herbarium of the Netherlands, Leiden Branch), Raymond Clarysse (National Botanic Garden, Belgium), Hervé Burdet (Conservatoire et Jardin Botaniques, Geneva, Switzerland), Walter Lack and Norbert Kilian (Botanischer Gärten und Botanisches Museum, Berlin, Germany), Helen Cohn (Royal Botanic Gardens, Melbourne, Australia), and – last but not least – Carol Spawn and her staff at the library of the Academy of Natural Sciences, Philadelphia, as well as staff at the Philadelphia Free Library, where work was carried out on this revision prior to 1993.

Many thanks are also due to Maria Murphy, Cambridge University Press, for her interest and patience during what became a protracted undertaking due to other commitments, and to Erica Schwarz, acting on behalf of the Press, for critically working over the text and putting up with late changes in an inevitably futile attempt to ‘fix’ what is, after all, a moving frontier.

Finally, I would like to thank my former supervisor, the late E. J. H. Corner, my sister, Joanna Frodin and my father, Reuben Frodin, as well as Bill Baker, Martin Cheek, Sarah Darwin, Aljos Farjon, Mark Griffiths, Chris Humphries, Frances Livingstone-Ra, David Mabberley, Bob Makinson, Rudi Schmid, Sy Sohmer, Camilla Speight, William T. Stearn, and the late B. C. Stone as well as others not specifically named for their moral and other support as well as in some cases for reading and advising on parts of the text. I am most grateful for their consistent support over the years, seeing me through medical and other problems.

## Part I

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General introduction



## An analytical–synthetic systematic bibliography of ‘standard’ floras: scope, sources and structure

Primarius noster scopus hic est ad redigendos auctores in ordinem, seu libros botanicos in methodum naturalem, ut tyrones sciant quos libros eligere debeant, auctoresque noscant, qui in hac vel illa scientiae nostrae partae scripserint.

Linnaeus, *Bibliotheca botanica* (1736).

Die Bibliographie ist in ihrem weiteren Umfange der Codex diplomaticus der Literar-Geschichte, der sicherste Grad- und Höhenmesser der literarischen Kultur und Tätigkeit.

Ebert, *Allgemeines bibliographisches Lexikon* (1821);  
quoted from Simon, *Die Bibliographie der Biologie* (1977).

The difficulty in publishing an extended list of floras is to know where to stop.

Turrill, ‘Floras’; in *Vistas in Botany* (ed. Turrill), vol. 4 (1964).

### Definition and scope of the work

The aim of the present work, a revised and expanded version of that first published in 1984, is to furnish in bibliographic form a geographically arranged one-volume guide to the most useful nominally complete floras, checklists and related works dealing with the vascular plants of the world.<sup>1</sup> Also included are concise historically oriented reviews of the state of floristic knowledge in different parts of the world, geographical conspectuses, and references to local and general bibliographies and indices. The work attempts as far as possible to account for titles up through 1999 that fall within its scope. The sequence of geographical units is, with slight modifications, that devised for the first edition.

In contrast to *Geographical guide to floras of the world* by Sidney F. Blake and Alice C. Atwood (vol. 1, 1942; vol. 2 by Blake alone, 1961) only one to a few ‘standard’ works are listed for each recognized geographical unit. With some exceptions, no detailed coverage of florulas and lists of comparatively local scope has been attempted, and only limited attention has been given to works on weeds and poisonous or useful plants. Such limitations have made it possible to cover, in an approximately uniform fashion and within a single volume, a well-tempered selection of floristic works for the student and general reader as well as the specialist. For those interested in more information on any given unit, region or ecological synusia, the work provides references to local, regionally or topically specialized bibliographies, guides and indices. As with Linnaeus’s *Bibliotheca botanica* (1736; 2nd edn., 1751), our aim is to furnish not only a bibliography but also an introductory digest.

## Sources and the historical background

### General

Since the seventeenth century, various world-wide botanical bibliographies and indices have been produced; with the passage of time these have become increasingly specialized, more or less automated, or absorbed into biological information systems. More recently they have been supplemented by numerous local, regional and supraregional bibliographies. The following paragraphs review the most significant of these works, starting with general botanical bibliographies and followed by those specifically relating to floras.<sup>2</sup>

Botanical bibliography effectively began, as did bibliography in general, with the work of the sixteenth-century Swiss natural historian and polymath Conrad Gesner (1516–65). His *Bibliotheca universalis*, a general compendium of some 12000 items in Latin, Greek or Hebrew arranged by authors' forenames, appeared in 1545 as an attempt to bring some order into the rapidly increasing range of literature consequent to the Renaissance and the introduction of printing. A classified index, the *Pandectarum*, followed in 1548 and a supplement, *Appendix bibliothecae C. Gesneri*, with 2000 additional works, in 1555. Further editions of the *Bibliotheca* appeared from time to time after the author's death, the last in the 1720s. In Italy, the Bologna professor of medicine and natural history Ulisses Aldrovandi (1522–1605) essayed a similar work in 12 volumes; unfortunately, this remained unpublished. Gesner himself contributed bibliographical chapters to the Kyber edition of Hieronymus Bock's *De stirpium* (1552) as well as his own edition of Valerius Cordus's *Historia stirpium et Sylva* (1561). Caspar Bauhin – whose elder brother Johannes had been a student of Gesner's – continued this tradition of a special bibliographical supplement with the *Recensio* in his *Pinax theatri botanici* (1623).<sup>3</sup> Such supplements (or sections) have ever since remained a feature of serious textbooks; recent examples include Woodland's *Contemporary plant systematics* (1997) and *Plant systematics: a phylogenetic approach* (1999) by Walter Judd *et al.*<sup>4</sup>

With the gradual differentiation of botany as a distinct scientific discipline in the seventeenth century, it is not surprising that at some time there would appear a botanical bibliography. This was first achieved by Ovidio Montalbani (1601–72), like Aldrovandi at Bologna University. His *Biblioteca botanica* (1657, pub-

lished under the pseudonym of J. A. Bumaldi), a chronologically arranged duodecimo work, covered literature through 1652. With its reissue in 1740 (and again in 1762) as an appendix to Séguier's *Bibliotheca botanica*, it became more widely disseminated.<sup>5</sup> In Switzerland, the Gesnerian tradition was for natural history maintained through the work of his fellow-Zürcher Johann Jakob Scheuchzer (1672–1733). Scheuchzer's key published contribution was *Bibliotheca scriptorum historiae naturalis* (1716; reissued 1751), written preliminary to a fuller study of Swiss natural history. Its primary arrangement was therefore geographical; titles were arranged chronologically under authors in each section. As such, it was the first worldwide geographical guide to natural history works – including floras.<sup>6</sup>

It is to Carl Linnaeus that credit must go for the first botanical bibliography arranged by subject: his didactic, somewhat baroque *Bibliotheca botanica* (1736; 2nd edn., 1751). This was first written during his sojourn in Holland and put forward as part of his comprehensive botanical reform campaign.<sup>7</sup> Here, titles were arranged hierarchically into 16 *classes* or chapters – each with one or more *ordines* or sections – based on the author's perception of their contents, as outlined in the brief introduction, and often furnished with sometimes pointed commentary. Principal sources (*historici litterarii*), including the already-mentioned works of Gesner, Montalbani and Scheuchzer, are listed on pp. 2–3. His class VIII, 'Floristae', is in the present context significant: it is in effect a geographically arranged world guide to regional and local floristic literature. Here, country subdivisions became in effect 'genera' and countries 'orders' (with all extra-European works being grouped together in a single 'order', *Extranei*).<sup>8</sup>

That Linnaeus could thus apply his so-called *methodus naturalis* to books – and people – in the same way as fauna and flora was a mark of his 'scholastic' view of the world. As Cain and Stearn have pointed out, Linnaeus's approach, while containing some elements of empiricism, was primarily based upon Aristotelian logic.<sup>9</sup> Later 'universal' systems of knowledge, such as the Dewey Decimal System (DDC) with its common geographical denominators, were, however, seldom adopted in botanical bibliography. Most subsequent classifications of botanical literature, including geographical entities, would be more or less *empirically* based. Such differences in approach not unnaturally reflect the divergent outlooks of specialists

and generalists. They also highlight a recurrent conflict among essentialism, empiricism, nominalism and other doctrines in the theory and practice of any kind of classification.<sup>10</sup>

With empirical or more strictly historical principles being considered more desirable, Linnaeus's *methodus naturalis* was accordingly rejected as impractical by other compilers. Among them were the authors of the two other major botanical bibliographies of the mid-eighteenth century: the homonymic *Bibliotheca botanicae* of Jean François Séguier (1740; supplement, 1745; 2nd edn., 1760) and Albrecht von Haller (1771–72; revised index by J. C. Bay, 1908). Linnaeus drew upon the former for the 1751 edition of his own *Bibliotheca*, while in the latter the last of its 10 'books' or primary divisions was named after him. Both were very critical as well as more complete than that of Linnaeus. Séguier adopted but three main subject divisions (botany proper, *materia medica* and agriculture and horticulture), while within his historically based classes from 'Book 1' (the Greeks and Romans) through 'Book 10' von Haller arranged authors chronologically from the date of their first publication.<sup>11</sup> Neither author recognized floras and related works as a separate class.

In the wider world of the natural sciences – corresponding to the three kingdoms of Linnaeus – there appeared two other key works before the final years of the century. These comprised a suite prepared by L. T. Gronovius including the second edition of Séguier's *Bibliotheca botanica* (1760) as well as his own *Bibliotheca regni animalis atque lapidei* (1760) and, a quarter-century later, *Bibliotheca scriptorum historiae naturalis* (1785–89) by G. R. Boehmer. The latter, a relatively massive work of some 65 000 partly annotated titles in five nominal 'volumes' or *Bände*, physically running to eight volumes, was arranged in the first instance by discipline; Bd. 3 (in 2 vols.) covered botany. Bd. 5 includes an expanded table of contents and author indices. As in von Haller's work, the internal arrangement of titles under subheadings was chronological, and – likewise – the lack of a subject index rendered the work difficult to use.<sup>12</sup>

The concept of a didactic subject classification comparable to that adopted in Linnaeus's *Bibliotheca botanica*, but in a more empirical and rational form, nevertheless gained more general currency by the end of the eighteenth century. This is an important feature of Jonas Dryander's *Catalogus bibliothecae historico-*

*naturalis Josephi Banks* (1796–1800), which accounts for some 25 000 items.<sup>13</sup> The third volume (1798), on botany, includes the first significant listing of floras and related works through and after Linnaeus's time. Although based upon a single book collection, this dry but very scholarly catalogue, though limited to independently published books and papers, was of such a quality and completeness as to be called at the time an *opus aureum*, or 'golden standard'.<sup>14</sup> Though in general lacking deep structure, the approach of the *Catalogus* gives the user a quick impression of the kinds of botanical studies then being undertaken. Floras, arranged geographically but without a hierarchy of areas, encompass classes 126 through 163 over 63 pages.<sup>15</sup>

The Banksian catalogue as a whole marks the beginning of the tradition of monographic subject bibliographies in the natural sciences which, although inevitably becoming more specialized, reached its fullest development in the century after 1815.<sup>16</sup> In spite of its limitation to independent works, it remained a standard reference for the first half of the nineteenth century.<sup>17</sup> It was afterwards for systematic biology largely superseded by *Bibliotheca historico-naturalis* (1846) by Wilhelm Engelmann, *Thesaurus literaturae botanicae* (1847–52; 2nd edn., 1871–77) by George A. Pritzel, and *Bibliographia zoologiae et geologiae* (1848–54) by Louis Agassiz. Of these, only the *Thesaurus* will be further considered here.<sup>18</sup>

The two editions of Pritzel's *Thesaurus*, both highly critical and based as far as possible on personal observations, are with respect to systematic botany the apogee of the broadly based nineteenth-century bibliographic tradition. Both were much praised in their time as well as afterwards.<sup>19</sup> They respectively encompass 11 906 and 10 871 entries, with some classes of works being eliminated for the second edition. While the primary arrangement of titles in the *Thesaurus* is by author, it shows historical sensibility in its chronological arrangement of multiple works by a given writer along with, in many cases, concise biographical notes. As in Dryander's work, each entry is bibliographically fully described. In the classified index, all entries appear in short-title form. In both editions several of the index classes deal with regional and local floristic literature. These, along with the work's quarto format, provide a good visual overview of the state of progress in description and analysis of the world's flora.

The second edition of the *Thesaurus* was soon followed by Benjamin Daydon Jackson's *Guide to the*

*literature of botany* (1881).<sup>20</sup> Although offered as a companion to the *Thesaurus*, it is effectively an independent work. With some 10000 entries organized by empirically derived subject classes, it may be directly compared to the index of the *Thesaurus*; entries are in short-title format and there is no alphabetical author section. A substantial portion (over 180 pages) in Jackson's *Guide* is devoted to geographically arranged classes of regional and local floras, enumerations and lists. The level of geographical subdivision therein, especially for regions outside Europe, is more precise than in Pritzel's work. This arguably acknowledges the rapid development of 'overseas' literature (notably in North America and South Asia).

In neither of these works is there extensive commentary. Annotations are few and for the most part strictly bibliographic, although in the *Thesaurus* brief critical notes do appear here and there. As in the Banksian *Catalogue*, only independently published works are covered. The already significant periodical literature was for the most part bypassed; this was done not only for reasons of economy but also in recognition of the advent (in 1867) of the Royal Society of London's *Catalogue of Scientific Papers*. Pritzel himself acknowledged the latter with volume and page cross-references from each author entry in the *Thesaurus*.<sup>21</sup> To these criteria might be added a not-uncommon contemporary scholarly view that periodical papers were 'ephemeral' or at least precursory compared with monographic works.<sup>22</sup>

The final major monographic botanical bibliography largely to appear before World War I, and – save for the late twentieth-century *Taxonomic Literature-2* – the only real successor to the tradition set by Pritzel and Jackson, is the *Bradley Bibliography* (1911–18) by Alfred Rehder. This is a five-volume guide to literature on woody plants published through 1900 and encompassing 145000 entries. A total of 75000 (more than half) are concerned with dendrology, with a large proportion of them taxonomic. An innovation in the 'Bradley' is the inclusion of papers in serials. In the first volume (Dendrology, I) is a classified list of woody floras and 'tree books'.

All these nineteenth and early twentieth century works combine various traditions of earlier bibliographers but they are also the final more or less general botanical bibliographies.<sup>23</sup> World War I with its attendant disruption and loss of resources as well as changes in fashion and technology led to what has become a per-

manent fragmentation in the coverage of systematic and related botanical literature. The manifold expansion in the number of titles alone (let alone potential technical problems) would now render all but impossible the compilation of a full retrospective botanical bibliography. To cope with the increasing volume as well as specialization of the literature – clearly evident by the mid-nineteenth century – three main directions have been pursued: (1) monographic subject or thematic bibliographies, including world guides to floras; (2) national and regional bibliographies, beginning as early as 1831 but most notably after World War II; and (3) periodical surveys of new literature, initially in more general journals but by the mid-nineteenth century in specialized bibliographic journals and, from the 1960s, computerized information retrieval services. To these may be added the catalogues of major libraries, especially those specialized in botany or natural history, as well as alternative professional or commercial outlets. All these are in turn considered in the sections that follow.

#### *World guides to floras*

The publication of Pritzel's *Thesaurus* led directly to the first known separate guide to floras of the world, namely George L. Goodale's *The floras of different countries* (1879), originally published by the Harvard University Library in its *Bulletin* and then separately as one of its 'Bibliographical Contributions'. This selective compilation of 12 pages, with about 400 entries, is comparable to the present work in scope although by and large it was limited to independently published works available within Harvard University. The primary arrangement of titles is as in the *Pars systematica* of the *Thesaurus*: geographical and then chronological. The brief annotations are mainly bibliographical. Noteworthy is the omission of the great majority of the smaller local floras, already very numerous in Europe and elsewhere increasing in number, both inside and outside North America. At the end of the list is an appendix entitled 'Botanical Handbooks for Tourists'. In his brief foreword, Goodale indicated that his list was 'simply an attempt to answer questions frequently asked respecting the systematic treatises upon the vegetation of different countries'.<sup>24</sup>

Goodale's list was followed in 1911–14 by a rather more substantial compilation, a mostly unannotated series of contributions by William Holden and Edith Wycoff entitled 'Bibliography relating to the



Floras'. With some 7750 entries, it comprised most of volume 1 of *Bibliographical Contributions from the Lloyd Library*.<sup>25</sup> More than a mere library catalogue, however, the series was an attempt to list all known independently published floras; those actually present in the Library were especially indicated. The work is divided into major geographical units comparable to those in the *Thesaurus* or Jackson's *Guide*; however, within each the arrangement of titles is alphabetical by author. As with Goodale's list, the series was produced in the interest of service to the public. Though seemingly not well known, it remained for long the only substantial guide to floras completely covering the earth, and is still useful for some parts.<sup>26</sup>

As the twentieth century progressed, critical bibliographic scholarship filtered through to more specialized biological fields including vascular plant floristics. In both Europe and North America several key monographic bibliographies were produced.<sup>27</sup> Among these was the next bibliography of floras: *Geographical guide to floras of the world* by Sidney F. Blake and Alice C. Atwood (vol. 1, 1942; vol. 2 by Blake alone, 1961). The first volume, completed by 1940, covers Africa, the Americas, Australasia, and the islands of the Atlantic, Indian and Pacific Oceans; the second volume provides detailed coverage for most of western Europe (save the German states). Based upon a wide range of primary and secondary sources and many years of critical research and experience on the part of its authors, it was in its time the most comprehensive and original contribution of its kind to be published.<sup>28</sup> Unfortunately, the work, left incomplete upon the death of Blake in 1959, does not cover the rest of Europe and the continent of Asia. No official plans were ever made to complete it,<sup>29</sup> although in a posthumous contribution a leading Kew botanist, William B. Turrill, considered this to be a task of high priority.<sup>30</sup>

The arrangement of the *Geographical guide* is fairly simple, with continents and their subdivisions arranged alphabetically in volume 1 and the countries and their administrative subdivisions similarly arranged in volume 2. Coverage extends to local florulas and checklists as well as encompassing the more important larger works and – appropriately to an agricultural research branch – works on applied botany (medicinal and poisonous plants, useful plants, and weeds) are also included. Each primary citation contains extensive bibliographic details and is briefly annotated; associated with these are many secondary

citations (supplements, reviews, related or superseded works, etc.). Like the *Bradley Bibliography* but in contrast to the works of Goodale and of Holden and Wycoff, it features detailed coverage of floristic contributions in periodical and serial literature. Geographical and author indices are also provided. The *Geographical guide*, an *opus aureum* like those of Dryander and Pritzel, was a primary source for the original edition of the present work.

Following publication of the first edition of the present *Guide*, there appeared *Plants in danger: what do we know?* (1986) by S. D. Davis *et al.*, published by the International Union for the Conservation of Nature and Natural Resources (IUCN) with support from the World Wide Fund for Nature (WWF) and its Plant Conservation Programme. Exemplifying the collective approach feasible within an established organization, this work was a response to the needs of the rapidly growing environment and conservation movements and the requirements imposed by the Convention on International Trade in Endangered Species (CITES), promulgated in 1973. Organized by countries, it lists in addition to 'standard floras' other useful works as well as references on threatened plants.<sup>31</sup> *Plants in danger* has been of great value for the revision of this *Guide*.

Other, more or less abridged, lists of floras have appeared in a wide variety of references. Among these are textbooks of systematic botany, notably *Taxonomy of vascular plants* by G. H. M. Lawrence (1951), *Taxonomy of flowering plants* by C. L. Porter (1959; 2nd edn., 1967), *Vascular plant systematics* by A. E. Radford *et al.* (1974), and *Contemporary plant systematics* by D. W. Woodland (1997) (see also Appendix A). There is also a compact list in *Biodiversity assessment: field manual 1* (1996), published by HMSO in the United Kingdom.

#### *Regional and national floristic bibliographies*

In addition to the world guides just described, there have been since the mid-nineteenth century many lists of floristic publications with a regional or local scope. These have been published either independently or as parts of more general national and regional botanical (or biological) bibliographies. Only the more salient aspects of this now rather extensive literature will be dealt with here.

The earliest regional bibliography in North America devoted exclusively to floras appears to be *A list of state and local floras of the United States and*

*British America* by N. L. Britton (1890; in *Annals of the New York Academy of Sciences* 5: 237–300). Its main feature was a geographically arranged listing of 791 works.<sup>32</sup> Partial successors included *State and local floras* (1930; in *Bull. Wild Flower Preserv. Soc.* 1: 1–16) by A. C. Atwood and S. F. Blake and, more fully, the North American section of Blake and Atwood's *Geographical guide*, with coverage through 1939. Canada (along with Alaska, Greenland and Newfoundland) was through 1945 very thoroughly documented in the nine installments of *Bibliography of Canadian plant geography* (1928–51) by J. Adams, M. H. Norwell and H. A. Senn.

Since about 1950, however, continent-wide lists of floras in North America have been limited to the most significant works. Short lists were published by Charles Gunn in 1956 for the United States and by Stanwyn Shetler in 1966 for North America north of Mexico. More substantial was a list by Lawyer *et al.*, announced for *Torreya* in the late 1970s but never published. Popular floras of the United States, including 'wild-flower books', were covered in some detail by Blake in 1954 and later, but less thoroughly, by Elaine Shetler in 1967. United States tree books have similarly been rather fully covered, firstly by Dayton in 1952 and subsequently by Little and Honkala in 1976.

Of more import, particularly in the twentieth century, have been bibliographies for states, provinces, or other more or less limited areas in the continent. A notable pre-1950 contribution was *Bibliography of botany of New York State, 1751–1940* (1942) by then-state botanist Homer D. House. Others were incorporated into floras and enumerations. There have since been numerous – some of them quite substantial – additions to this range; as far as possible they have been accounted for in the present book.

In Europe, national or regional bibliographies or indices have been produced more or less in tandem with the growth of interest in local floristics, beginning as early as 1831 with *Conspectus litteraturae botanicae in Suecicae* by Stockholm professor Johann Wikström but becoming more numerous only after 1860.<sup>33</sup> Now available in one or another form in most countries, they have become a significant source for literature on floristics. There have also been some more general botanical bibliographies, sometimes the work of specialist librarians. Literature has also been cumulated, at least partly, within national floras or enumerations; an example is Erwin Janchen's treatment of seed plants in *Catalogus*

*florae austriacae* (1956–60). Perhaps not surprisingly, the only comprehensive work for nearly a century following Pritzel and Jackson was the second volume of Blake and Atwood's *Geographical guide* (1961). Even then, it does not cover Germany or its predecessors, the rest of Central Europe, the Balkans, or the European part of the former Soviet Union.

The first modern European lists of floras dealing with the whole of that continent did not make their appearance until after the initiation of the *Flora Europaea* project in the 1950s.<sup>34</sup> As with the lists of Gunn and Shetler in North America, these latter were limited to what their authors considered to be the most significant and/or generally useful works, thus obtaining a depth of coverage comparable to that in the present *Guide*. Heywood's list appeared, with successive revisions, in every volume of *Flora Europaea* (1964–80) and in the first volume of its second edition (1993). With respect to individual countries, two sets of listings were published under the aegis of the Flora Europaea Organisation, firstly in 1963 following their second international symposium and again in 1974–75 following the seventh; these were important sources for the present *Guide* (see **Division 6**). Significant floras in Europe – and, less thoroughly, other parts of the Holarctic zone – were listed in a botanical bibliography for Central Europe published (initially in 1970, with a second edition in 1977 but not since revised) to accompany *Illustrierte Flora von Mitteleuropa*.<sup>35</sup> Literature for countries surrounding the Mediterranean was listed in 1975 in *La flore du bassin méditerranéen*.<sup>36</sup>

Biological literature in the former Soviet Union has been the subject of surveys since 1847 but only in 1968–69 were floras, at least in part, separately reviewed. This critical study by M. E. Kirpicznikov, however, never covered more than Russia-in-Europe, Belarus, Moldova and Ukraine as well as the Baltic States. Good coverage can also be had in Lebedev's historico-didactic but selective *Vvedenie v botaničeskiju literaturu SSSR* (1956) as well as in Lipschitz's empirical but more complete *Literaturnye istočniki po flore SSSR* (1975). There are also many national, republican and regional bibliographies. With economic, social, political and technological changes since 1991, new works in that genre have, however, become scarce.

For other parts of the world, there are now a considerable number of botanical bibliographies, many published since 1981. Important supranational works include those by Merrill and Walker for eastern Asia

(1938; supplement by Walker, 1960) and van Steenis for Malasia and adjacent areas (1955), the Field Research Projects' bibliography for southwestern Asia (1953–72), Hultén's excellent source bibliographies (1958, 1971) covering the whole of the north temperate and polar zones, that by Yudkiss and Heller for the *Flora orientalis* area (1987), and three bibliographies for southern Africa (1988, 1990, 1997). Many national bibliographies have also appeared; some, like those of Langman for Mexico (1964), Kanai for Japan (1994) and Strid for Greece (1996), are extremely detailed. That by Nayar and Giri (1988–) for India is geographically arranged. There are also some brief continental or subcontinental literature surveys; among them are those by Léonard for Africa and the islands of the southwestern Indian Ocean (1965; in *Webbia* 16: 869–876) and Zohary for southwestern Asia and adjacent areas (1966, in the first volume of *Flora palaestina*). With respect to floras, these latter cover 'standard' works and thus, like Heywood's lists for Europe or those in North America, provide a level of coverage comparable to this *Guide*.

The majority of printed bibliographies discussed here are arranged in the first instance by author, the entries sometimes being numbered. Any classification is limited to the indices, which generally are confined to a numerical or author cross-reference. In some cases there may be a limited regional or subject breakdown within the primary listing. Rarely are the indices themselves in short-title form – a recent example being D. M. C. Fourie's *Guide to publications on the southern African flora* (1990) – or even inclusive of keywords (used by Egbert H. Walker among others) which might offer clues. Where cross-referencing is skeletal, subject-related searches may potentially be time-consuming, requiring much copying and page-turning. Far less common are classified bibliographies, which for well-established topics (including taxa and regions) have been much easier to use.

Until relatively recently, all bibliographies and catalogues perforce were published in print (after World War II sometimes also, or only, in microform). Electronic dissemination became possible from the 1960s but, though gradually increasing its penetration, remained relatively limited until the 1980s. With the advent of less costly and more convenient storage media such as the CD-ROM, as well as the introduction of the World Wide Web, such material has begun also – or even exclusively – to appear in electronic form,

with increasingly enhanced searchability.<sup>37</sup> These developments and their consequences will be more fully discussed in Chapters 2 and 3.

#### *Periodical indices and other current awareness services*

From the seventeenth century, timely coverage of new literature had been a regular feature of many scientific journals.<sup>38</sup> The first botanical periodical began publication in 1787, and in 1840 a weekly newsletter, *Botanische Zeitung*, was established. Specialized bibliographic journals made their appearance mainly after 1860, although the Swedish Academy published an annual *Öfversigt af botaniska arbeten* from 1825 to 1843/44 (again the work of Wikström) and, in Berlin, the *Archiv für Naturgeschichte* from its foundation in 1837 had included a second, purely bibliographic section.<sup>39</sup> From 1864 through 1871 the well-known German journal *Flora* carried in its *Beiblättern* listings of new literature. In the decade of the 1870s there were founded four serials – all German – which would find wide use in general as well as systematic botany: *Repertorium annum literature botanicae periodicae* (1873–86), covering literature for 1873 through 1879, *Just's Botanischer Jahresbericht* (established in 1874), *Naturae Novitates* (from 1879), and the relatively timely *Botanisches Centralblatt* (from 1880). From 1902 they were joined by the *International Catalogue for Scientific Literature*, section M: *Botany* (established as one of the coordinated successors to the *Catalogue of Scientific Papers*).<sup>40</sup> In the Americas, the Torrey Botanical Club in 1886 initiated the *Index to American Botanical Literature* as part of their *Bulletin* and, in 1918, a group of interested botanists led by the physiological ecologist B. E. Livingston of Johns Hopkins University founded *Botanical Abstracts* (in 1926 expanded into *Biological Abstracts*).<sup>41</sup> *Biological Abstracts*, and its sister journal *Biological Abstracts/RRM* (as well as, since 1968, the on-line *BIOSIS Previews*), are now (along with *Bibliography of Agriculture* and *CAB Abstracts* and their electronic counterparts) among the leading information sources for new biological literature. These and others are further described and evaluated in Appendix A. However, no botanical counterpart to *Zoological Record* (begun in 1864) was established until the advent of *Kew Record for Taxonomic Literature* in 1971.

As time progressed, however, the continuing and indeed exponential growth of biological literature along

with the increasingly lesser percentage accounted for by systematics, floristics and related subjects have resulted in changes which have not necessarily been favorable either to effective coverage in these fields or to easy retrieval. Until the advent of on-line electronic dissemination and indexing in the late 1960s an inevitable failing of abstracting and indexing services was, over time, their relative inflexibility in relation to the kinds of deeply retrospective searches required in systematics or, indeed, any history-dependent or encyclopedic area. Already in the latter part of the nineteenth century, therefore, classified taxonomic-bibliographic card catalogues were established in some botanical institutions.<sup>42</sup> The catastrophes of the two world wars of the twentieth century would also leave their mark. The *International Catalogue of Scientific Literature* network of bureaux was disrupted by World War I and its aftermath and, in spite of efforts at revival, ceased operations in the 1920s – the United States in particular having chosen not to assume a greater share of support.<sup>43</sup> *Botanisches Centralblatt* also became less truly international, its coverage being reduced from 1922 – concomitantly with the rise of *Botanical Abstracts* in the United States. More serious were the effects of World War II, especially the physical destruction and subsequent division of Germany (including in particular the loss of the library of the Berlin Botanical Museum) which put an end to *Botanisches Centralblatt* (renamed *Botanisches Zentralblatt* in the 1930s), *Just's Botanischer Jahresbericht*, and *Naturae Novitates*. Nothing would succeed them until the late 1950s and indeed by then in some respects their time had passed. The institutional card catalogues would also, one by one, cease to grow as costs rose and scientific fashions as well as technologies changed; that in Washington, for example – a major source for Blake's *Geographical guide* – was closed in 1952.<sup>44</sup>

The place of the former journals would eventually be taken by two new works: *Excerpta Botanica*, sectio A, begun in 1959 by Gustav Fischer Verlag (the publishers of the defunct *Zentralblatt*) under an agreement with the International Association for Plant Taxonomy, and *Kew Record of Taxonomic Literature*, which initially absorbed certain regional indices including the *Index to European Taxonomic Literature* (begun in 1965) and *Index to Australasian Taxonomic Literature* (begun in 1968).<sup>45</sup> The former, edited at first from Berlin but later from Kassel and finally Cologne before its termination in 1998, included short summar-

ies for each title, prepared by a network of collaborators. In this fashion it continued the tradition of its Central European predecessors but inevitably there developed a time lag ultimately reaching some 2–3 years. It also to the end remained purely a paper product. The initially annual *Kew Record* became a quarterly in the mid-1980s – at the same time going 'on-line' – and remains timely. It is now the only worldwide indexing serial of its kind in the field.<sup>46</sup>

Apart from these sources, reliance – especially for more up-to-date coverage – has customarily had to be placed upon more general botanical and biological abstracting and indexing journals (and their electronic counterparts), worldwide and regional newsletters with literature lists, booksellers' catalogues, advertising leaflets, and announcements and reviews in professional journals. Summary lists of new floras and related works have appeared from time to time in the annual *Progress in Botany* (formerly *Fortschritte der Botanik*), begun in 1932.<sup>47</sup> Rudolf Schmid as book review editor of *Taxon* since the mid-1980s has created a detailed and well-indexed section for new literature in that journal which carries some of the flavor of the old *Botanisches Zentralblatt*. *Biological Abstracts* along with *Referativnyj Zhurnal* (established in 1954) and *Bulletin Signalétique* comprise the main group of more general abstracting and indexing journals useful for systematics and floristics; they focus, however, on journal articles and are not as broad in their coverage as *Excerpta Botanica* (through 1998) or *Kew Record*. By contrast, *Current Contents (Agriculture, Biology, and Environmental Sciences)*, a widely consulted commercial publication begun in 1970, is with respect to systematic botany more useful for developing areas such as molecular systematics, phylogenetic reconstruction and biodiversity analyses rather than floristics.<sup>48</sup> Its emphasis has not unnaturally been on more widely used journals (as measured through citation analysis)<sup>49</sup> as well as more prominent symposium reports. The relative strengths and weaknesses of the various periodical indices are considered along with other general sources in Appendix A.

Various indices have also functioned at national or regional level. In North America, the *Taxonomic Index*, based on the *Index to American Botanical Literature*, was conducted (partly in *Brittonia*) by the American Society of Plant Taxonomists from 1939 through 1967. From 1996, however, it was in effect revived – again in *Brittonia* – with the restriction of the

larger *Index* to systematics and related fields. With other changes, it has now become a continent-wide index to floristic literature, and moreover is also (and, from 1999, exclusively) available on-line.<sup>50</sup> Apart from the *Index*, recourse must be had to *Biological Abstracts* (and *BIOSIS Previews*) or *Kew Record for Taxonomic Literature*. In Europe, the country reports prepared for the second *Flora Europaea* symposium gave rise to an interest in ongoing documentation of new literature. Initially this was realized in *Index to European Taxonomic Literature* (1966–71, 1977), covering the years 1965 through 1970; afterwards, coverage was absorbed into *Kew Record*. At a later date came the ‘European Floristic, Taxonomic and Biosystematic Documentation System’ (more commonly known as the ‘European Science Foundation/European Documentation System’ or, for short, ESFEDS). This was first proposed in 1977 as a means of continuing the integrative processes in European taxonomic botany set in motion by *Flora Europaea*.<sup>51</sup> Due to technical and conceptual difficulties, however, an initially projected bibliographic module had not been developed by the close of the project in 1987.<sup>52</sup> Current documentation of European botanical literature, where undertaken, is – apart from *Kew Record* (and, through 1998, *Excerpta Botanica*) – presently at national or regional level. In the Russian Federation, indexing of new literature on any scale has since the 1950s been concentrated in *Referativnyj Žurnal*, although *Botaničeskij Žurnal* remains useful for reviews and notices. Elsewhere, recent outlets for continuing documentation have included *Flora Malesiana Bulletin* (1947–), *AETFAT Index* (1952–86, afterwards absorbed into *Kew Record*), and *Bibliografia Brasileira de Botânica* (1957–75).

#### *Progress reports and reviews*

In recent decades, the publication of review articles and reports in plant systematics and geography has extended to include reports on the state of floristic knowledge for different parts of the world. This is, in part, related to the growth of the conservation movement as well as to increased general awareness of the tropical biota. Such reports vary considerably in scope and quality, and range from isolated articles to sometimes elaborate surveys covering large areas; more or less extensive bibliographies may be included.

Examples of these reports include the previously mentioned surveys of European and Mediterranean floristics; the reviews of the state of tropical floristic

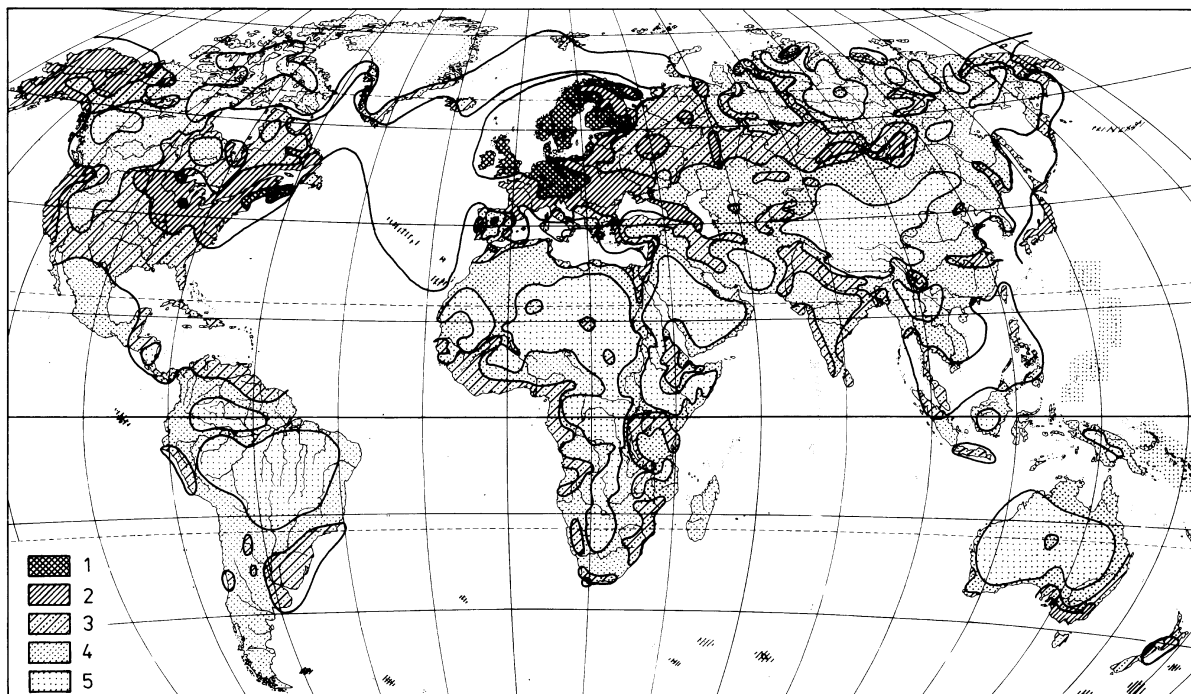
inventory firstly by Prance and later by Prance and Campbell and Campbell and Hammond,<sup>53</sup> the many articles in Verdoorn’s *Plants and plant science in Latin America*,<sup>54</sup> and reviews presented at the congresses of AETFAT (Association pour l’Étude Taxonomique de la Flore d’Afrique Tropicale), Flora Malesiana, the Pacific Science Association, the Inter-American Botanical Association, and elsewhere.<sup>55</sup> In recent years, there has also been floristic reporting at International Botanical Congresses.

All these sources collectively constitute a valuable source of information on the progress of floristic research and (where applicable) the institutional background. They are, however, scattered far and wide through the literature and could potentially be overlooked.<sup>56</sup> They have sometimes been intertwined with historical surveys of botanical exploration or biographical sketches.<sup>57</sup> Valuable also are the introductory portions or volumes of many floras and checklists.<sup>58</sup> On the other hand, as Jonsell has warned, the user should take note of the standard of these reviews and surveys; many are not well documented and in addition may be unreliable.<sup>59</sup> It is also important to distinguish levels of floristic documentation from mere botanical inventory, as E. J. Jäger (see below) has done.

The best periodical worldwide surveys of progress in floristics were those produced from 1976 through 1993 by Jäger in the already-mentioned *Fortschritte der Botanik/Progress in Botany*.<sup>60</sup> The initial survey included a world map depicting floristic progress based upon four criteria.<sup>61</sup> A revised version of this map was presented as Map II in the original edition of this book and, in the absence of a successor, is reproduced here (as Map I). Much progress has since been made in hitherto imperfectly known parts of the Americas, Asia, Malesia and Australia, but in others advance has been slower and in some polities civil disturbances and other factors have all but prevented field and other studies. Prolonged economic recession, slow development, and a relative reduction generally in public funds have also limited progress. Nevertheless, the many additional floras and related works published since 1980 have certainly, if nothing else, helped towards the construction of improved world species richness maps.<sup>62</sup>

#### *Major library catalogues*

A final – and by no means inconsequential – major source of floristic references are printed library



**Map I.** Five-grade map of the approximate state of world floristic knowledge as of 1979. Based upon (1) quantity, quality, age and completeness of floras, (2) collecting density, (3) an estimation of the percentage of undescribed and/or

unreported species, and (4) status of distribution mapping. [From E. J. Jäger in *Progress in Botany* 38: 317 (1976); revised by him for the first edition of this *Guide*. No subsequent version has been published.]

catalogues (and their on-line successors). That of floras issued by the Lloyd Library in 1911–14 has already been discussed. Other principal printed catalogues from before 1950 include those of the Royal Botanic Gardens, Kew (1899; supplement, 1919), the present Natural History Museum, London (1903–15; supplement, 1922–40), and the Arnold Arboretum of Harvard University (1914–17; supplement, 1933). In the third quarter of the twentieth century the Boston (Mass.) firm G. K. Hall produced numerous catalogues in book form reproduced from library cards; among those covered was the Kew Library (1974). A catalogue, with supplement, of the U.S. National Agricultural Library through 1970 was published in 1967–73 by a New York (later Totowa, N.J.) firm, Rowman and Littlefield. In that decade and the next, however, the application of computer-based information technology in libraries – already initiated for production purposes in the 1950s – began to spread widely. Since then, major developments have included the rise of network services such as OCLC and RLN and on-line access to

individual catalogues – including most of those referred to above – via Telnet or the World Wide Web. Further details appear in Appendix A.

## Plan and philosophy of the present work

### *Definition of a 'standard' flora*

For the purposes of this *Guide*, a 'standard' flora (or corresponding manual, manual-key, enumeration, or list) is considered to be a current scientific work which yields the maximum information about the vascular plants of a given geographical unit within parameters set by the nature and style of the work and available resources. It thus saves the enquirer an extensive (and often time-consuming) search in the more detailed (and usually very scattered) taxonomic and floristic literature. Put in another way, standard floras are generally those which one turns to first for information about the plants of a given region, state or country; in many instances they may be the only ones consulted, as they are likely to suffice for the query in hand. They represent among floristic literature an optimum ratio of

information to effort. Ideally a 'standard' flora should contain descriptions, keys for identification, and supporting documentation, but often only an enumeration or checklist is available for a given area. Further evaluations of the different kinds of floristic writing appear in Chapters 2 and 3.

The concept of a standard flora as expressed herein is by no means original. Its initial formulation appears to have been by Vernon Heywood in his 1957 report on the organization of the *Flora Europaea* project.<sup>63</sup> His suggestion therein was that a list of about 100 titles had to be considered in obtaining a general overview on any given European taxonomic or floristic problem. The value of the concept was shortly afterwards reiterated by Thomas G. Tutin in his foreword to the *Flora Europaea* 'Green Book' of 1958: 'It is our belief that the list of Standard Floras . . . will be generally welcome. These floras, as far as we can ascertain, are the ones most generally acknowledged by botanists in the countries concerned'.<sup>64</sup> Although originally developed in a European context, the author believes the standard flora concept to be, with variations, applicable worldwide.<sup>65</sup> Indeed, a satisfactory paraphrase of Tutin's words might read as follows: 'Standard floras, as far as can be ascertained, are the ones most generally acknowledged by botanists in, or working on, the countries or other regions concerned'. As indicated in the previous section, the concept was reflected directly or indirectly in various continental and subcontinental lists of floras published in the 1950s and 1960s and moreover has passed into other languages.<sup>66</sup>

'Standard' floras contrast with, but should relate to, works which are less geographically comprehensive, such as county or provincial floras or checklists. These latter normally deal only with areas of relatively limited extent and are, comparatively speaking, of more interest to specialists on local floristics, local amateurs, and persons engaged on detailed monographic, revisionary or chorological work. They should also as far as possible include references to taxonomic monographs and revisions and other key contributions. For some parts of the world – above all Europe – the regional and systematic literature is very large indeed; as already related, there is room for improvement in the ease of extraction of desired information.

#### *Selection and coverage of standard floras*

The preparation of a comprehensive list of standard floras, no matter what definitions or guidelines are

available or may be evolved, necessarily entails a difficult process of evaluation and selection. It is also essential that a reasonably uniform standard of coverage be adhered to throughout the bibliography. The nature, quantity and quality of the corpus of regional literature, however, varies greatly from one part of the world to another. Many tropical areas, such as the island of New Guinea, have no general floras or enumerations of relatively recent date and the student or non-specialist is faced with an ill-digested mass of florulas, expedition reports, and scattered 'contributions', revisions, notes, and the occasional monograph of varying scope. By contrast, the bulk of Europe is covered for the most part by a plethora of local, national and regional floras and lists of varying dates from which it was necessary to make a careful and limited choice. These areas and others have also become blanketed with more or less widely used 'popular' works.

Fortunately, the exacting tasks of selection and establishment of an approximately uniform standard of coverage were for the 1984 edition greatly facilitated by the existence of some useful guidelines. These were (1) the regional lists of floras already referred to (including the 'Green Books' and the lists of Shetler, Lawyer, Léonard, van Steenis, and Zohary); (2) the selected lists in the standard textbooks referred to on p. 7; and (3) two lists of works considered to be of 'greatest general utility' in Blake and Atwood's *Geographical guide*.<sup>67</sup> Other reference points have included a series of unpublished memoranda on various regions prepared in 1970 for internal use in the Kew Herbarium as part of a major reorganization,<sup>68</sup> a 1979 list prepared at Geneva for the projected 'Med-Checklist'; published 'state of knowledge' reports for a wide variety of countries and geographical areas; and verbal and written advice from a number of specialists and others with local knowledge. Similar surveys and sources have been consulted for the present edition.

The *Guide* is modeled on Blake and Atwood's *Geographical guide* but features historically oriented unit prologues along with more detailed commentary. As far as possible, every primary entry in this book has been provided with an annotation describing its style and contents. These have been as far as possible based upon personal examination of the works concerned. For those not seen, my annotations have been based on notes and/or extracts supplied by correspondents, who have been acknowledged in the text, or published or circulated secondary sources. Any material not seen at

first hand has been so indicated. Subsidiary and historical titles – i.e., those not given separate entries – appear in the unit prologues unless they are direct extensions of or closely related to a primary work.

Some works covering only parts of basic geographical units as delineated in this work have been included. Such works are seen as bridging gaps left by the absence, relative antiquity, or inadequacy of a general work or works. They may also be of an exceptionally high standard or of acknowledged value well beyond their nominal circumscription.<sup>69</sup> Amelioration of the limitations on coverage has also been applied with respect to sets of ‘contributions’ and/or expedition reports covering imperfectly known areas where these appear to be of exceptional importance or are otherwise often routinely consulted.

Provision has also been made for certain kinds of ancillary works. Atlases of illustrations, if of major importance, have usually been accorded the status of primary entries, unless they are clearly companions to descriptive works. Separate subheadings have been set aside under a given unit heading if there are separate keys to families (and genera) and/or dictionaries, but in practice this has been done only at regional level and above. The same has been done with atlases of distribution maps and like chorological works, save for a few such as *Pacific plant areas* (given under 001 as they are not readily referable elsewhere).

Under unit headings, any ‘local’ or ‘partial’ work deemed important enough for inclusion has been treated as a ‘secondary’ work and its citation and commentary appear in smaller type, usually following a subheading. The same procedure has been adopted with respect to works on the woody flora (including ‘tree books’), the ferns and fern-allies, and (in a very few cases) the grasses, groups also accounted for in the *Guide* due to general interest or where these groups are not well accounted for in available floras.

### *Schedule of geographical entities*

The arrangement of titles is, as already noted, geographically systematic in accordance with a three-tier hierarchical decimal scheme devised especially for the original edition of this book. Development of this scheme was begun in the belief that existing special schedules in standard library classification schemes or other, more specialized works – though sometimes with a wealth of detail – were obsolete or not particularly suited to the material in hand.<sup>70</sup> Moreover, many exist-

ing schedules were largely rooted in nineteenth-century ‘Eurocentric’ notions of history and geography, past and present. A new scheme was also seen as useful not only for floras but, by extension, for any geographically oriented systematic biological (and earth sciences) literature.

The possibility that universal geographical schemes as used in major library classifications were unworkable appears first to have been raised by de Grolier in 1953.<sup>71</sup> With respect to history and geography, de Grolier argued that a schedule suitable for physical geography would not suit economic geography, and even less would it suit history (upon which most general schemes had been based). Likewise, following de Grolier, it is argued here that the regional literature of botany (and zoology) is more closely related to that of physical and ‘political’ geography (and geology) than to history or economic geography. However, apart from two recent proposals discussed below, no geopolitical scheme rooted in the biological or earth sciences regional literature and at the same time potentially compatible with one or more of the existing widely used classifications (particularly the Universal Decimal Classification or UDC, which formally allows for specialized schedules) has been seen.<sup>72</sup>

The first of these proposals, published some time prior to the 1984 edition of this book, was – as will be further noted below – S. W. Gould’s *Geo-code*.<sup>73</sup> Purely geographical, it was based on latitudinally and longitudinally founded sectors similar to those used for the 1:1000000 *Map of the World* and related products. Such a rigid structuring, however, negated any sense of geographical continuity as well as any relationship to existing (and likely) publication patterns; its adoption for the present book was impossible. The second scheme is that of the Taxonomic Databases Working Group, first published in 1992 under the authorship of S. Hollis and R. K. Brummitt as *World geographical scheme for recording plant distributions*.<sup>74</sup> Its basic hierarchy is similar to that in the UDC and the present book but lacks a first-level ‘zero’ element (corresponding to our ‘World floras, isolated oceanic islands, and polar regions’). In addition, for its third level it uses more or less mnemonic triplets of letters in place of a single digit.<sup>75</sup> Its geographical progression at the first and second levels is ‘Eurocentric’; such a methodology requires major sequential ‘retracings’ and moreover fragments the temperate parts of the Southern Hemisphere. It is also wholly politically based, being, as



its title suggests, primarily intended for precision in recording the sovereign geographical distribution of biota.

In summary, what best suited this work was a representative and uniform geographical schedule suitable in the first instance for floristic (and, by extension, faunistic) literature. It was early evident that the structural pattern – or what is known in librarianship as the ‘literary warrant’ – of existing (and expected) floristic literature was such that it could be grouped into successive hierarchical arrays, thus enabling construction of a ‘decimal’ system in form resembling the UDC.<sup>76</sup> In comparison with those systems, however, our actual geographical arrangement of divisions, regions and politics is quite different. In constructing a necessarily linear schedule of geographical units, primary concerns have been logic, practicality, mnemonic value, and physical and biogeographical relationships.<sup>77</sup>

#### *Common auxiliaries*

A purely geographic schedule is, however, not enough for current floristic literature. It is also necessary to formulate an adequate classification of physiographic and synusial isolates such as alpine zones and wetlands. Many key floras meeting our criteria as ‘standard’ already existed for these isolates by 1981; more have appeared since. At the time of writing of the 1984 edition, no logical schedules or sets of common auxiliaries suited to floristics and faunistics appeared to exist.<sup>78</sup> Following a first empirical attempt at listing works not conveniently included in a geopolitical unit, a system of nine common auxiliaries based upon those used for the UDC was developed.<sup>79</sup> As revised for the present edition, it features the following structure:

- 01 Vague areas (e.g., Patagonia, tropical Africa)
- 02 Major uplands or highlands (e.g., the Guayana Highland, the Ural)
- 03 Alpine and upper montane areas (e.g., the Andes, the Alps, the Pamir)
- 04 Ectopotrophic areas (e.g., serpentine and limestone formations)
- 05 Steppes and deserts (e.g., the Sahara, the Gobi, the North American Great Plains)
- 06 Rivers and riverbanks
- 07 Great lakes and their littoral (e.g., Lake Baikal, Victoria Nyanza, the Great Lakes of North America)
- 08 Wetlands
- 09 Oceans and the oceanic littoral; islands

The nine auxiliaries are in theory definable in all 10 divisions of the *Guide*’s geographical system; in practice they do not appear unless there are appropriate works to be covered.

Usage of these auxiliaries has been comparatively sparing, save for –03 and –08. For these two the opportunity has been taken to refer to them all (or most) such works covered in the *Guide*, even where their geographical compass fell wholly within one third-level polity (as in *Rocky Mountain flora* (103) and *Alpine flora of New Guinea* (903)). Wetland floras of subregional level or below have, however, largely been omitted. Auxiliary –09 in particular has the potential for coverage of marine and littoral non-vascular as well as vascular taxa.

#### *The system hierarchy*

The highest category in the system adopted here is the *division*. These are numbered from 0 through 9; general floristic works with a division-wide coverage are designated by the numbers 100, 200, etc., up to 900. The category below is the *region*. These are numbered from 01 through 99, according to the division into which they fall (00 being used notionally for worldwide floras, world synusial works (such as *Rheophytes of the world* by C. G. G. J. van Steenis, here under 006), and (under 001) certain major chorological works such as *The amphi-Atlantic plants* by E. Hultén). Some regions are grouped together into *superregions*, with separate principal headings; these are designated by hyphenated figures, such as 14–19, 42–45, or 91–93, indicative of the regions they encompass. Very large single regions comprising more than nine units (among them the northeastern U.S.A., Brazil, and eastern Europe) are designated by a stroke between two figures, such as 14/15, 35/36, or 68/69. Individual regional floras, enumerations, etc., are always given a three-digit number ending in a single zero, viz. 160, 220, 560, 830, or 990, except that floras of superregions, such as *Flora orientalis* or *Index florum sinensis*, are designated by ‘inclusive’ unit numbers such as 770–90, 910–30, etc.

The lowest category – the ‘species’ of the system – is the *unit*. These are designated by figures running from 001 through 999 (excluding those ending in a zero). Units as recognized here generally correspond to geographical areas such as states, countries of small or medium size, large provinces, or significant islands or island groups. It is for these that the bulk of ‘standard’ floras have been written. By contrast, *regions* comprise large countries (or natural groups of smaller countries

or states) or comparable areas of large size; while *divisions* consist of continents, parts of continents, giant aggregates of islands, or combinations of these. No category has been devised for the relatively small number of local or partial floras included in the *Guide*; they are set off from principal works by subheadings.

Examples of divisions are North America, Europe, or Greater Malesia and Oceania. The polar zones beyond the 'tree-lines' of north and south, together with some isolated oceanic islands, have been allocated to Division 0. Representative superregions include the West Indies, South Asia, Greater Malesia, and Australia (with Tasmania). Areas such as the southeastern United States, Argentina, South Central Africa, Madagascar, Western Australia, Central Europe, the British Isles, the Russian Far East, Southeast Asia, Papuasias, and the Hawaiian Islands constitute regions. At the unit level are areas such as Macquarie Island, St. Helena, Alberta (Canada), New York State (U.S.A.), Puerto Rico, Mato Grosso (Brazil), Buenos Aires Province (Argentina), South Australia, Mauritius, KwaZulu/Natal (South Africa), Nigeria, France, Finland, Ukraine, Sakha, Iraq, Uttar Pradesh (India), Nepal, Korea, Sichuan Province (China), Java, the Solomon Islands, and the Marquesas.

Physiographically, ecologically or synusially defined standard floras, or those covering broad but vague geographical areas, are classified according to the 'common auxiliaries' introduced under the previous subheading. The resulting three-digit numbers feature a *middle zero*, e.g., **201**, **703**. Examples of the areas covered are the Sonoran Desert, the Andes, the Afroalpine zone, and the Altai and Sayan Mountains. In general, this class comprises areas which are too awkward to fit into geopolitical regions, or which otherwise deserve special emphasis. As already noted, under these auxiliaries are included *all* appropriate works for a given division; thus, *Alpenflora* should not be sought for under a country or region, but under **x03** where **x** is any number from **0** through **9**.

The 10 primary divisions are all listed in the table of contents, but for ready reference are repeated below:

Division 0: World floras, isolated oceanic islands and polar regions

Division 1: North America (north of Mexico)

Division 2: Middle America

Division 3: South America

Division 4: Australasia and islands of the southwest Indian Ocean (Malagassia)<sup>80</sup>

Division 5: Africa

Division 6: Europe

Division 7: Northern, central and southwestern (extra-monsoonal) Asia

Division 8: Southern, eastern and southeastern (monsoonal) Asia

Division 9: Greater Malesia and Oceania

The full classification scheme for each division appears as a conspectus under the respective main heading. The spread and limits of the primary divisions are depicted in Map II.

### *Bibliographies and indices*

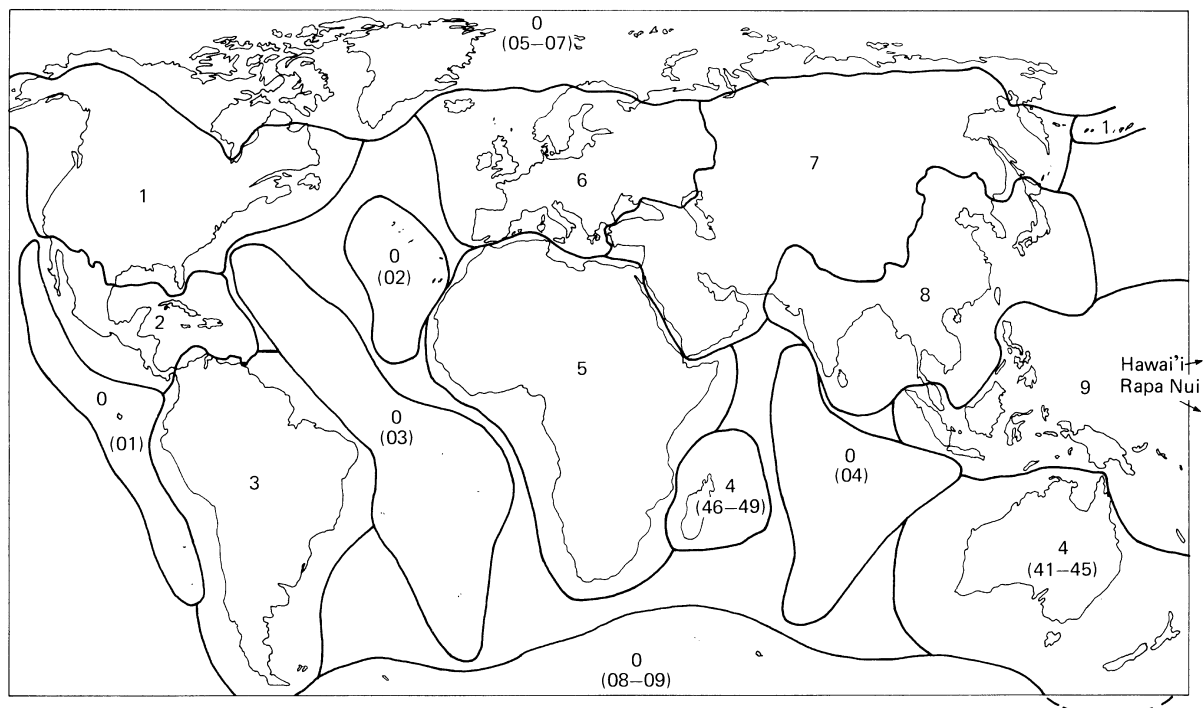
A special feature of this *Guide* is the systematic inclusion of references to more detailed local, regional, and general botanical and floristic bibliographies. Anyone seeking more detailed information on any given area will thus learn where to turn. These references are included under their appropriate headings. For general bibliographies (such as those of Blake and Atwood, Hultén, or Jackson) and indices (such as *Excerpta Botanica* or *Kew Record*), abbreviated references or mnemonic devices appear throughout the text at divisional and regional levels; full citations of these works are given in the **General bibliographies** and **General indices** lists located under **Conventions and abbreviations** at the beginning of Part II, the *Guide* proper.

Under the appropriate headings are also included references to reviews of the state of floristic knowledge for given major geographical entities; no attempt is made, however, at exhaustive coverage of such literature.

### *Limitations*

In order to make this *Guide* as compact and practical as possible, various limitations have been imposed. These are:

1. The *Guide* is limited to works covering **vascular plants**, either exclusively or as part of their total scope. Extension of coverage to non-vascular plants and fungi would have unduly increased the size of the work. There is, however, certainly scope for similar guides to these groups.
2. **Superseded** floras or enumerations are covered only in regional or unit introductions or, in some cases, as subsidiary titles. This is part of an attempt to place current listings in a historical perspective. Such works generally appear only in



**Map II.** The spread of Divisions 0–9 as used in this book. For explanation see text. (Antarctica has for technical reasons not been depicted.)

short-title form; fuller details may be had elsewhere, including the sources listed in Appendix A.

3. With but few exceptions, no literature dating from **before 1840** appears as primary entries. As discussed in Chapter 2, only from about this time did the format of descriptive floras begin consistently to be recognizably ‘modern’ (as exemplified by W. J. Hooker’s *Flora boreali-americana* (1829–40), *Flora brasiliensis* (begun in 1840), Torrey’s *Flora of the state of New-York* (1843), J. D. Hooker’s *Flora antarctica* (1843–47), and Grenier and Godron’s *Flore de France* (1848–56)). The year 1840 moreover marks, with rare exceptions, the demise in floras of the Linnaean system of classification.<sup>81</sup>
4. No purely **popular** works are included, nor does coverage extend to lexica and other works on vernacular names. To do so again would greatly increase the bulk of the *Guide*. In recent decades, however, the distinction between ‘scientific’ and ‘popular’ floras has become less clear. Exceptions have consequently had to be made, especially for

areas for which no good recent standard floras exist. The European Alps furnish a good example of a compromise.<sup>82</sup> In addition, many more or less popular works on trees (and woody plants in general) have also been included as explained under §5 below.

5. With regard to works dealing only with **trees** (or **woody plants**), coverage varies according to the importance of these life-forms in the total vascular flora. Speaking generally with respect to trees alone, within the largely Holarctic divisions 1, 6 and 7 only works which cover areas the size of regions or larger have been fully listed. Wherever the whole woody flora is accounted for, however, works covering smaller units are included. In addition, where the shrub flora is substantial (as, for example, in California), separate works on this synusia are also listed and described. Many works dealing with the woody flora (or the trees) in Europe and northern Asia also include a substantial number of introduced park and garden trees, reflecting a long interest in dendrology and landscape improvement. For

other parts of the world, particularly those lying within the humid tropics where tree floras are large, dendrological works, woody floras, semi-popular 'tree books' and the like have been selected on the same criteria as full floras and enumerations.

6. Works on **ferns** and **fern-allies** (i.e., the pteridophytes) have been selected in the same manner as works on the woody flora of given entities, with in general a later 'starting-point'. Sweeping changes to fern taxonomy and nomenclature have taken place since World War II.<sup>83</sup> Older fern floras are now to all intents and purposes obsolete and thus have largely been excluded unless no other coverage is available. Even those published from 1939 through the 1960s or still later are presently in need of considerable revision. In a number of instances, 'fern floras' of a given area have been cited where there is no corresponding standard work or works on the whole vascular flora.
7. Works on **applied botany**, i.e., regional treatises on economic, medicinal or poisonous plants and on weeds have generally been omitted. It is the author's belief that, important though many of these works are, they should not come within the scope of a basic guide to floras. Moreover, as with other classes of regional works referred to above, their inclusion would greatly increase the size of this work. There is, however, scope for a separate topical guide along similar lines to the present work.
8. With few exceptions, no works covering **single families** of seed plants are included. It should be noted, though, that for the Poaceae, Fabaceae and Orchidaceae (and for some other groups such as Cactaceae in the New World and Dipterocarpaceae in Malesia) a more or less extensive canon of regional works exists, which might merit the preparation of separate bibliographies.<sup>84</sup>

### Summary remarks

During the preparation of the original edition of this work, the author sometimes was asked to defend the preparation of a selective rather than a comprehensive treatment. In response to this question, two major points should be considered.

Firstly, it seems evident that as in all other fields

of botany the mass of taxonomic literature, including 'nominally useful' floras, has within the last six decades or so increased severalfold. At the same time, there has been fragmentation and change in the system of botanical information reporting, processing and indexing. Some of this surely relates to shifting interests in biology but there has also been increasing specialization and regionalization in floristic and taxonomic studies. More immediately, disruptions resulting from World War II (including the loss of the library of the Botanical Museum in Berlin, a leading source for documentation) and the already-mentioned discontinuance of the botany union subject catalogue of the U.S. National Agricultural Library have led to a gap of two decades in consolidated classified coverage of the field (except in those institutions where classified catalogues have been maintained). Save for *Excerpta Botanica*, sectio A (discontinued in 1998) and *Kew Record of Taxonomic Literature*, none of the indexing and abstracting journals relevant to systematic botany furnishes truly effective coverage. Regional monographic and periodical bibliographies remain for the most part only in print mode. Retrospective coverage on the scale necessary for a renewal of comprehensive coverage of floristic or revisionary literature would require substantial institutional support, financing and personnel, and could sensibly be realized at but few locations.<sup>85</sup> It was thus unfortunate – but perhaps understandable – that the appropriate authorities made no provision for completion of the *Geographical guide* after Blake's death.<sup>86</sup>

The second point, less obvious but perhaps more important, revolves around the *need* or *desire* for such a work, especially when measured against the mechanics involved. With increasing specialization and changing interests and methodologies, there is a necessity from time to time to review the *scope* and *style* of publications, including reference works, with regard to function and efficiency. This has been done for floras: in the 1960s and 1970s by Aymonin, Heywood, and the author,<sup>87</sup> in the 1980s by Heywood and by Morin *et al.*,<sup>88</sup> and in the 1990s by Jarvie and van Welzen, Palmer *et al.*, and Schmid.<sup>89</sup> Some of these writers, in particular Jarvie and van Welzen, believe that floristic works serve two or more functions; what is required are publications of differing scope rather than all-purpose works. Similarly, in bibliographical compilation and writing in the field of botany it has long been evident that functional differentiation is necessary.<sup>90</sup> Apart

from the sheer volume of literature to be assessed, much of the material that would perforce be included through simple extensions of the older general works is likely to be of relatively local or specialized interest. Thus, a single, comprehensive work covering floras of the world as conceived by Blake and Atwood – while perhaps still conceptually valid as a statement of knowledge – is very likely not now satisfactory or even desirable as a methodological, let alone practical, solution.<sup>91</sup>

Given these limiting factors, in the late 1960s there still seemed clearly to be a need for a convenient general-interest guide to floras in a single volume. Application of the ‘standard flora’ concept first suggested by Heywood and the development of relatively objective criteria for inclusion, along with the provision of pointers to more extensive source bibliographies and indices, allowed for the separation of the functions of comprehensiveness and general utility. This is not dissimilar to post-World War I directions in information handling as described by Malcès<sup>92</sup> and, in taxonomy, to the distinction between ‘general-purpose’ and ‘special-purpose’ classifications strongly advocated by Gilmour in the mid-twentieth century.<sup>93</sup> Such a distinction is also *a posteriori* a measure of the principle of parsimony<sup>94</sup> and moreover is broadly congruent with the bibliometric Bradford ‘law’ (actually an axiom) of ‘scatter’ and its inverse, Garfield’s ‘law’ of ‘concentration’.<sup>95</sup> Quantitative testing of patterns of usage in floristic literature by recognized procedures is a task which remains;<sup>96</sup> it is, however, likely that these will merely confirm the perceived pattern of usage and its broad conformity with the above-mentioned bibliometric ‘laws’, already demonstrated in many different contexts.<sup>97</sup>

The final result as originally presented had a number of advantages. With a more limited scope than the comprehensive treatment customarily considered as ideal in systematic botany, the use of ‘pointers’ to detailed sources, and with the formal listings supplemented by historical and other commentary related to the genesis of the standard works selected, it has been possible to fashion this *Guide* as a kind of analytico-synthetic systematic bibliography. It thus recalls the bibliographic styles of Linnaeus and von Haller in being more communicative than a purely ‘empirical’ work and thus more ‘open’ to the student and non-specialist – the ‘tyrones’ of Linnaeus’s *Bibliotheca botanica*. Rather than a mere list of books, perhaps the

*Guide* could serve a *codex diplomaticus* as advocated by F. A. Ebert in the first volume of his *Allgemeines bibliographisches Lexikon* (1821).<sup>98</sup> The value of critical selectivity has been well demonstrated in other fields, as, for example, in the studies of Leonard Webb and others on rain forest vegetation.<sup>99</sup> Where the means exist, quantitative procedures, including the use of information technology, can (and should) be used in support of the overall study, but never so mindlessly that they dominate the final form and thrust of the work.<sup>100</sup>

A similar philosophy has guided preparation of the present edition with additional features being increased attention to the historical setting of current literature as well as a somewhat deeper coverage of national and regional bibliographies and dendrological manuals. Many items accorded full entries in the 1984 edition have been superseded and are therefore treated as historical. The sheer increase over the last two decades in the number of current works meeting the original criteria has, however, brought about a considerable expansion of the work. In addition, the author has thought it necessary to expand somewhat on the history of floras in general; this now forms the subject of the next chapter.

## Notes

- 1 Both works are successors to a preliminary version (Frodin, 1964).
- 2 For a chronological sequence of major biological bibliographies, see table 17 in Simon, 1977, pp. 185–187. They are also listed alphabetically therein (pp. 12–23).
- 3 For Gesner, see Wellisch, 1984, and Heller, 1983 [originally publ. 1970], p. 171; for Aldrovandi, see Simon, 1977, pp. 28–30; for Bauhin, see Heller, 1983 [originally publ. 1970], p. 171. Simon makes reference to Aldrovandi’s contributions to bibliographical scholarship in general, and notes that his *Bibliothecarum thesaurus* of 1583 remains extant in the Bologna University Library.
- 4 Woodland, 1997; Judd *et al.*, 1999.
- 5 For Montalbani, see Heller, 1983 [originally publ. 1970], pp. 171–172, and Simon, 1977, p. 30. Simon suggests that Montalbani may well have drawn upon Aldrovandi’s work. Although the *Bibliotheca* was said by Linnaeus in his own *Bibliotheca botanica* to be very rare – he himself had not seen it – Ewan (1970) has recorded that the late seventeenth-century English priest, explorer and natural historian John Banister possessed a copy. Ewan

- further notes that it was subsequently acquired by the Virginian planter William Byrd II, whose library was before 1750 one of the two or three most important collections in North America.
- 6 For Scheuchzer, see Simon, 1977, pp. 30–35. Scheuchzer also prepared more detailed bio-bibliographies in botany and zoology; these were never published but remain in the Zürich Zentralbibliothek.
  - 7 Stearn, 1957.
  - 8 For commentaries, see Heller, 1983 [originally publ. 1970], pp. 146–204, and Simon, 1977, pp. 36–39.
  - 9 Cain, 1958; Stearn, 1959.
  - 10 Davis and Heywood, 1963, p. 18; Ghiselin, 1997.
  - 11 As already noted, Séguier included Montalbani's catalogue as an appendix to his main work.
  - 12 Simon, 1977, pp. 43–44.
  - 13 Besterman, 1965–66. The Banks Library was willed to the British Museum; it is now part of the British Library, London. The *Catalogus* was reissued in 1966 by Johnson (as *Sources of science* 22).
  - 14 Heller, 1983 [originally publ. 1970], p. 202; from F. J. Cole, *A history of comparative anatomy* (1944, London). The historian of botany E. Meyer would in 1849 call the whole work 'ein Muster bibliographischer Genauigkeit' (*Bot. Zeit.* (Berlin) 7: 290–292); Heller himself regarded it as stylistically and intellectually a great advance on Linnaeus's *Bibliotheca botanica*.
  - 15 The *Catalogus* as a whole is more fully described by Heller, 1983 [originally publ. 1970], pp. 201–202.
  - 16 Simon, 1977, pp. 44–45, 184, 186–187.
  - 17 Periodical literature to 1800 was covered in *Repertorium commentationum a societatis litterariis editarum* (1801–02, in 2 vols.) by J. D. Reuss, with botany in vol. 2. Its successor was the Royal Society *Catalogue of Scientific Papers* (1867–1925).
  - 18 Engelmann's *Bibliotheca historico-naturalis* was originally intended to comprise three volumes, with the second and third devoted respectively to botany and geology; these latter, however, were never published. Its two successors were exclusively zoological.
  - 19 For a modern commentary, see Stafleu, 1973. Pritzel, trained as a botanist, was librarian of the Prussian State Library, Berlin. Completion of the second edition had to be supervised by his associate K. F. W. Jessen (author of *Botanik der Gegenwart und Vorzeit* (1864), an important and culturally oriented history of botany) on account of Pritzel's debilitating illness and (in 1874) death.
  - 20 Jackson was for many years librarian of the Linnean Society of London. He was also managing editor of the original *Index Kewensis* (1893–95) and of its first supplement (1901–06).
  - 21 The *Catalogue* is more fully discussed under **General indices** in Appendix A. It was fortunate for Pritzel that, with the substantial growth of serial literature, this critical reference had come into being.
  - 22 Cf. Malclès, 1961. In today's scholarly world, monographs, especially by a single author, are comparatively rare.
  - 23 A successor to the *Thesaurus*, to cover the period from 1870 through 1899, was planned by J. Christiaan Bay, in the early twentieth century librarian of the John Crerar Library, Chicago, Ill., U.S.A. (now part of the University of Chicago Libraries). However, all that he published was a list of bibliographies (1909; see **General bibliographies** in Appendix A).
  - 24 Although largely derivative, Goodale's little bibliography was an early example of the life-long interest in public relations and popular education on the part of the creator of the Harvard Botanical Museum and its famous 'glass flowers' (Sutton, 1970, pp. 171–172; see also B. L. Robinson, 1926. *Biographical memoir: George Lincoln Goodale, 1839–1923*. Washington, D.C.: U.S. Government Printing Office. (Mem. Natl. Acad. Sci. 21(6).))
  - 25 The Lloyd Library was established in the late nineteenth century as a private foundation by the Lloyd family (including the mycologist C. G. Lloyd) in Cincinnati, Ohio, U.S.A. Its specialities have been in systematic botany, mycology and pharmacognosy. The authors of the bibliography were at the time respectively chief librarian and assistant (later chief) librarian.
  - 26 Some omissions were, however, unavoidable; as acknowledged by the compilers, its external sources were largely secondary. No special trips outside Cincinnati were essayed and much use had thus to be made of such works as the *Thesaurus* and Jackson's *Guide* as well as the available volumes of the catalogue of the library of the British Museum (Natural History), *Botanisches Centralblatt*, and the *Index to American Botanical Literature*.
  - 27 Simon, 1977, pp. 68ff.
  - 28 Blake was a botanist with the Crops Division of the Agricultural Research Service of the United States Department of Agriculture; Atwood, a librarian and bibliographer with the departmental library (now the National Agricultural Library). The latter had also been responsible for the library's botany subject union card catalogue, a prime source for the *Guide* until its discontinuance in 1952 (for description, see Atwood, 1911).
  - 29 Elbert L. Little, Jr., personal communication.
  - 30 Turrill, 1964.
  - 31 The archives for this work are presently housed in the World Conservation Monitoring Centre near Cambridge, England.
  - 32 Britton's list was arguably comparable to Linnaeus's *Bibliotheca botanica* in being part of an overall research

- programme. For the author this was the reform of North American taxonomy and floristics including the development of a nominalistic (but for a time influential) 'American' school of taxonomy at once more 'scientific' and less reliant on 'tradition'.
- 33 Wikström's work is the first purely bibliographic national literature survey. Other contemporary works were primarily historical or bio-bibliographic, including those of Sternberg for Bohemia (1817–18), Adamski for the Polish lands (1825), Haberle for the Hungarian lands (1830), and Trautvetter for the Russian Empire (1837).
- 34 Heywood, 1958, 1960; Lawalrée, 1960.
- 35 Hamann and Wagenitz, 1977.
- 36 Heywood (coord.), 1975.
- 37 Indeed, it is arguably one of the most important uses for the Web and its search engines.
- 38 Simon, 1977, pp. 82ff.
- 39 The Swedish Academy also published a zoological review (1826–42). The Berliner *Archiv* accounted for new botanical literature only through 1855, with geographical botany contributed by the noted plant geographer August Grisebach. In later years it became all but a 'house organ' of the Berlin Zoological Museum.
- 40 The *International Catalogue* is described more fully in Appendix A.
- 41 *Botanical Abstracts* was established as a direct response to the entry of the U.S.A. into World War I and the consequent disruption to *Botanisches Centralblatt*.
- 42 Such subject catalogues existed in St. Petersburg, Brussels, Geneva, Washington, and perhaps elsewhere. In zoology, however, some institutionalization of information handling took place with the formation in 1895 of the *Concilium bibliographicum* in Zürich (Simon, 1977, pp. 145–152). This body published author and classified cards as well as annual indices (*Bibliographia zoologica*) until the mid-1930s. There was, however, no comparable contemporary movement in botany. Classified bibliography – though not limited to the sciences – was also an objective of the *Institut International de Bibliographie* in Brussels. Organized in the same year as the *Concilium* and a participant in the ICSL, it moreover effectively introduced the Dewey Decimal Classification (DDC) to Europe and other parts of the world through its sponsorship of a derivative, the Universal Decimal Classification (UDC), first published in full in 1904–07.
- 43 The efforts of the U.S. bureau are recorded in contemporary annual reports of the Smithsonian Institution. Also effectively interrupted or altered were the activities of both the *Concilium bibliographicum* and the *Institut International de Bibliographie*. The latter was in 1924 reorganized as an international federation of documentation organizations (now known as *Fédération Internationale d'Information et de Documentation*) while the former, after a partial revival in the 1920s and 1930s, was liquidated in 1941. By this time, of course, *Biological Abstracts* was well established.
- 44 It was partly succeeded by *Bibliography of Agriculture* (Blake, 1961).
- 45 In the 1980s *Kew Record* would also absorb the *AETFEAT Index*.
- 46 The *Kew Record* database may be consulted within the Royal Botanic Gardens, Kew, and on-demand lists of titles generated. It has also been available through bibliographic search services. All queries, however, have hitherto been command-line based. In 1999–2000, though, a World Wide Web 'client' interface was developed and, after internal release, was made generally available to the public in September 2000 (at <http://www.rbgekew.org.uk/kr/KRHomeExt.html>).
- 47 Cf. Jäger, 1976 *et seq.*
- 48 For *Biological Abstracts* and ornithology, see R. Mengel in Buckman, 1966, pp. 121–130; for *Biological Abstracts*, *Current Contents* and systematic botany, see Delendick, 1990.
- 49 Garfield, 1979.
- 50 Available through the New York Botanical Garden website (<http://www.nybg.org/bsci/iabl.html>).
- 51 The project was mounted under the aegis of the Committee of the European Science Research Councils and financially supported by the European Science Foundation (European Science Foundation, 1978–81). The ESFEDS itself was described in some detail in Heywood and Derrick, 1984; a further summary appears in Heywood, 1989. The project itself ran for five years from November 1981. A successor initiative (currently known as 'Euro+Med PlantBase') received substantial support from the European Union in 1999 after a decade of discussion, meetings, and proposals to funding agencies beginning in 1988. A succinct summary appears in *Linnean Society Annual Report 1998*, pp. 17–18 (1999).
- 52 The capability of the computer hardware in use at the time was by current standards quite limited. A basic taxonomic database was, however, realized; it is maintained at Edinburgh and may be accessed through the World Wide Web (<http://www.rbge.org.uk/forms/fe/>).
- 53 Prance, 1977 (publ. 1978); Prance and Campbell, 1988; Campbell and Hammond, 1989.
- 54 Verdoorn, 1945.
- 55 Also of value is the already-mentioned *Plants in danger* (Davis *et al.*, 1986).
- 56 This category of botanical literature is difficult to survey and may be seen as one example of the inadequacy of parts of the present biological information system (cf. Wyatt, 1997). Fortunately, the area has to a considerable extent been covered by the periodic studies of plant

- geographical literature by Jäger, 1976 *et seq.*, in *Progress in Botany* – a review annual not, however, mentioned in Wyatt's book. The surveys of Davis *et al.*, 1986, and Campbell and Hammond, 1989, are also valuable.
- 57 For a good survey of this material, see Bridson and Forman, 1998.
  - 58 Examples include *Flora Malesiana* and *Flora of the Venezuelan Guayana*.
  - 59 Jonsell, 1979. Chapter 4 (pp. 91–111) in the UNESCO synthesis report *Tropical Forest Ecosystems* (1978, Paris) can serve as an example.
  - 60 Jäger, 1976 *et seq.*
  - 61 Jäger, 1976, p. 317.
  - 62 Barthlott, Lauer and Placke, 1996; this follows on from a first attempt by Malyshev, 1975.
  - 63 Heywood, 1957.
  - 64 Heywood, 1958, 1960.
  - 65 The high level of congruence between the selections in the original edition of the *Guide* and in *Plants in danger* (Davis *et al.*, 1986) seems to support this view.
  - 66 The French and German equivalents are, for example, respectively 'flore de base' and 'Standardflora'.
  - 67 Blake and Atwood, 1942, pp. 15–16; Blake, 1961, pp. 27–28.
  - 68 Sections in the Kew Herbarium responsible for collections were at that time reorganized on a systematic rather than a geographical basis as had been in place since the nineteenth century.
  - 69 An exception has been made for the district floras of India; these have consistently been included as until recent years there have been few state floras.
  - 70 Among those then (and still) in wide use were the purely enumerative geographical units within the QK (Botany) section of the Library of Congress (U.S.A.) Classification (1901 onwards) and the common or universal geographical auxiliaries in the Dewey Decimal Classification (DDC; 1876 onwards) and its derivative, the Universal Decimal Classification (UDC; 1895 onwards). Within natural history several schemes were available; those seen included, for floras, the broadly geographically arranged Lloyd Library scheme (Holden and Wycoff, 1911–14) and the alphabetical schemes of Blake and Atwood (1942) and Blake (1961) – also for floras – and Travis *et al.* (1962) for entomological literature.
  - 71 Cf. Vickery, 1975, pp. 46–47.
  - 72 I have not here attempted a fuller examination of the development of this aspect of bibliographic classification. A potential source is E. L. Schamurin, 1967. *Geschichte der bibliothekarisch-bibliographischen Klassifikation*, 1. Munich: Dokumentation.
  - 73 Gould, 1968–72.
  - 74 Hollis and Brummitt, 1992. This scheme evolved partly from work done by the International Legume Database and Information Service (ILDIS); see S. Hollis, 1990. *ILDIS type one data: geography*. Version 4. 35 pp. Southampton. A revision of the 1992 scheme is in preparation.
  - 75 The first two of the letters in each triplet embody the ISO-3166 country code.
  - 76 For a discussion of the concept of the 'literary warrant', see Kumar, 1979, pp. 266–267, 283.
  - 77 Relatively few changes have been made for the present edition. Among them are subdivision of the Arabian Peninsula (Region 78), the shift of the Baltic republics to Region 67 and of Slovenia to Region 64, and renumbering of some other units in Regions 63, 64 and 68/69.
  - 78 Among possible alternatives was a 'symmetrical' scheme proposed by Ranganathan (1957). Its basic principle became a partial basis for the common auxiliaries adopted here.
  - 79 The UDC standard consulted was British Standard (B.S.) 1000, 5th edn. (1961).
  - 80 'Malagassia' is here introduced as a portmanteau word for the islands and reefs of the southwest Indian Ocean. It is based on 'Malagasy', after the inhabitants of Madagascar, by far the largest island, and 'Thalassia', referring to their oceanic location.
  - 81 It was also expected that *Bibliographia Huntiana* would provide a detailed review of all pre-1840 botanical literature, inclusive of floristic works; however, as of writing the project has effectively been abandoned (Sylvia FitzGerald, personal communication, 1999). Photocopies of the master list of this project exist in some botanical libraries.
  - 82 For this important and well-studied physiographic unit no separate complete modern flora is available – a lacuna already noted in the 1950s by the Innsbruck botanist Helmut Gams (Gams, 1954). Various more or less popular works, notably *Unsere Alpenflora* by Elias Landolt (available in four languages), have perforce been included. A new general flora for the European Alps has, however, been projected.
  - 83 Pichi-Sermolli, 1973; Wagner, 1974.
  - 84 This is in fact being addressed in two ways: through independent family bibliographies or, since 1996, within the *World Checklists and Bibliographies* series of the Royal Botanic Gardens, Kew. Useful selections also appear in the Springer series *Families and genera of vascular plants*, edited by K. Kubitzki (1990–).
  - 85 Consideration was, however, being given by the Library of the Royal Botanic Gardens, Kew, to extension of coverage by *Kew Record* to pre-1971 literature (Sylvia FitzGerald, personal communication, 1998).
  - 86 Apart from the sheer length of time required – 20 years were required by Blake for vol. 2 – technological advances have been such that the need for such a work



- may be largely satisfied in other ways including simultaneous Web searches.
- 87 Aymonin, 1962; Heywood, 1973*a,b*; Frodin, 1976 (publ. 1977).
  - 88 Heywood, 1984; Morin *et al.*, 1989.
  - 89 Jarvie and van Welzen, 1994; Palmer, Wade and Neal, 1995; Schmid, 1997.
  - 90 Cf. Malclès, 1961.
  - 91 The standards of coverage adopted for the *Geographical guide*, while perhaps relatively satisfactory as an index of the status of knowledge in entities such as Europe, North America, and a scattering of others elsewhere where good floras are more or less numerous, may also on the other hand fail to reflect accurately actual standards of floristic knowledge over a great part of the earth's surface. In such areas, there may exist a considerable 'literature' but comparatively few substantial floras or checklists (as in much of Latin America, where until recently at least publication of floristic and taxonomic records has been very much more in journals than in books). Enumerative bibliography is now only a part of the wider field of information science, and the whole approach towards fields of knowledge – and the questions asked – have become more systemic. The already-mentioned proposal for retrospective extension of coverage by *Kew Record* represents, however, an important first step.
  - 92 Malclès, 1961, pp. 109–110.
  - 93 Gilmour, 1952.
  - 94 Ziman, 1968, p. 125.
  - 95 Bradford, 1953, pp. 144–159; Garfield, 1979, pp. 21–23. Garfield (1980) later likened it to a comet.
  - 96 cf. Leimkuhler, 1967; Bulick, 1978.
  - 97 Garfield, 1980. This law of 'scatter' is actually a manifestation of the Zipf distribution, of which another is J. C. Willis's 'law' of distribution of subordinate ranks. See Nalimov, 1985, pp. 13–14.
  - 98 Simon, 1977, p. 1.
  - 99 Webb *et al.*, 1970, 1976.
  - 100 An analytical bibliography may also be looked upon as a kind of scientific monograph or treatise, a vehicle for communication eloquently defended by Ziman (1968). Paradoxically, however, such works often are seen as not 'orthodox'. As a result, scholarly bibliographies, even of comparatively restricted scope (when compared with the major artisan-bibliographies of the eighteenth, nineteenth and early twentieth centuries), are now – as with major monographic studies in general – less often attempted (a notable recent exception being *Taxonomic Literature-2* and its supplements). This reflects present patterns of funding and management as well as widespread short-term thinking; but on a deeper plane may be related to a lessened interest in intellectual values. This work is nevertheless offered in the hope that some scope remains in the canons of science for serious monographs, bibliographies and similar treatises.

## 2



### The evolution of floras

As concerns the flowering plants we may say that we live again in an age of floras and floristic work. [It is part of] a cyclic development [with several phases].

Stafleu, *Syst. Zool.* 8: 66 (1959).

Seit der Mitte des Jahrhunderts hält eine Epoche des Florenschreibens an.

Jäger, *Prog. Bot. [Fortschr. Bot.]* 40: 413 (1978).

Floras should always be regarded only as a stage, although an important one, in understanding plants and contributing to botanical knowledge. . . . They can never be definitive: new facts and information are always coming to light.

Hedge, in *Contributions selectae ad floram et vegetationem Orientis* (eds. Engel *et al.*), p. 312 (1991).

#### Introduction and general considerations

The preparation and publication of floras and related works has been a constant feature of systematic botany since late in the sixteenth century. In that time, this activity in a formal sense has spread from central and western Europe to other parts of the world. In some cases, however – and particularly in eastern Asia – it absorbed, and was to an extent influenced by, autochthonous floristic traditions. At different times – and particularly in the twentieth century – floristic work has prevailed over other approaches to plant diversity. This trend, first noted in 1959 by Stafleu<sup>1</sup> and later by Thorne<sup>2</sup> and Gómez-Pompa,<sup>3</sup> was affirmed in an extensive review by Jäger in the late 1970s.<sup>4</sup> From the 1980s, floristics (and its products) have received renewed emphasis from conservation and biodiversity interests, and the scope, strengths and weaknesses of floras have been analyzed in symposia<sup>5</sup> and individual articles.<sup>6</sup>

The rapid development of computer technology and the recent spread of the Internet with its tools for information access and exchange are bringing, and will continue to bring, further change in the ways floristic information is presented; this will be further examined in Chapter 3. While critical remarks have already been heard,<sup>7</sup> it is nevertheless likely that geographically based taxonomy related to state, national and regional flora and checklist production will continue to predominate in systematics. Such floristic studies, along with research on medicinal plants, figure among the oldest classes of botanical literature; they will remain essential if not representative of more truly original study and thought.

This chapter is concerned with the general development of floras and floristic documentation over some four centuries or so, with some attention given to particular regions. It is an area of enquiry which until recent years attracted relatively little attention from historians of botany. A. G. Morton in his *History of*

*botanical science* (1981), writing primarily from the general-botanical point of view notably championed in the late nineteenth century by Julius von Sachs (depicted in the frontispiece of Morton's book), does not single it out;<sup>8</sup> neither did Sachs himself in his *Geschichte der Botanik von 16. Jahrhundert bis 1860* (1875) beyond ascribing (wrongly) the introduction of the term 'flora' to Linnaeus.<sup>9</sup> The diversity of aims, styles and content in floras – already recognized in the 1730s by Linnaeus<sup>10</sup> and, almost two and a half centuries later, by Brenan<sup>11</sup> – will be examined with an attempt to relate these to philosophical, methodological and historical movements in botany. Orthodox and alternative styles will alike be examined, with reference to both professional respectability and user experience.

### Floras in Europe and by Europeans before 1805

The floras of the sixteenth, seventeenth and eighteenth centuries – up to the appearance of the Candollean edition of *Flore française* in 1805 – fall into two relatively discernible periods: those published before the suite of methodological reforms introduced by Linnaeus in the 1730s and those of the mid- and later eighteenth century. These are considered in succession.

#### *Early writers*

The effective renewal in the Renaissance of botany as a field of enquiry began firstly with commentaries on Theophrastus, Dioscorides, Pliny and other classical writers; it then gradually extended its reach to encompass native plants, medicinal and otherwise.<sup>12</sup> To these were added the findings of voyages of exploration from the second half of the fifteenth century onwards and of survey commissions, notably in the Americas but also in the Far East. By 1536 Antonio Musa Brasavola (of Ferrara) noted in his *Examen omnium simplicium medicamentorum* that 'not a hundredth part of the herbs existing in the whole world was described by Dioscorides, not a hundredth part by Theophrastus or Pliny, but we add more every day and [thus] the art of medicine advances'. By the middle of the century there arose a serious appreciation of the diversity of plant life worldwide, a phenomenon reduced only by drought or by cold.

A first chair of *materia medica* including botany was established in Padua in the then-Venetian Republic in 1533. In 1534, Luca Ghini became reader in *materia*

*medica* at Bologna University and in 1538, professor; later he moved to Pisa in Tuscany. In this period and particularly in the 1540s Ghini revolutionized the study of plant diversity with his innovations of the herbarium for the preservation of plants and plant parts and, at both Pisa and Florence, the botanical garden for the cultivation and observation of living plants. It was in Central Europe, however, that a lasting tradition of encyclopedic plant documentation first became established, aided by the spread of plant portraiture based on the wood-cut.<sup>13</sup> The earliest such works are those of Otto Brunfels (*Herbarium vivae eicones*, 1530), Leonhart Fuchs (*De historia stirpium*, 1542) and Hieronymus Bock (Tragus) (*Historia stirpium*, 1552, with later editions to 1630). The works of these so-called 'German fathers of botany'<sup>14</sup> were followed by those of Rembertus Dodoens (*Historia stirpium*, 1554; 2nd edn., 1563, with reissues to 1644; French version by Carolus Clusius, 1557; English version (translated by H. Lyte), 1578, with reissues to 1619), Valerius Cordus (*Historia stirpium*, 1561), Petrus Matthioli (*Commentaria in VI. libros Dioscoridis*, 1554 and later editions, and especially *Compendium de plantis omnibus*, 1571), Lobelius (*Plantarum seu stirpium historia*, 1576, with revisions under other titles to 1655), and Jacob Tabernaemontanus (*Historia plantarum tomi tres*, 1588).<sup>15</sup>

These works were all arranged according to classifications based on gross form or simply by plant names; the main developments were in descriptions and iconography. A distinct philosophical movement arose in 1583 – two years before the Council of Trent – with publication of *De plantis libri XVI* by Andrea Caesalpino, a student of Ghini. The 1500 plants accounted for therein were arranged according to a system based directly on plant observation, particularly of fruits, and perceived relationships. With this work systematic botany could be said to have become separate from the study of *materia medica*. The question of plant relationships as an area of enquiry could be pursued for its own sake; indeed, already evident in Caesalpino's classification were groups corresponding to several now generally accepted families. By its nature, however, Caesalpino's work would have relatively little direct influence on the developing literature of regional floristics.

By the mid-sixteenth century, as already noted, it was accepted that there was a considerable diversity of plants around the world. It was also well understood

that plants were not uniformly distributed. Bock in particular in his *Historia stirpium* had already made note of this here and there – and likewise with respect to habitats and altitude. As Möbius has indicated, this marks a transition in emphasis from herbal to local flora.<sup>16</sup> At the same time, exploration of Europe and the rest of the world was continuing, and travel and survey reports including many references to animal and plant life were being published.

This rapid increase in information about the natural world and its ‘wonders’ not unnaturally stimulated interest in a total documentary approach. Notable exponents of this method were two polymaths, the Swiss Conrad Gesner and the Fleming Carolus Clusius (Charles de l’Écluse). Gesner focused on Central Europe, especially Switzerland; after his death his wider botanical interests were diffused mainly through his student Johannes Bauhin and, in turn, Bauhin’s younger brother Caspar.<sup>17</sup> By contrast, Clusius, forced out of the greater Netherlands by the struggle for independence from Spain, traveled extensively, firstly in that country and then in Pannonia (the Hungarian Basin). His reports of these travels, respectively published as *Rariorum aliquot stirpium per Hispanias observatarum historia* (1576) and *Rariorum aliquot stirpium per Pannoniam, Austriam et vicinas quasdam provincias observatarum historia* (1583), along with editions of the *Coloquios dos simples* by the Portuguese Garcia da Orta (a work on Indian and other medicinal plants), engendered an interest in ‘exotick’ botany. This would be translated into his subsequent career in the newly independent United Provinces, where he became professor of botany and head of the botanical garden at Leiden University (1593–1609). Clusius also contributed a digest of his work on Pannonia, *Nomenclator pannonicus* (1584) – the first known ‘checklist’ of a distant land.

It was the Bauhins who, along with Jacques Daléchamps at Lyon, were effectively the founders of world floristic documentation. Johannes Bauhin firstly contributed to Daléchamps’s *Historia generalis plantarum* (1586–87; reissues 1615, 1653) and then, with Johann Cherler, produced *Historia plantarum universalis* (1650–51, posthumously), covering 4000 plants. Not to be outdone and aware of the many errors in the *Historia generalis*, Caspar Bauhin firstly produced a preliminary checklist, ΦΥΤΟΠΙΝΑΞ (*Phytopinax*) seu *Enumeratio Plantarum* (1596) and then, late in life, published his most famous work, ΠΙΝΑΞ (*Pinax*) *theatri botanici* (1623; reissue 1671). Subdivided into 12

‘books’ corresponding to his ideas on primary classification, it covered some 6000 species and was based on collections, literature records and personal information. Its universality also set a new contemporary standard for botanical nomenclature. Truly the first ‘world list’, the *Pinax* was not unnaturally much used by Linnaeus, as his own annotated copy testifies.<sup>18</sup>

Conrad Gesner himself also had had a considerable influence on floristic botany through his work on the Alps; various observations on individual mountains were made and lists of plants compiled by him along with others.<sup>19</sup> He may thus well be considered the founder of ‘topographical botany’, a principal basis for the local flora tradition. One of Gesner’s students was Anton Schneeberger, later of the Jagiellonian University in Krakow; while there he published *Catalogus stirpium quarundum* (1557), an alphabetically arranged, annotated enumeration of 432 native and exotic plants intended for student use. This work may be considered a precursor to the earliest true local flora, which appeared in Germany in 1588. This was *Sylva harcynia* by Johannes Thal; covering the Harz Mountains, it featured localities, vernacular names, and scientific and economic commentary for some 600 plants. As would remain customary for another century or more, the plants were arranged alphabetically by their botanical names.<sup>20</sup>

With Thal’s work the basic conventions of local floras were established; from then on such works began to proliferate, particularly after 1600. The earliest are those of Johannes Wigand on Prussia, *De herbis in Borussia nascentibus* (1590), and Caspar Schwenckfeldt on Silesia, *Stirpium et fossilium Silesiae enumeratio* (1601), while the best is *Catalogus plantarum circa Cantabrigiam nascentium* (1660) by John Ray. Others particularly recommended by Linnaeus are those of Rupp on Jena (1718), Dillenius on Giessen (1719), and Vaillant on Paris (1723, 1727). Improvements to the arrangement of the plants, nomenclature, content and organization along with the provision (sometimes) of descriptions and keys gradually took place. Of particular note was the adoption of the Caesalpinio system by Christoph Knauth for his *Enumeratio plantarum circa Halem Saxonium* (1687); however, alphabetical, phenological or gross-morphological arrangements remained usual until the spread of the Linnaean system in the mid-eighteenth century, beginning with that author’s own *Flora lapponica* (1737).

During the seventeenth century, the geographi-

cal horizons of the local flora began to widen, particularly in those countries with something of a national consciousness. Not unnaturally, the idea of a national flora took root most quickly in the smaller polities. The first of these was *Flora danica* (1648) by Simon Pauli; this was followed by *Plantae in Borussia sponte nascentium* (1655) by Johannes Loeselius. In 1670 Ray extended his Cambridge flora to cover all England, as *Catalogus plantarum Angliae*; later, this was revised and expanded as *Synopsis methodica stirpium britannicarum* (1690). For some time this remained standard, undergoing revisions in 1696 and 1724 (the latter by Dillenius who had moved to Oxford). Dillenius's edition was regarded by Linnaeus as the best among a small number of good floras. In the Low Countries, the first were *Herbarius belgicus* (1670) by Petrus Nyland and *Catalogus plantarum indigenarum Hollandiae* (1683) by Jan Commelijn (a revision, also well thought of by Linnaeus, appeared in 1709). In France, *Prodromus botanici parisiensis* (1723) and its revision, *Botanicum parisiense* (1727), both by S. Vaillant, were influential, with the latter containing many observations. Few, if any, others of real scope would appear until the middle of the eighteenth century. The last major 'pre-Linnaean', though transitional, work was *Flora helvetica* by Albrecht von Haller (1742). While not following the Linnaean precepts of classification, it nevertheless called itself a 'flora' in the manner suggested by the rising Swedish master.<sup>21</sup>

The relative lack of good floristic works would leave some scope for Linnaeus and his students to fill gaps, as will be noted in the next section. Already in 1736 – but with more lasting effect in 1751 – he had commented unfavorably on Spain: 'dolendum est quod in locis Europae cultioribus, tanta existat nostro tempore barbaries botanices!' Yet already some catalogue-floras had been published for extra-European lands; among them were *Flora malabarica* (1696) by Jan Commelijn (based on *Hortus malabaricus* by van Rheede), *Catalogus plantarum insulae Jamaicae* (1696) by Hans Sloane, *Catalogus plantarum americanarum* (1703) by Charles Plumier (1703), and *Museum zeylanicum* (1717) by Paul Hermann. Many florulas were also published by James Petiver; these are collected in *Musei petiveriani cent. I–X* [1692–1703] and *Gazophylacii . . . decades X* (1702–09).

General compendia continued to appear subsequent to Bauhin's *Pinax*. Among these were 'Le petit Bauhin', *Histoire des plantes de l'Europe* (1670, with

many reissues and a revision by Gilibert in 1798 and again in 1806), *Historia plantarum universalis* by Robert Morison (1680–99, not completed), and Ray's magisterial *Historia plantarum* (1686–1704). The last-named was the ultimate solo pre-Linnaean descriptive world flora.<sup>22</sup>

#### *The Linnaean and post-Linnaean eras*

It is generally appreciated that by the 1730s the world of botany was in some disorder, ripe for new proposals in management of its information. In particular, the number of known plants was increasing to the point where the old Latin polynomial diagnostic nomenclature had become a hindrance; moreover, there was an increasing interest in new approaches to classification as the potential of additional plant parts became recognized. Into this milieu came the confident young Linnaeus, who within the space of a few years would furnish what we might today call a 'total package'. Set out in a variety of works including the original edition of his *Systema naturae* (1735), his strongly pragmatic scheme was for botany first expounded in *Fundamenta botanica* and *Bibliotheca botanica* (1736) and in *Critica botanica* (1737). These include clear expositions of the concepts of a flora and of 'florists', with an indication of possible aliases and synonyms as well as ideas about the form and contents of floras.<sup>23</sup>

Linnaeus's ideas were first realized in a practical fashion in his *Flora lapponica* (1737), the first proto-modern flora. Covering 534 species and arranged according to its author's system of classification, it included geographical distribution along with taxonomic notes.<sup>24</sup> Augustin-Pyramus de Candolle in 1813 credited Linnaeus with our present concept of a flora and *Flora lapponica* as being an excellent model,<sup>25</sup> while in 1905 E. L. Greene wrote of this work that it was 'the most classic and delightful' of Linnaeus's writings.<sup>26</sup> *Flora lapponica* was soon followed by the first (and so far only!) flora of Virginia in North America, *Flora virginica* (1739; 2nd edn., 1762) by Jacob Gronovius (with whom Linnaeus had been well acquainted in Leiden) and then by Haller's already-mentioned *Flora helvetica* (1742) and Gmelin's *Flora sibirica* (1747–69). Linnaeus's next flora was *Flora suecica* (1745; 2nd edn., 1755, with binomial nomenclature). Its two editions respectively covered 1140 and 1297 species inclusive of cryptogams, and incorporated diagnostic features, synonymy, vernacular names, and notes on habitat, distribution, uses and properties. A version in checklist form

appeared as *Chloris suecica*.<sup>27</sup> From these, Linnaeus – by 1753 having added species epithets to his other methodological reforms – turned his attention to the flora of other parts of Europe and the world in a series of theses, all except the first featuring binomials (their respondents in parentheses):

*Plantae rariores camtschatcenses* (Jonas P.

Halenius, 1750)

*Flora anglica* (Isaac O. Grufberg, 1754)

*Herbarium amboinense* (Olof Stickman, 1754)

*Flora palaestina* (Bengt J. Strand, 1756)

*Flora monspeliensis* (Theophil E. Nathhorst, 1756)

*Flora alpina* (Nicol N. Åmann, 1756)

*Prodromus florae danicae* (Georg T. Holm, 1757)

*Flora jamaicensis* (Carl G. Sandmark, 1759)

*Flora capensis* (Carl H. Wännmann, 1759)

*Flora belgica* (Christian F. Rosenthal, 1760)

*Plantae rariores africanae* (Jacob Printz, 1760)

*Necessitatum promovendae historiae naturalis in*

*Rossia (Flora sibirica)* (A. Karamyschew, 1766)

*Flora Akeröensis* (Carl J. Luut, 1769)

*Pandora et Flora Rybyensis* (Daniel H.

Söderberg, 1771)

*Plantae surinamenses* (Jacob Alm, 1774)

On his own account, Linnaeus had already ventured outside Europe with *Flora zeylanica* (1747),<sup>28</sup> and in 1758 he edited and published *Iter hispanicum* by his former student Pehr Löfving. The various editions of his *Genera plantarum* (beginning in 1737) set precedents for generic floras (a genre with yet few examples in spite of some strong advocacy in the past). Finally, his and later editions of *Species plantarum* are in effect world floras, while the later editions of *Systema naturae* and *Systema vegetabilium* are world enumerations.

The work of Linnaeus brought about nomenclatural and methodological changes which for the most part were relatively soon adopted, if in some quarters his classification system was not.<sup>29</sup> Most floras after the 1750s would adopt Linnaean binomial nomenclature along with his preferred format. Among the first by an author other than Linnaeus was *Flora carniolica* by J. A. Scopoli (1760), covering the major part of modern Slovenia; others quickly followed, among them those of Crantz in Austria (1762–67), Gunner in Norway (1766–72), and Gorter in the Netherlands (1767–77). Works adhering to earlier forms of nomenclature, such as *Flora gallo-provincialis* by Gérard (1761), soon were seen as old-fashioned, with any merits overshadowed.<sup>30</sup>

The spread of Linnaean methodology has been well documented by Stafleu;<sup>31</sup> it will suffice here to record that by the end of the eighteenth century much of Europe was covered by ‘modern’ floras. For other parts of the world, several ‘Linnaean’ floras and check-lists of varying quality had also been produced; leading authors included Nicolaas Burman, Johann Reinhold and Georg Forster, Pehr Forskål, Olof Swartz, and Carl Thunberg. A preliminary account of the flora of the Spanish viceroyalty of Peru, *Flora peruviana, et chilensis prodromus* by Hipolito Ruiz and José Pavón, appeared in 1794 as the first of the few contemporary fruits of the series of expeditions in the Americas initiated in the 1770s under the Spanish king Carlos III.

A need for economy as well as convenience had forced many floras to be relatively compact. Linnaeus himself from time to time faced paper shortages; moreover, he was concerned with making information affordable as well as widely available.<sup>32</sup> Elsewhere, however, liberal patronage – as well as prestige – led to the presentation of geographical and natural history reports of new or little-known lands in a generous, often lavishly illustrated fashion, beginning already in the Renaissance. Examples of such works prior to Linnaeus’s time – some of them already mentioned – include *Primera parte de la historia natural y general de las Indias* (1535) by Gonzalo Fernández de Oviedo, the two *Historiae* of Clusius (1576 and 1583) and his *Exoticorum libri decem* (1605),<sup>33</sup> *De plantis Aegypti liber* (1592) by the Venetian Prosper Alpinus,<sup>34</sup> *Historiae rerum naturalium Brasiliae libri* (1648) by Georg Marggraf, *Historiae naturalis et medicae Indiae orientalis libri sex* (1658) by Jacob Bondt, *A voyage to the islands Madera, Barbados, Nieves, S. Christophers and Jamaica* (1707–25) by Hans Sloane, *Amoenitatum exoticarum* (1712) by Engelbert Kaempfer, and *The natural history of Carolina, Florida and the Bahama Islands* (1730–47) by Mark Catesby. By the latter part of the seventeenth century, however, more methodical approaches to description and documentation of exotic natural history had emerged. The best-known works in this genre include *Hortus indicus malabaricus* (1678–93) by Hendrik van Rheede, *Herbarium amboinense* (1741–50; supplement, 1755) by Georg Rumpf, *Flora peruviana, et chilensis* by Hipolito Ruiz and José Pavón (1798–1802, not completed), and – methodologically closer to our own time – *Flora brasiliensis* (1840–1906), begun by Carl Philip von Martius and further considered below. Expedition reports would also continue to appear until

well into the twentieth century, some with significant florulas and, from around 1900, vegetatiological accounts.<sup>35</sup>

The European fashion for large-scale descriptive works of natural history was not limited to exotica. Increasing wealth, a growth in national consciousness, improved technology and more widespread connoisseurship, along with the Linnaean reforms and the growth of the encyclopedic tradition, led to the appearance after 1750 of similar large-scale illustrated floras in the old subcontinent. The examples set by Denis Diderot's *Encyclopédie* and its contemporaries also led to a development of an interest in phytography as a literary rather than purely documentary form (while still retaining the rational organization promoted by Linnaeus), while public sensibility was increased with the introduction of fine illustrations.

The first of the 'large' works was *Flora danica*, begun by Johann C. Oeder and published from 1762 through 1883; ultimately it featured 3240 plates of phanerogamic and non-phanerogamic plants and fungi from Denmark and other territories then under Danish rule.<sup>36</sup> *Flora danica* was followed by the similar *Flora austriaca* (1773–78) by Nicolas Jacquin (limited to plants not figured in *Flora danica*), *Flora rossica* by Peter S. Pallas (1784–88, not completed), *English botany* (1790–1814; supplements, 1829–66) by James Sowerby and James Edward Smith, *Flora batava* (1800–1940), begun by Jan Kops and running to 2240 plates, *Svensk Botanik* (1801–43) begun by Johan W. Palmstruch and C. W. Venus, *Plantes de la France* (1805–22) by Jean Henri Jaume de Saint-Hilaire, *Flora graeca* (1806–40) begun by John Sibthorp and J. E. Smith, and finally – late in the day, and fulfilling Oeder's wish for a major all-German flora – *Icones florum germanicae et helveticae* (1834–1914), begun by Ludwig Reichenbach.<sup>37</sup>

By the end of the eighteenth century, floristic documentation had settled into three forms: the large-scale descriptive flora, the smaller national or regional flora with synonymy, diagnoses and notes, and the enumeration or checklist. The smaller works, the vast majority essentially Linnaean in method and system, were in a later generation termed *diagnostic documentary enumerations*.<sup>38</sup> To these had recently been added a new form: the analytical, strictly dichotomous key, introduced by J. B. de Lamarck in his *Flore française* (1778; 2nd edn., 1783 or 1788). Lamarck, strongly critical of parts of the Linnaean methodology, saw floras as

tools for identification and not as documentary works in their own right, aimed largely towards the scholarly world. To him, the latter function was best addressed through such works as *Encyclopédie méthodique: Botanique*, begun by himself in 1783 and, after his move to zoology in 1793, continued until 1817 by Jean Louis Marie Poiret. This featured an alphabetical arrangement of entries including individual genera and species. This last work was equivalent to a 'world flora', and may be compared with Caspar Bauhin's unfinished *Theatri botanici*. It had the added merit of extensively documented sources, whether literature or specimens.

Lamarck's views on floras, as well as his analytical method, were expressed in the 'Discours préliminaire' of *Flore française*. The work was designed almost entirely as a handy means of plant identification and, although species were included under their respective genera (as in the works of Linnaeus), no families or other suprageneric categories were introduced.<sup>39</sup> While there were antecedents to analytical keys in, for example, Morison's *Plantarum umbelliferarum distributio nova* (1672) and Ray's *Historia piscium* (1686), Lamarck has to be credited with their application in a consistent fashion. At the same time he should be credited for his projection of floras into one of their lasting and still-relevant roles.<sup>40</sup>

The work of Lamarck, however, did not effectively question the Linnaean order, which continued to prevail – even in France<sup>41</sup> – until well into the nineteenth century and changes in sensibility within as well as without.<sup>42</sup> Antoine-Laurent de Jussieu made no attempt to popularize his revolutionary *Genera plantarum secundum ordines naturales disposita* (1789); indeed, no version in French appeared until 1824. Similarly, the development and exposition of Linnaeus's own ideas on 'natural' suprageneric groups by Paul Giseke in his *Praelectiones in ordines naturales plantarum* (1792) only slowly made themselves felt. With respect to world compendia, successive editions of Linnaeus's *Systema vegetabilium* retained their vogue, while the Berlin botanist Carl Willdenow went so far as to prepare a wholly revised edition of *Species plantarum* (1797–1805, not completed). The latter moreover improved on Linnaean practice through the provision of more complete descriptive phrases. Only Christiaan Persoon (better known to posterity as a mycologist) endeavored to bring a more cursive, though still concise, uniform and truly comparative, style to bear on plant description with his *Synopsis plantarum* (1805–06;

revised as *Species plantarum*, 1817–21). Though Linnaean in arrangement, in phytography it clearly reflects the influence of Lamarck and the *Encyclopédie*. A transition to a ‘natural’ system and a more definitive phytography were to be the next steps, part of the effective entry of empiricism into systematics.

### The emergence of ‘conventional’ floristic styles, 1805–70

#### The ‘Lamarckian’ phytographic style

The first half of the nineteenth century saw the evolution of the descriptive flora into more or less its present format. This development began in France after 1800 with the third edition of *Flore française* (1805–15, as *Flore française*) and would be expressed as principles in *Théorie élémentaire de la botanique* (1813; 2nd edn., 1819). Both works, as we shall see, were by the Genevan botanist Augustin-Pyramus de Candolle, then resident in France. Like the first, this third edition introduced radical changes which would make largely obsolete the Linnaean method in flora-writing and set in train the development of new ‘schools’. Both were part of the broader range of developments in French botany in the latter part of the eighteenth century during which much of Linnaean philosophy was rejected and modern systematics founded.<sup>43</sup>

Chief among the new precepts and methods as applied to floras was the concise paragraph-length descriptive ‘plant portrait’ with necessary supporting information including in particular distribution, properties and uses. Such a style of phytography had first been developed around 1782 by Lamarck for the botanical volumes of Panckoucke’s epochal *Encyclopédie méthodique* (1783–1808; supplement, 1810–17), the large-scale revision of Diderot’s *Encyclopédie* and a definitive work of the Revolutionary and Napoleonic eras.<sup>44</sup> Lamarck evidently devised it as an alternative not only to the diagnostic but telegraphic Linnaean style but also to the rambling ‘herbalist’ mode of documentation and writing of many pre-Linnaean authors which here and there was undergoing a revival.<sup>45</sup> The ‘Lamarckian’ style, maintained by Lamarck’s successor Poiret in the project after 1791, in time became very influential. Apart from *Flore française*, an important early application was by Aimé Bonpland and Carl S. Kunth in the botanical volumes of Humboldt and Bonpland’s Spanish-American expedition of 1799–1804, including the latter’s *Nova genera et species plantarum* (1815–25).

The excellence of this last work, along with de Candolle’s own writings, effectively further diffused the new style. Time, resources, and democratization here and there forced condensation of this ‘French style’ both in Europe and elsewhere. In other cases, however, generous financial and other support, project institutionalization, prestige, and a continuing sense of ‘elitism’ led to a sometimes substantial degree of stylistic expansion (or ‘inflation’), as will be seen in the next section. Nevertheless, even with the addition of many new classes of information and the appearance of all kinds of variations, the Lamarckian phytographic formula, a product of reasoned essentialism framed in a nominalist superstructure, has continued to the present time as the accepted standard for descriptive floras of all kinds from the concise to the elaborate.<sup>46</sup> Over nearly two centuries, few significant modifications have been incorporated. Among these have been increasingly extensive taxonomic and biological commentary, greater ecological and geographical detail, and – significantly – another of Lamarck’s innovations, the now-commonplace analytical keys for identification.

#### *Flore française and the Prodromus*

*Flore française* may be considered the first ‘modern’ descriptive flora. It was published under the nominal authorship of Lamarck and the Genevan botanist Augustin-Pyramus de Candolle. Lamarck, however, played no direct part in this work, having ceded botany to proponents of natural classification: de Jussieu, Poiret, Jaume de Saint-Hilaire (whose *Exposition des familles naturelles* also appeared in 1805) and René Desfontaines. Instead, the whole was, as already noted, written by de Candolle, then 32 years old. Added to Lamarck’s keys, retained from the earlier editions, were cursive plant descriptions with notes on distribution, habitat and special features similar in conception to those of Persoon’s *Synopsis*, if less concise. The work was so arranged that all the keys were in one volume, the descriptions in the others. Moreover, the work was also the first following a ‘natural’ arrangement – that of de Jussieu.<sup>47</sup>

The *Flore* was a ground-breaking work. It represented a melding of the flora as a medium for regional plant documentation, the plant name and a diagnostic phrase, the descriptive, methodological phytographic style, indication of distribution and habitat along with pertinent notes, keys for identification, application of a



natural system of classification, and the use of a vernacular language with vernacular names. It was at once scholarly and popularly oriented. By contrast, its synonymy was relatively limited and citation of specimens was omitted. These lacunae would draw some criticism from the academically inclined; however, they were (and are) the province of the more elaborate 'research' flora or of monographs and revisions, the latter a genre which would rapidly develop during the first half of the nineteenth century. A current work such as *Jepson's Flora of California* (1993) – covering a flora comparable in size to that of France – remains true to the principles of *Flore française*. What has increased is mainly the range and sophistication of data now considered apropos to a manual-flora; there have also been stylistic changes including the interleaving of keys and descriptions under generic and family headings, a mid-nineteenth century development indicative of a renewal of 'academic' influence.

With the success of *Flore française*, de Candolle began to look for new challenges. In the decade or so following, he conceived a wide-ranging reform of general and systematic botany, much as had Linnaeus 80 years before. This would be firstly expressed in the form of a textbook and then crowned by a new world flora written according to his concept of the natural system. The latter was undertaken in the seemingly firm belief that such a task could still be achieved largely single-handed (the world flora being then thought to encompass some 25000–30000 species). Seven years after *Flore française* he published the first edition of his *Théorie élémentaire de la botanique*; in 1818 came the first volume of *Regni vegetabilis systema naturae*, with a second in 1821.

Floras form the topic of sections 217–219 (pp. 269–274) of *Théorie élémentaire*. Section 217 comprises a general critique of contemporary works as well as the still-prevalent Linnaean canons influencing them. Section 218 contains guidelines for a 'good' flora, a summary of which follows:

- 1) An introductory account, inclusive of such topics as physical features and vegetation
- 2) A systematic arrangement, in the first instance by families according to a 'natural' system
- 3) Name and diagnosis [or 'specific phrase']
- 4) Essential synonymy
- 5) Vernacular names
- 6) A sufficient description

- 7) Local variability
- 8) Distribution with detail in inverse proportion to a plant's ubiquity, localities to be given only for the uncommon or rare; in mountainous areas the altitudinal range to be included. For small areas documentation to be relatively strict; larger areas to make use of 'authorities'
- 9) Notes on uses, medicinal values, etc.

Selected works are cited under each rubric. The final section cautions against omission of commonly cultivated plants. Disagreeing with purist opinion, de Candolle in particular indicated that not to account for the olive in Provence, or the 'trèfle' in the Palatinate, would be quite wrong. All that was needed was clearly to indicate their status. A flora so enhanced would be of far more value to land economy and other fields.<sup>48</sup>

These nine principles reflect the author's experience with *Flore française*, and not unnaturally they would also guide *Regni vegetabilis systema naturae*. The definitive approach taken in the latter, however, called for additional synonymy and documentation. It was this greater detail which, after two volumes, caused de Candolle to realize that to continue in that vein would require 80–100 years more. He then initiated a more concise work in the manner of Persoon's *Synopsis: Prodrum systematis naturalis regni vegetabilis*. Despite inevitable limitations, the *Prodrum* (1824–73) became the definitive work of the first two-thirds of the nineteenth century: 'le régulateur de la botanique descriptive'.<sup>49</sup> As such, it will always remain a standard research reference. For many plant groups, ground was often seriously broken for the first time – and too often never since in such a fashion.<sup>50</sup> By the time of its termination following completion of the dicotyledons it encompassed 5134 genera and 58975 species. The latter figure amounted to *twice* what had been estimated for the *whole plant kingdom* in the early 1820s and more than *ten times* what Linnaeus had accounted for in the second edition of his *Species plantarum* (1762–63). From a solo undertaking when begun it gradually developed – notably under de Candolle's son Alphonse, editor from 1841 – into a collaborative enterprise, with ultimately 33 contributors. It also – perhaps inevitably – became more like the original *Regni vegetabilis systema naturae*, with longer descriptions and more details.

As the nineteenth century progressed, stylistic refinements to the elder de Candolle's principles of flora-writing were put into place by both de Candolles

as well as by their contemporaries William J. Hooker, George Bentham, Joseph D. Hooker, and others. Rooted in empiricism as well as faith, these principles were succinctly summarized by Alphonse de Candolle<sup>51</sup> and, for the English-speaking world, by George Bentham.<sup>52</sup> They have remained more or less current to the present. Until relatively recently they were rarely seriously questioned, not only in absolute terms but possibly also because of increasing conservatism in the profession.<sup>53</sup>

Arguments have since been made from time to time for other forms of presentation, but apart from the manual-key (itself derived from Lamarck's *Flore française*) few found wide acceptance. The professional 'standard of excellence' has thus by general consent been the critical descriptive or 'phytographic' flora with the species as the main working unit: essentially the form so eloquently re-advocated in the 1950s by van Steenis.<sup>54</sup>

#### 'Encyclopedic' floras and Central Europe

The above-mentioned ideas of Lamarck and de Candolle on the writing of floras would in time find wide acceptance, displacing most of the Linnaean methodology and style. However, there remained during much of the nineteenth century a belief that a descriptive flora, particularly of a new 'exotic' area, should continue to act as a detailed compendium and repository of information about its plants – in short, a specialized encyclopedia. Like the growing genre of critical monographs and revisions of 'natural' families and lesser taxa, the sometimes submonographic accounts presented in such works had to contain detailed descriptions, synonymy, specimen citations, extensive notes, and (often) illustrations in large plates. Tradition called for publication in a sumptuous format in the manner of the 'scientific results' of most contemporary voyages and expeditions.<sup>55</sup>

This concept of a flora seems to have taken hold most strongly in the Central European intellectual sphere, and cannot fail to have been influenced by the Germanic predilection for detail rather than conciseness. This trait could be viewed as having descended directly from the herbals and other botanical compilations of preceding centuries, the very works against whose frequent verbosity and mindlessness Lamarck so strongly reacted. For many writers, the Linnaean sexual system had simply furnished a new and improved framework for the preparation of general

compendia of the plant kingdom which seemingly enjoyed a continuing popularity.<sup>56</sup>

It thus comes as little surprise that, with exceptions, the Linnaean system of classification, along with much of its methodology, persisted as dogma longer in the German Confederation than elsewhere. This reflected the strengths of scholastic traditions and, in universities, the authoritarian professorial system. The marked differences which existed between Central European and French botany in the early nineteenth century are exemplified in the philosophy and styles of the respective treatments of Humboldt and Bonpland plants by Kunth for *Nova genera et species plantarum* – already mentioned – and by Roemer and Schultes for their version of Linnaeus's *Systema vegetabilium*.<sup>57</sup> The first major systematic work in Central Europe professing a 'natural' system was *Ordines naturales plantarum* (1830) by Friedrich G. Bartling in Göttingen – more than a generation after Giseke's proposals – yet use of the Linnaean system persisted here and there for another decade or more.<sup>58</sup> With the rise of the 'new botany' over the next generation or so taxonomy would come under attack for its seeming mindlessness – particularly from the influential physiologist Julius von Sachs.<sup>59</sup>

Following *Nova genera et species plantarum*, a number of large-scale semi-monographic descriptive floras written on the French model and following 'natural' systems were commenced. In format they approximated to their sumptuous Linnaean-era predecessors including *Flora peruviana, et chilensis*. Among them were Blume and Fischer's *Flora Javæ* (1828–51), Webb and Berthelot's *Phytographia canariensis* (1836–50), Moris's *Flora sardoa* (1837–59, not completed), Torrey's *Flora of the state of New-York* (1843), and, notably, the Reichenbachs' *Icones florae germanicae* (1834–1914). These were, however, outdone by the regally sponsored and, symbolically, king-sized *Flora brasiliensis* (1840–1906) begun by the Bavarian botanist and Amazonian explorer Carl Philip von Martius. At the same time it was the first comprehensive, wide-area 'tropical' flora given the sheer size of the country covered and its geographical position. Contemporary reviews greeted the first fascicles of this work as a major step forward in floristic phytography, and it soon became widely influential as the best Central European systematic work of the period.<sup>60</sup>

This greatest of comprehensive nineteenth-century floras was to drag its detailed pages slowly on for what would ultimately be 66 years. Together with

the de Candolles' *Prodromus* and (after 1870) *Monographiae phanerogamarum* it was long a prominent influence in contemporary European phytography. Like those undertakings it was a collaborative work – an approach now standard for most flora projects. Martius's project, however, featured – as would *Flora Europaea* a century later – an organization comprising general and managing editors, professional co-workers or flora-writers (*Privatassistenten*), and ultimately a total of 65 specialist contributors. Nearly all the leading botanists of the day were in one way or another involved, so fostering development of the spirit of international collaboration ever since characteristic of most of systematic botany. Through it – as well as other works – the Central European predilection for large compendia was shifted into new and fruitful channels, with in later decades lasting results – notably under Adolf Engler, a *Privatassistent* in Munich to the second general editor, August Eichler, and later ordinary professor successively in Kiel and Breslau (Wrocław) and (from 1889) Eichler's successor in Berlin (in the last-named with the notable support of Ignatz Urban, the *Flora*'s third and last general editor).

*Flora brasiliensis* thus established the tradition – still with us – of large-scale, multi-volume, descriptive regional floras, although these are now, like the British colonial floras, usually published in octavo format. They came to be seen as suitable vehicles for submonographic studies (often by students in their sponsoring institute or institutes). Most remain more or less encyclopedic, and as well retain an aura of prestige: a form of institutional 'cachet'. For many botanists, they represent the ideal in floristic phytography, particularly for areas not intensively well known. Their merits and inadequacies are further discussed in Chapter 3.

*The concise, critical descriptive flora: British and other examples*

While large-scale works such as *Flora brasiliensis*, *Phytographia canariensis* and *Flora sardoa* were (and are) representative of one phytographic ideal, they were – as Linnaeus had already complained in 1753 – necessarily costly and relatively limited in their distribution.<sup>61</sup> The powers of the conservative 'Holy Alliance' may have been victorious in 1815, but the next decades would see the effective rise of a middle class in much of Europe, the propagation of more liberal social and political ideas, and the progress of real or imagined nationalism.<sup>62</sup>

The impact of the 'Scottish Enlightenment' and a fashion for utilitarianism meant that the ideas on conciseness in floras and cursive descriptions with supporting data espoused by Lamarck, Persoon and Augustin-Pyramus de Candolle relatively early found favor among some British botanists, in spite of the continued strength of Linnaean traditions. Much of the credit for propagating these ideas should go to William J. Hooker, author of *Flora scotica* (1821) and until 1841 professor of botany at Glasgow University, George A. Walker-Arnott, a later incumbent of that chair and author (with Robert Wight) of *Prodromus florum peninsulae Indiae orientalis* (1834), and Robert Brown, a Scot who, after his Australian explorations, was resident in London as Joseph Banks's last librarian/assistant, botanist to the British Museum, discoverer of the biological nucleus, and author of the first Australian flora, *Prodromus florum Novae Hollandiae* (1810, not completed).<sup>63</sup> Further refinements and a more formal expression of the 'utilitarian' philosophy were the work of George Bentham and Hooker's son, Joseph D. Hooker.<sup>64</sup>

Following *Flora scotica*, the elder Hooker first employed 'concise' stylistic principles in an overseas flora, *Flora boreali-americana* (1829–40). Yet, while contemporaneous with the early editions of his *British Flora* (an octavo work first published in 1830), in its quarto format the North American work remained faithful to the tradition of 'prestige' overseas floras like Kunth's already-mentioned *Nova genera et species plantarum*. Similarly in quarto were three major expedition reports, two of them collections of floras: the *Botany of the Antarctic Voyage of H.M. Discovery Ships Erebus and Terror* (1843–59) by the younger Hooker (with colored illustrations by that great mid-century botanical artist Walter H. Fitch), *Botany of the voyage of H.M.S. Sulphur* (1844) by Bentham, and *Botany of the voyage of H.M.S. Herald* (1852–57) by Berthold Seemann.<sup>65</sup> By the late 1850s, however, the senior Hooker was to argue that the proposed colonial floras – discussed below – should be in octavo, 'botany [not being] what it once was, a science confined to the learned, and of little or no benefit to the people at large'.<sup>66</sup> Precedents had been set by the already-mentioned *Prodromus florum peninsulae Indiae orientalis* and by the first volume of J. D. Hooker and Thomas Thomson's *Flora indica* (1855), both of them in an octavo format. The latter was, however, aborted due to other commitments of the authors and finally by the

dissolution of the East India Company. Its style also proved too detailed for expeditious completion; its successor, *Flora of British India*, would be more concise.<sup>67</sup>

As the mid-nineteenth century progressed, some differences of opinion were expressed concerning the use of analytical keys in floras. With experience of those in *Flore française* while living in France as a young man (1817–26), Bentham, who termed them ‘indexes’, naturally was an advocate.<sup>68</sup> He introduced them into his *Handbook of the British Flora* (1858 and subsequent editions), and with this and his later colonial floras may be credited with their effective integration into floras, now a standard practice and used in place of the contrasting synoptic statements characteristic of the *Prodromus* and many other contemporary works. By contrast, the Hookers continued to use such synoptic statements, both in the *British Flora* of the elder (through the 8th and last edition in 1860) and by the younger in his *Student’s Flora of the British Islands* (1870; 3rd edn., 1884). The latter evidently believed that such keys made things too easy: students might well pay insufficient attention to diagnoses and descriptions.<sup>69</sup> Instead, in his *Student’s Flora* he gave particular emphasis to geographical distribution and habitat.<sup>70</sup>

The relative popular success of the above-mentioned British floras and an unquestioned, characteristically Victorian confidence in their governing precepts caused them to be adopted as standards for the growing British Empire by the elder Hooker – by now director of Kew – upon the commencement of his colonial floras scheme.<sup>71</sup> Conceived in 1857 and launched three years later, it has continued – with modifications – to the present as part of the work of the Kew Herbarium.<sup>72</sup> Indeed, J. D. Hooker was to write in the preface to his *Flora of British India* in 1872 that in style and phraseology he was specifically following ‘my *Flora of the British Islands*’. Like his father’s *British Flora*, the latter work was originally written with a view to the requirements of the Scottish universities; with characteristic singlemindedness, however, the younger Hooker believed it a suitable model for a much longer work for a very different part of the world. Bentham’s experience with his own *Handbook* doubtless similarly influenced his two major contributions to the imperial botanical survey: *Flora hongkongensis* (1861) and *Flora australiensis* (1863–78) as well as his *Outlines of Botany*, further considered below.

So influential were these colonial floras and such

was the spirit of the era within which most of them were published that not until the first Imperial Botanical Conference of 1924 did the approach and style represented by these works begin to be questioned.<sup>73</sup> Stronger criticisms would appear in the 1930s;<sup>74</sup> these will be further discussed in Chapter 3.

Outside Britain, the concise styles of the *Prodromus* and the British floras were adopted by Karl F. Ledebour for his *Flora altaica* (1821–34) and *Flora rossica* (1842–53), Charles Grenier and D. A. Godron in their *Flore de France* (1848–56), F. A. W. Miquel in his *Flora indiae batavae* (1855–59) covering the then-Dutch East Indies and neighboring lands, Moritz Wilkomm and Johan Lange in their *Prodromus florum hispanicae* (1861–80; supplement, 1893), and Edmond Boissier in his *Flora orientalis* (1867–88).<sup>75</sup> Analytical keys are, however, absent or were but partially employed in these works; as in the *Prodromus* and the Hookerian manuals, separation in larger groups was achieved through synoptic devices, necessitating close reading of descriptions to achieve identification. Even then, without authentically named specimens one could not always be certain, especially if, as was very often the case, the flora was imperfectly known.<sup>76</sup>

In North America, floras and identification manuals first appeared in any numbers only after 1810. A democratic tradition and relatively limited means in the United States surely contributed towards the relative utilitarianism and conciseness of most early work, including Amos Eaton’s *Manual of botany for the northern states* (1817; 8th edn., 1840), Thomas Nuttall’s *Genera of North American plants* (1818), and John Torrey’s *Compendium of the flora of the northern and middle states* (1826, not completed) as well as floras of lesser areas such as Jacob Bigelow’s *Florula bostoniensis* (1814; 2nd edn., 1824; 3rd edn., 1840), Stephen Elliott’s *A sketch of the botany of South Carolina and Georgia* (1816–24), Constantin Rafinesque’s *Flora ludoviciana* (1817), and William Darlington’s *Flora cestricea* (1826; 2nd edn., 1837). The publication of *Flora boreali-americana* as well as the advent of state surveys in the 1830s furnished new opportunities and challenges. Torrey with Asa Gray commenced a continental flora on the natural system, *Flora of North America* (1838–43, not completed), while the well-financed New York survey provided Torrey with the opportunity to write his already-mentioned large-scale *Flora of the state of New-York* (1843). The needs of teaching at Harvard, as well as competition from an entrepreneur,

Alphonso Wood (author of *Class-book of botany*, first published in 1845), then turned Gray towards a concise regional work, his *Manual of botany of the northern United States* (1848). The works of Torrey and Gray by and large established the manual-flora format characteristic of state and regional works in North America; with variations, this has remained standard. Large-scale semi-monographic works remained few until the twentieth century.

The principles of the concise flora have scarcely been put better than in Bentham's *Outlines of Botany*. They first appeared in 1861 in that author's *Flora hongkongensis* (as pp. i–xxxvi) and would do so again in nearly all of the other 'Kew floras' as well as some other contemporary anglophone works.<sup>77</sup> They are embodied in the first five of the 247 aphorisms of the *Outlines*. The first three of these are particularly apropos and I repeat them here:

- 1) The principal object of a Flora of a country, is to afford the means of determining (i.e. ascertaining the name of) any plant growing in it, whether for the purpose of ulterior study or of intellectual exercise.
- 2) With this view, a Flora consists of descriptions of all the wild or native plants contained in the country in question, so drawn up and arranged that the student may identify with the corresponding description any individual specimen which he may so gather.
- 3) These descriptions should be clear, concise, accurate, and characteristic, so as that each one should be readily adapted to the plant it relates to, and to no other one; they should be as nearly as possible arranged under natural divisions, so as to facilitate the comparison of each plant with those nearest allied to it; and they should be accompanied by an artificial key or index, by means of which the student may be guided step by step in the observation of such peculiarities or characters in his plant, as may lead him, with the least delay, to the individual description belonging to it.

The second part of the fifth aphorism is also of some interest and is likewise quoted:

The botanist's endeavours should always be, on the one hand, to make as near an approach to precision as circumstances will allow, and, on the

other hand, to avoid that prolixity of detail and overloading with technical terms which tends rather to confusion than clearness. In this he will be more or less successful. The aptness of a botanical description, like the beauty of a work of imagination, will always vary with the style and genius of the author.

#### *Analytical keys and the 'manual-key' flora*

The cleavage in the function of systematic works – especially floras – effectively espoused by Lamarck before 1793<sup>78</sup> gradually found practical expression outside France, though rarely in anglophone circles – very likely on account of, as we have seen, Bentham's effective integration in his manuals of analytical keys with concise floristic text.<sup>79</sup> As the century progressed, the pure analytical key was, however, modified to provide some of the elements of descriptive floras. Ultimate leads (those ending in a given taxon) were furnished with diagnoses, essential synonymy, and very concise (often coded) indication of distribution, habitat and other classes of information along with vernacular and accepted botanical names. The resulting form, which I am here calling a 'manual-key', thus – as Lamarck would have wished – came largely to supplement or complement larger descriptive works. These latter continued to be viewed as belonging to the herbarium, library or salon and, as we have seen, were ideally of a more or less encyclopedic (and sometimes 'prestigious') character. In this manner, for example, in Denmark the manuals and field-guides firstly of Johan Lange (*Haandbog i den Danske flora*, 1851; 4th edn., 1886–88) and later of Rostrup and Raunkjær came to complement *Flora danica*,<sup>80</sup> while in Central Europe Wilhelm Koch's *Synopsis florum germanicae et helveticae* (1837, with further editions to 1903) similarly complemented the Reichenbachs' *Icones*.<sup>81</sup> The real spread of the 'manual-key' in Europe came, however, only after 1870 as travel greatly increased, secondary school education became much more widespread, and recreational field-botany gained popularity. In 1878 the method made its first substantial appearance in Australia in Spicer's *Handbook of the plants of Tasmania*; von Mueller's larger but still compact *Key to the system of Victorian plants* followed a decade later.<sup>82</sup>

#### *Enumerations and checklists*

In spite of the new approaches to flora-writing espoused from early in the nineteenth century,

economic forms of presenting systematic information, dating back to Bauhin's *Pinax* and exemplified by the many editions of Linnaeus's *Systema naturae* and its successor, *Systema vegetabilium*, yet continued to find favor. These included Carl Kunth himself who wrote two major lists, *Synopsis plantarum quas in itinere ad plagam aequinoctialem orbis novi Alexander de Humboldt et Amatus Bonpland* (1822–23) and the ambitious *Enumeratio plantarum omnium hucus cognitarum* (1833–50, not completed). His contemporary Carl Blume began a similar work for Java, also not completed: *Enumeratio plantarum Javae* (1827–28). These had followed such eighteenth-century works as the already-mentioned *Flora malabarica* by Caspar Commelijn, *Enumeratio systematica plantarum* (1760) by Nicholas Jacquin (a preliminary list of the West Indian flora), and J. R. Forster's *Florae americanae septentrionalis* (1771). In such works, only essential information of greater or lesser brevity is provided, and descriptions and (for the most part) keys are lacking. They were prepared with an eye towards rapid and convenient publication of results, but at first they were regarded as summaries of, or precursors to, larger descriptive undertakings. Gradually, however, the synopsis or enumeration (and its even more telegraphic relative, the checklist – a genre in existence since the sixteenth century) developed into an independent area of floristic writing.

Although the greater part of the self-contained floristic enumerations – which from the mid-nineteenth century onwards appeared in considerably increased numbers – were for local or insular areas of relatively limited extent, a number were written for whole countries, groups of countries, or even subcontinents. Many earlier enumerations and checklists were more or less uncritical compilations and contained numerous errors, a problem of which even before 1600 Caspar Bauhin was well aware. Those based wholly or largely upon personal research by the author were not unnaturally more reliable. An important step forward towards respectability for the floristic enumeration in the mid-nineteenth century was Thwaites's *Enumeratio plantarum Zeylaniae* (1858–64). Its major development as a form, however, took place after 1870 as the great floristic richness of, for example, China as well as many tropical areas came to be realized.

While enumerations (and checklists) have been sharply criticized by some writers, such works, particularly if an attempt has been made at critical evaluation of taxa, should be regarded as better than no consoli-

dated work at all. In many instances they represent the only serious work for botanically poorly known areas, especially in the tropics, and more than once have fared, or may well fare, better than semi-monographic floras. Even in extra-tropical areas use has sometimes been made of checklists where floras are large, as in Natal and Western Australia. Their authors and/or editors have often lacked the means and/or the time to prepare full descriptive works but believed some kind of consolidated publication, even if imperfect, to be necessary.<sup>83</sup>

### The 'imperial' era and its aftermath, 1870–1930

By the time of the Franco-Prussian War in 1870–71 and the coeval foundation of the Second German Empire, the main genres of floristic writing had by and large assumed the forms which would remain standard for the next 100 or more years. While floristic works became more sophisticated through critical research and inclusion of new classes of information, they also grew intrinsically more 'remote' from wider audiences – in spite of the general substitution of modern languages for Latin in the majority of works. This probably reflects the relative stasis which had come over the practice of taxonomy from the latter part of the nineteenth century and the concomitant growth of interest in 'general' or 'causal' botany.<sup>84</sup> More particularly, the period after 1880 – and even more so after 1900, with the rise of genetics and ecology – was characterized by an evident lessening of interest in the production of major descriptive floras (save in certain circles in North America, western Europe, and the Russian Empire) as many key projects of the mid-nineteenth century were completed or became far advanced.<sup>85</sup> This trend was, however, offset by a rise in the publication of state and regional floras in increasingly better-known areas, among them parts of North America,<sup>86</sup> European Russia and adjacent areas, South Asia,<sup>87</sup> the Japanese Empire, southern Africa, and Australia where strong demand of one or another kind prevailed. The era also saw the production of the first tropical forest floras, beginning in the British Indian domains but by the first half of the twentieth century also in Malesia and Africa.<sup>88</sup>

### Centers of influence: Kew and Berlin

Fortunately for posterity, the period 1870–1930 may be viewed as one of outstanding progress in

synthetic systematics. In no small measure credit for this should go to contemporary patterns of geographical, economic and political development, particularly before World War I. This in turn gave rise in some countries to the emergence of large, mainly state-supported taxonomic centers with half a dozen or more specialist staff. The most important of these before 1900 were the Royal Botanic Gardens, Kew, and the Botanischer Garten und Botanisches Museum, Berlin. Several more such centers attained variously comparable positions of strength in the following two to three decades, mainly in Europe and North America; for most, either Berlin or Kew or both were models. Each of these institutions was active in both flora preparation and monographic studies; many were also concerned with 'lower plants' as well as 'economic botany'. A major impetus for the development of these centers was the need for effective knowledge of the flora of recently acquired or opened territories.<sup>89</sup> Strong personalities or social and cultural factors also played a role.

In the last third of the nineteenth century Kew was perhaps the most influential center. This was in no small measure due to the several colonial floras published or in preparation along with *Genera plantarum*, completed in 1883, and two major enumerations: one comprising the botanical part of *Biologia centrali-americana*, the other, *Index florae sinensis*. Yet Kew's taxonomic work overall was more practical than theoretical,<sup>90</sup> moreover, by the end of the nineteenth century decentralization and local scientific development had led to changes in priorities in flora-writing. In the author's opinion, the absence of an early successor to *Genera plantarum* on avowedly evolutionary principles – and a very marked emphasis on flora-writing as well as imperial consultancy related to what may be seen as a narrowly conceived remit – could be said to have placed Kew scientifically at a disadvantage.<sup>91</sup> Ultimately more influential for twentieth-century practice was the work of the integrated 'Englerian school' of taxonomy, phytogeography and comparative morphology in Berlin whose 'heyday' about spans our 60-year period.<sup>92</sup> As a research institute of the then-University of Berlin, it was more closely associated with the academic world than was Kew, until 1984 under the direct control of successive government departments.

This leadership from Germany was no isolated phenomenon: in the five decades before World War I the 'teuton' had come to dominate most branches of

science and scholarship as well as to assume leadership in scientific bibliography.<sup>93</sup> This not unnaturally reflected the drive towards German unity – and later world influence – led initially by Prince Otto von Bismarck and, later, Kaiser Wilhelm II. What has come to be called the 'Englerian school' of systematic botany itself had in effect been founded in the 1870s by Eichler upon his appointment at Berlin; but because of his long tenure as Eichler's successor (1889–1921) and organizational ability this 'school' will always bear Engler's name.<sup>94</sup> Together with Ignatz Urban, who as already noted had been, like Eichler and Engler, seriously involved with *Flora brasiliensis* and in Berlin had connections in high places, and Ludwig Diels – Engler's later associate and successor and 'einer der letzten grossen, in der ganzen Welt geachteten deutschen Pflanzensystematiker'<sup>95</sup> – Engler was largely responsible for his 'school' becoming imbued with the scholarship and *Weltanschauung* which were to make it so influential.

With its leaders' intellectual interests and formal academic links, the *Berliner Kreis* was able to specialize in large-scale monographic works rather than floras. Among their lasting contributions were the monumental *Die natürlichen Pflanzenfamilien* (1887–1915; 2nd edn., 1926–, not yet completed) and *Das Pflanzenreich* (1900–), detailed series of regional revisions and other studies, notably for Africa and the western Pacific (*Beiträge zur Flora von Afrika*, *Monographien afrikanischer Pflanzen-Familien und -Gattungen*, *Beiträge zur Flora von Papuasien*, etc.), and plant geographical and vegetatological studies (especially the monographic series *Die Vegetation der Erde*). On the other hand, apart from the continuation and completion of *Flora brasiliensis* their only major floristic work was the very detailed *Synopsis der mitteleuropäischen Flora* of Paul Ascherson and Paul Graebner. In their endeavors, the Berlin group was strongly supported by the botanical circle at Breslau, from 1884 until the end of the period led successively by Engler and (after 1889) Ferdinand Pax. Elsewhere in Germany there was rather less activity, save in Hamburg where the younger Reichenbach and his circle were completing *Icones florae germanicae et helveticae* (1837–1914), and in Munich where a successor of Eichler, Gustav Hegi, was responsible for another leading encyclopedic work, *Illustrierte Flora von Mitteleuropa* (1906–31; 2nd and 3rd edns., 1935–, not yet completed). On the whole, however, there were relatively few concise floras outside of the *Heimat*; the

only significant colonial work was Karl Schumann and Karl Lauterbach's privately sponsored *Flora der deutschen Schutzgebiete in der Südsee* (1900; *Nachträge*, 1905) for German New Guinea, Micronesia and Samoa.<sup>96</sup> Indeed, floras as a whole perhaps were seen – particularly in Berlin – as secondary in relation to revisions, monographs and taxonomic studies; Diels in his treatise on the methodology of systematics makes little or no mention of them.<sup>97</sup>

#### *The Russian Empire and the Soviet Union*

Close links continued to exist between German and Russian botanists into the 'imperial' era, although under Czars Alexander III (1881–95) and Nicholas II (1895–1917) more nationalistic policies came into effect.<sup>98</sup> For many years in the latter part of the nineteenth century the head of the botanic garden in St. Petersburg had been Eduard Regel who was also editor of a leading German horticultural periodical, *Gartenflora*. From the last decade of the century, however, the prominent figures in floristics and plant geography were all Russians. Expansion and development of the Russian Empire was vigorously pursued and floristic exploration also promoted until World War I as well as afterwards in the early Soviet period. Significant works included, in the 1890s, *Flora srednej i juznoj Rossii, Kryma, i Severnogo Kavkaza* (1895–97) by I. F. Schmal'hausen and *Tentamen florum Rossiae orientalis* (1898) by Sergei Korshinsky; after 1900 there came *Flora caucasica critica* (1901–18) led by Nikolai I. Kuznetsov in Jurjew, *Flora Altaja i Tomskoj gubernii* (1901–14) by Porphyry N. Krylov in Tomsk, *Plantae asiae mediae* (1906–16) by Olga A. and Boris A. Fedtschenko, *Jakutskaja Flora* (1907) by B. A. Fedtschenko, *Flora Evropejskoj Rossii* (1908–10) by B. A. Fedtschenko and Alexander F. Flerow, the same authors' *Flora asiatskoj Rossii* (1912–24), and, finally, *Flora Sibiri i Dal'nego Vostoka* (1913–31) led by I. Borodin and Dimitri I. Litwinow. Russian botanists were also active in Korea, Manchuria and northern China prior to 1910. The first Korean flora was *Conspectus florum Koreae* by Ivan Palibin (1898–1901); however, it had been able to make use of the already-mentioned *Index florum sinensis*. Manchuria, then partly under Russian influence, was the subject of the young Vladimir Komarov's *Flora Man'čžurii* (1901–07); on the other hand, his *Flora poluostrova Kamčatki*, prepared around 1910, was not published until 1927–30, well into the Soviet era.

Komarov's Kamchatka flora was contemporaneous with the last of the 'primary' regional floras, *Flora Rossiae austro-orientalis* by B. A. Fedtschenko and B. K. Shishkin (1927–36; index, 1938), and the early volumes of Krylov's *Flora zapadnoj Sibiri* (also begun in 1927). Most of the rest of Siberia and the Far East was concisely covered in two works by Komarov, *Malyj opredelitel' rastenij Dal'nevostočnogo kraja* (1925, with Evgenija Klobukova-Alisova), and *Vvedenie v izučenie rastitel'nosti Jakutii* (1926). The former was shortly afterwards expanded as *Opredelitel' rastenij Dal'nevostočnogo kraja* (1931–32, with Klobukova-Alisova), just as major organizational changes were overtaking the botanical institutions in St. Petersburg (by now Leningrad) and elsewhere. This very considerable effort over four decades was to be a cornerstone for *Flora SSSR* which, however, belongs to the 'modern' era.<sup>99</sup>

#### *Austria-Hungary and the Balkans*

Austro-Hungarian botanists were also active in this period, particularly in exploration and documentation of the flora of the Balkans and Greece. During the late nineteenth century, most of their documentation took the form of 'expedition reports', but after 1890 some notable floras were published: *Flora bulgarica* by Josef Velenovský (1891; supplement, 1898), *Conspectus florum graecae* by E. von Halácsy (1900–08; supplement, 1912), and *Flora Bosne, Hercegovine i Novopazarskog sandžaka* by G. Beck von Mannagetta (begun 1903 with three of four volumes by 1930). Serious summaries of the Romanian flora likewise began in the 1870s, initially with *Plantae Romaniae hucusque cognitae* by August Kanitz (1879–81). After World War I, there were fewer new initiatives but one major synthesis: *Prodromus florum peninsulae balcanicae* by August von Hayek (1924–33). Locally based activity also further developed, a notable contribution being the first edition of *Flora na Bălgarija* (1924–25) by Nikolai Stojanov and Boris Stefanov.

#### *France*

Among circles of floristic writing less directly influenced by Central Europe, notice may be taken firstly of those in other parts of that continent, followed by those in the United States and elsewhere. Through the middle of the nineteenth century systematic botany declined in France along with much else in national life.<sup>100</sup> Grenier and Godron's well-regarded



*Flore de France* – to which reference was made in the last section – lacked any significant successor until the 1890s; similarly, for some decades comparatively few overseas floras followed the example of Weddell's *Chloris andina* (1855–61). The suppression from 1853 to 1873 of any chair at the Muséum d'Histoire Naturelle in Paris specifically responsible for plant systematics, along with the not unrelated transfer by legacy of the Delessert Herbarium to Geneva in 1869, were serious setbacks.<sup>101</sup> Associated with this development was the continued formation and maintenance of several large private herbaria by wealthy amateurs including, in addition to the Delesserts, Ernest Cosson, Emmanuel Drake del Castillo, and Albert de Francqueville. It was upon them (and others) that French general systematic botany, with its strong tradition of monographic writing, largely rested in the mid- to late nineteenth century. They also contributed considerably to what overseas floras were produced in the last three decades of the nineteenth century.<sup>102</sup> At the same time, much of the abundant local and regional floristic work and publication within France was, as in other countries, the work of clerics and schoolmasters, one of whom, Abbé Hippolyte Coste, contributed a national flora of the greatest importance about which more will later be said.<sup>103</sup> The universities in this period became largely concerned with 'general botany', the school of comparative anatomy at the Sorbonne under Philippe Édouard van Tieghem enjoying particular prominence. No major floras were, however, associated with the Université de Paris prior to the advent of Gaston Bonnier in the 1880s. Montpellier, situated within the Mediterranean Basin and moreover with a long botanical tradition of its own, retained some distinctiveness as a place for the study of plant diversity under J.-É. and L. Planchon. In the early twentieth century under their successor, Charles Flahault, it began to emerge as an important center for the new disciplines of ecology and phytosociology.

Professional revival in systematics in Paris, led by Henri Baillon, L. Édouard Bureau and, somewhat later, Bonnier and Henri Lecomte, was gradual, Bureau having in his time at the Muséum but few resources at his disposal.<sup>104</sup> A strong stimulus was, not unnaturally, an awareness of and a felt need to improve knowledge of the extensive botanical resources of the developing Second French Empire. Until early in the twentieth century, however, the writing of overseas floras

remained in the hands of individuals, sometimes with grants-in-aid from metropolitan or colonial authorities.<sup>105</sup> The concept of organization and teamwork in flora-writing already manifest elsewhere was first effectively implemented at the Muséum by Lecomte in 1906 following his succession to Bureau's chair. Influenced in particular by *Flora of British India* and perhaps also *Flora brasiliensis*, the latter completed in the same year, he initiated, under the sponsorship of the colonial administration in Saigon, *Flore générale de l'Indochine*.<sup>106</sup> With this work began the 'Paris school' of semi-monographic floristic writing which has continued to the present and has influenced the conduct and format of similar works in Belgium, Portugal and even Britain.

Floristic botany in France itself in the late nineteenth and early twentieth centuries, also pervaded by a renewed spirit of optimism, was marked by the production of three major national floras, two by non-professionals and the third by the already-mentioned Sorbonne professor Gaston Bonnier. The *Flore descriptive et illustrée de la France* by Coste was perhaps the most influential. It was in part based on the style established by Britton and Brown in their *Illustrated flora of the northern United States, Canada and the British possessions* (1896–98) and enjoyed considerable input from Flahault in Montpellier. Bonnier's manual (1909) and illustrated flora (1911–35), the latter doubtless inspired by Hegi's contemporary *Illustrierte Flora*, have also enjoyed lasting popularity.<sup>107</sup>

#### *Belgium, the Netherlands, Italy and the Iberian Peninsula*

Detailed national floras were also published in Belgium, Holland, Italy and Spain and Portugal at this period, likewise largely through the efforts of amateur and para-professional botanists. In Belgium the advent of the Congo Free State after 1884 gave its botanists an important new opportunity for tropical studies. Rather generous support was furnished by Léopold II for explorations, institutions and publications, but in the time of Théophile Durand and Émile De Wildeman the extent of knowledge was considered premature for a descriptive flora. Their main synthesis was *Sylloge florae congolanae* (1909), published shortly after transfer of responsibility for the Congo to the Belgian government. Italian overseas floristic contributions were mostly *ad hoc* undertakings resulting from individual needs and interests rather than as parts of any

common strategy. Emilio Chiovenda's main publications on Somalia were moreover prepared in some isolation; like the French in Indochina, many of his novelties, particularly genera, have gradually fallen into synonymy. Local undertakings in Spain and Portugal were relatively limited. In the latter part of the nineteenth century the main development therein was *Prodromus florae hispanicae* (1861–80; supplement, 1893) by Moritz Willkomm and Johann Lange. This laid a foundation for various national and regional undertakings, the most notable being *Flora de Catalunya* (1913–37) by Juan Cadevall i Diars and his associates. By contrast, the remaining tropical possessions were largely neglected, save in Mozambique where T. R. Sim was contracted to write a forest flora (1909).

With respect to the Netherlands, the increasing wealth of the East Indies possessions and the strong directorships of Rudolph Scheffer and Melchior Treub enabled the 's *Lands Plantentuin* in Buitenzorg (Bogor) near Batavia (Jakarta) to flourish as a biological center, not unnaturally including considerable contributions to regional floristic botany. It was, however, becoming clear that the Indies had, like Brazil and China, an extremely rich flora and Treub accordingly took the view that a new descriptive work in succession to that of Miquel was premature. An interim solution was *Handleiding tot de kennis der flora van Nederlandsch-Indië* by J. G. Boerlage (1890–1900), a 'generic flora' with lists of species (also accounting for published records in neighboring territories). More detailed documentary efforts became focused on Java, one of which ultimately was realized as *Flora of Java* (1963–68).

#### *The British Empire: later developments*

Returning to the United Kingdom, certain changes in interests developed after 1900. As already mentioned, by this time Kew had attained a peak in its range of floristic undertakings. Even the Herbarium itself was administered on a geographical basis, its 'sections' remaining so organized until 1970. Subsequent research, however, became strongly centered on Africa, with an emphasis on two very large works: *Flora of tropical Africa* and *Flora capensis*. With these largely completed by 1920 or so, efforts were directed towards a partial revision of the former as *Flora of west tropical Africa* (1927–36). With respect to the Americas, projected floras for what are now Guyana and Belize never

materialized; and Jamaica, not surprisingly, became with the rest of the Caribbean an interest of the British Museum (Natural History). As for Asia, following the completion of *Flora of British India* in 1897 and the *Handbook to the Flora of Ceylon* in 1900 responsibility for territories east of the Suez was largely devolved to Calcutta and Singapore. The several Indian regional floras of the post-1900 period, while in part prepared at Kew, were not directly a charge on that institution.

#### *United States of America and its 'spheres of influence'*

Across the Atlantic in the United States, where until 1890 or so the botanical frontier was largely domestic, the works of Torrey and Gray (and their associates and students) had caused the manual-flora to become firmly established as a genre for most U.S. descriptive regional (and, later, state and some overseas) works. This style has for the most part remained conventional, with a gradual increase in the number of illustrations as the twentieth century has progressed. Until about 1930, however, the majority of states were covered only by checklists or documentary enumerations, sometimes with keys. Several of the accounts were part of a programme instituted by Frederick Coville, for many years chief botanist to the U.S. Department of Agriculture and head curator of the U.S. National Herbarium.<sup>108</sup>

The efforts of the Torrey/Gray 'school' of botanists to establish a lasting tradition of sound scholarship (as well as to complete Gray's *Synoptical flora of North America* (1878–97), itself a continuation of Torrey and Gray's original *Flora of North America* project begun 40 years before) were, however, to fail for a time. One factor – not surprisingly – was regionalism, notably in California; of greater import, however, was the rise to a dominant position of the Britton 'school' in New York.<sup>109</sup> From the New York Botanical Garden in Bronx Park (founded in 1891 with assistance from some of the newly wealthy 'robber barons' of the era) Britton and his group authored numerous works both for different parts of the mainland United States (and southern Canada) and for Bermuda and the Caribbean. Among them were Britton's own *Manual of the flora of the northern states and Canada* (1901; 2nd edn., 1905, 3rd edn., 1907) and *Flora of Bermuda* (1918), J. K. Small's *Flora of the southeastern United States* (1903; 2nd edn., 1913) and *Manual of the southeastern flora* (1933), and P. A.

Rydberg's *Flora of the Rocky Mountains and adjacent plains* (1917; 2nd edn., 1922) and *Flora of the prairies and plains of central North America* (1932). All were written not only with a view towards the geographically and numerically rapidly increasing commercial market but also as part of an overall strategy, including propagation of the 'American Code' of nomenclature. This code, distinct from the 'gentlemen's agreement' international code used in other parts of the world as well as by Gray and his circle, was introduced in 1892 amidst a rising tide of nationalism and widely used in the United States until 1930.<sup>110</sup> More ambitiously, Britton also sought to prepare a complete flora of the continent; following preliminary planning in the 1890s<sup>111</sup> this commenced publication in 1905 as *North American flora*. He also introduced the systematically illustrated flora, producing *An illustrated flora of the northern United States, Canada, and the British possessions* (1896–98; 2nd edn., 1913; both co-authored with Addison Brown). This inspired several comparable works, both at home (notably *Illustrated flora of the Pacific States* (1923–60) by Leroy Abrams and Roxana Ferris) and abroad (notably Coste's French flora).

In addition to preparing works on different parts of North America, botanists from the United States were also active in floristic writing in Middle America, the Philippines and, in the last decade or so of the period, in China and British India. Major contributions, all published after World War I, include *Flora of the Bahama Archipelago* (1920) by N. L. Britton and C. F. Millspaugh, the already-mentioned *Trees and shrubs of Mexico* by P. C. Standley (1920–26), *Enumeration of Philippine flowering plants* by E. D. Merrill (1923–26), and *Botany of Porto Rico and the Virgin Islands* (1923–30) by Britton and P. Wilson. In China, botanists at Lingnan University in Canton (Guangzhou) focused on little-explored Hainan, with a first contribution, *An enumeration of Hainan plants* (1927), by Merrill.

#### *Other areas*

Elsewhere in the Americas, political instability, limited resources and social factors discouraged serious flora-writing save in Uruguay, Argentina and Chile. In these countries relatively extensive exploration, interested botanists, and developing local institutions led to a number of floras, among them *Flora de Chile* by K. Reiche (1896–1911, not completed) and *Flora uruguayana* by José Arechavaleta (1898–1911). In Brazil, four parts of a *Flora paulista* by A. Löfgren and G. Edwall

appeared between 1897 and 1905; it then ceased, far from complete. Interest in floristic botany in most of Latin America generally remained relatively limited and publications few until the second half of the twentieth century.

The situation in Canada, southern Africa, Australasia and northeast Asia was broadly more favorable. In Australia, Ferdinand von Mueller published two editions of a continent-wide census in 1882 and 1889, after which emphasis switched largely to the individual colonies (or, from 1901, states) as they variously acquired the capacity to prepare basic state floras or checklists. Several such appeared between 1890 and 1931, between them covering the whole country. As the twentieth century progressed, however, interest in biology was becoming more diversified with relatively less emphasis on taxonomy and floristics; moreover, the fashion for museums had passed.<sup>112</sup> In spite of representations as early as 1909, the formation of the Commonwealth did not soon lead to the institution of a biological survey, a national natural history museum, or sponsorship of major floristic or faunistic works. In Canada, by contrast, a differing political history, the needs of geology, settlement and agricultural development, and strong representations on the part of the pioneer paleobotanist John W. Dawson resulted in the formation of a national museum as well as an agricultural center at Ottawa in the decades after federation in 1867. A botanical survey was also established, one major result of which was John Macoun's *Catalogue of Canadian plants* (1883–1902). Similarly, a national botanical institute was established in South Africa relatively soon after formation of the Union in 1910, and the later parts of *Flora capensis* featured several contributions from local botanists. A national herbarium was also formed in New Zealand, though only near the end of our period and following the development of substantial collections in Auckland and Wellington. In northeast Asia, the foundation of Tokyo Imperial University and its science faculty in 1877 enabled the formation of a cadre of botanists who, with the aid of Franchet and Savatier's *Enumeratio* and other 'Western' works – notably those of Karl Maximowicz as well as Siebold and Zuccarini – were able by 1910 to furnish primary floras for Japan, Taiwan and Korea along with the Ryukyu and Kurile Islands. By 1925 most of the flora of the Japanese Empire could be incorporated into a large manual, *Nihon shokubutsu sôran* (1925; 2nd edn., 1931).<sup>113</sup>

### Overall trends

Altogether, the 'imperial' or 'post-Darwinian' phase of systematics, though long scarcely considered in most general histories of science or even biology and until recently seldom the subject of retrospective studies,<sup>114</sup> was one of continuing great publication efforts. This reflected a 'silver age' of exploration and natural history which accompanied imperial expansion; within the field it featured attempts at global influence through major efforts in consolidation (as exemplified by the Englerian school), international competition, chauvinism in the United States and elsewhere. In broader scientific terms, there were some attempts to merge evolutionary theory with taxonomy; systematic studies began to include speculations about putative ancestors and patterns of diversification over time. Nevertheless, floras (and other works) became increasingly stylized and academic; their role in communication gradually was lost sight of through misapplication of old formats to new different situations along with philosophical drift. At the same time, the interests of systematics and other areas of botany gradually diverged, with the latter seen as more 'progressive'. I see this here as forming a botanical parallel to some of the social, political and architectural developments of the period. There were, nevertheless, some rays of light, among them the appearance of a relatively forward-looking textbook, *Methods and principles of systematic botany* (1925) by the U.S. Department of Agriculture agronomist and protagonist of nomenclatural reform Albert S. Hitchcock, and the emergence of 'experimental taxonomy' (or, as it would later be known, biosystematics) in Europe, North America and elsewhere.<sup>115</sup>

### The 'modern' era

In considering developments after 1930 two sub-themes – which to an extent overlap – manifest themselves. The first centers around a marked renewal of flora-writing as well as accompanying intellectual and methodological developments, while the second concerns the rise of information technology in relation to floristic documentation.

### *Mid-twentieth century developments and intellectual renewal*

The 'modern' era of flora-writing is for convenience here dated from 1930. Apart from it being a time of general economic recession, a notable event was the

Fifth International Botanical Congress at Cambridge (England) at which a unified nomenclatural code was agreed. In that year also came the death of Engler (with that of Urban following early in 1931) and, in the Soviet Union, the organization of the *Flora SSSR* project. A year previously, Britton had retired from the directorship of the New York Botanical Garden. From this time forward, in part stimulated by the appearance (from 1934) of the successive volumes of the Soviet flora, renewed interest was shown in flora-writing. Old schemes were reviewed and new ideas floated; among the latter were proposals for modern floras of Indonesia, Europe and different parts of Africa.

This trend in floristics intensified after World War II with additional factors being proximally the loss in 1943 of most of the Berlin Herbarium, the political division of Germany, and the effective end of *Das Pflanzenreich* but also a greatly increased interaction of science with the public accompanied by changes in the nature of research funding. There was also a consummation of a shift, already apparent before 1930, of the center of gravity in the scientific world from Central Europe to the United States and its anglophone associates. Without such stimuli as *Pflanzenreich*, serious monographic work tended to lose ground to floristics except where the new cycle of floras provided suitable outlets or opportunities.<sup>116</sup> For some, including the author, this has been a regrettable but perhaps inevitable development.<sup>117</sup> By 1958 systematic botany was well and truly into a new 'Age of Floras', with activity extending over most of the earth's land surface; this 'boom' has continued to the present time.<sup>118</sup> From the 1970s it has also been influenced by rising public concern with the environment and the implementation of international conventions; in the same period, however, the climate for basic research has become more difficult.

The 1930s also saw the entry of major philosophical and other changes to systematic biology which have largely continued to the present. Of particular importance was the definitive formulation of the 'evolutionary synthesis' – which in effect was a manifestation in biology of the interwar Viennese 'unity of science' movement – as well as advances in the methodologies and techniques now collectively grouped under 'biosystematics'.<sup>119</sup> Under the impulse of what came to be known as the 'New Systematics', plant systematics – in principle at least – became more dynamic and outward-looking. Hitherto it had been for the most part

a static typological exercise based largely upon comparative morphology, even retaining some elements of creationism and essentialism; indeed, for the best part of a century the 'Darwinian revolution' of 1859 had little effective influence on much of taxonomic practice.<sup>120</sup> It thus began to interact with ecology, karyology, biochemistry and molecular biology; much more attention was paid to variability, evolutionary dynamics, and the potential for parallelism, convergence and neoteny as expressions of change. Indeed, as a whole, considerations of time became more integral to taxonomic thinking. In an increasingly technological age, the 'biosystematics' movement improved the credibility of systematics in the eyes of other, largely laboratory-based scientists, notably in the United States or elsewhere where reductionism has been a serious force.<sup>121</sup>

Among notable developments of the 'modern' period may be mentioned the following:

1. The successful prosecution of *Flora SSSR* and the publication of an all-but-comprehensive range of regional floras and manuals for the then-Soviet Union (see Region 68/69 and Superregion 71–75).<sup>122</sup> In the People's Republic of China, a similar comprehensive programme of floristic documentation at national and provincial level has been in place since the 1950s. Heading this has been the large-scale *Flora reipublicae popularis sinicae*, publication of which commenced in 1959 (with an interruption in the late 1960s and early 1970s).<sup>123</sup>
2. The initiation (in the 1950s) and successful completion of *Flora Europaea*, of which the last of five volumes appeared in 1980 after 25 years of work. The history of the project, the most important of its kind in Europe for a century or more, has been well described.<sup>124</sup> A number of corollary projects were then or afterwards initiated, some of which are continuing.<sup>125</sup>
3. Commencement of new floras of Australia and North America. In Australia, the *Flora of Australia* project was formally approved in 1979 after 20 years of agitation and the first volumes were published in 1981–82. Publication has continued more or less steadily until the present, if more slowly than originally envisaged.<sup>126</sup> The path to a new flora of North America, a continent with no complete coverage since the early nineteenth century, has been as long if not longer. A first modern initiative was the Flora North America Program of 1967–73; this, however, was abruptly terminated before any definitive results had appeared. The present *Flora of North America north of Mexico* is the result of a new initiative dating from 1982; formal support from the U.S. National Science Foundation was achieved in 1989 and publication commenced in 1993.<sup>127</sup>
4. The initiation of a goodly number of large-scale serial floras for various parts of the tropical zone as well as some extra-tropical areas (apart from Australia and North America). Among them are *Flore de Madagascar et des Comores* (1936–), *Flora of Peru* (1936–71; 2nd series, 1980–), *Flora of Panama* (1943–81), *Flora of Guatemala* (1946–77), *Flora Malesiana* (1948–), *Flora of tropical east Africa* (1952–), *Flore du Cambodge, du Laos, et du Viêt-Nam* and *Flora Zambesiaca* (1960–), *Flora Iranica* (1963–, now all but completed), *Flora of Turkey* (1964–88), *Flora Neotropica* (1966–), *Flora of Ecuador* (1966–), *Flore des Mascareignes* (1976–), *Flora de Colombia* (1983–), *Flora of India* (1993–), and *Flora Mesoamericana* (1994–). Many of these works represent a renewal and continuation of 'territorial flora' traditions which arose in many of the large taxonomic centers in Europe and North America during the latter part of the nineteenth century and beyond. Others have been entirely new initiatives. Progress, however, has often been slow, particularly where necessary materials have become widely scattered or where means or interest are limited.<sup>128</sup>
5. The publication of numerous modern, relatively concise, and more or less critical floras and manuals for many different parts of North America and Europe, with a more scattered output of such works in and for other parts of the world. Although viewed as 'routine' by van Steenis and others, there is a steady or even increasing market and, as van Steenis himself admitted, their quality has generally improved.<sup>129</sup>
6. The increasing development of inter-institutional and international links among botanists, largely replacing the old nationally oriented schools (and one-time colonial rivalries). Apart from the umbrella International

Association for Plant Taxonomy (established in 1950), these links include AETFAT (1951, for Africa south of the Tropic of Cancer), the Flora Europaea Organisation (1955–80; partially succeeded by the European Science Research Councils (ESRC) Ad Hoc Group on Biological Recording, Systematics and Taxonomy and, more recently, by the Euro-Mediterranean Initiative in Plant Systematics (now styled Euro+Med PlantBase), the Flora Malesiana Foundation (1950), the Organization for Flora Neotropica (1966), and OPTIMA (1975, for the Mediterranean Basin). To these should perhaps be added the Global Taxonomy Initiative (GTI). Forms of communication and gathering have varied, but most have conducted different kinds of serial publications along with periodic symposia; in more recent years electronic media including Web sites and newsgroups have been established. Similar groups may exist within more inclusive associations, for example the Committee on Pacific Botany of the Pacific Science Association. Official and unofficial agreements aimed at coordination of activities and reducing or eliminating duplication of floristic coverage also exist.

Offsetting these progressive developments have been a number of setbacks. Some projects have appeared just to ‘run out of steam’ on account of the death (or retirement) of their moving spirits, loss of institutional interest, lack of finance, or for other reasons.<sup>130</sup> Others have been variously affected by political or other external circumstances, either temporarily or permanently. As already indicated, the initiation of some projects has been more or less long drawn-out due to factionalism, government attitudes, and other factors.<sup>131</sup> A lack of firm organization and management, with consequent dissipation of available resources, is a probable major cause of many delays.<sup>132</sup>

Of all of the setbacks in the period after 1930 the most notable was perhaps the sudden termination of the first Flora North America Program in early 1973 shortly after it became ‘operational’.<sup>133</sup> A first attempt at revival in the latter part of the 1970s was less ambitious; it soon, however, sank without trace at a time of political paralysis. A second attempt, initiated by the American Society of Plant Taxonomists in 1982, would in the end be more lasting. Ironically, its first task was, in the words of one contributor to a precursory 1988

workshop, seen as ‘*not* to design computer databases of floristic information’.<sup>134</sup> While a role for information technology was clearly envisaged, there was an equal concern for a more traditional presentation of results, i.e., in a series of volumes comparable to *Flora Europaea* or the *Flora of Australia*. The new plan also called for less of a superstructure and more producer and user participation (including the establishment of a newsletter). As already noted, this approach was successful and *Flora of North America north of Mexico* is now a reality.<sup>135</sup>

All in all, however, the mid-twentieth century – the years of World War II excepted – should be seen as one of marked progress in world floristic documentation. The somewhat bleak picture painted by Blake in 1939 (Blake and Atwood, 1942) and Lawrence (1951) – the latter making particular reference to southwestern Asia – became rather less so by the 1970s. Sufficient advances had been made for some serious estimates, in cartographic form, of world levels of plant species richness by Malyshev<sup>136</sup> as well as thoroughness of floristic knowledge.<sup>137</sup> With additions, these would over the next two decades contribute to overall knowledge of world biodiversity as well as to conservation needs assessment. Yet major gaps in published knowledge remained, notably in parts of the tropics where much alpha-taxonomic research was still required; in many other cases available coverage was aging or otherwise unsatisfactory.

#### *The rise of information technology*

Of profound importance in recent decades has been the introduction into systematics and floristic botany of information systems technology. Acceptance of the new methodology was at first slow, and from time to time criticism was voiced. Among its earliest advocates was the International Business Machines (IBM) engineer and botanical enthusiast Sydney W. Gould.<sup>138</sup> In the 1950s and 1960s he successively developed his ‘International Plant Index’ (1962) and ‘Geo-code’ (1968–72) as well as a standardized list (with A. C. Noyce) of authors of plant generic names (1965).<sup>139</sup> From 1953, automatic data processing was also introduced for the mapping scheme later published as *Atlas of the British Flora* (1962).<sup>140</sup> Computers moreover came into use in the then-developing field of ‘numerical taxonomy’, and in addition began to be explored as potential tools in museum documentation.

The development of database and other more

advanced software tools, along with introduction in the mid-1960s of the first 'third-generation' computer systems, notably the 360-series of IBM, represented, however, decisive steps forward. Projects for their application in systematics were mounted by, among others, Theodore J. Crovello at Notre Dame University, the original Flora North America team under Stanwyn Shetler, and a group in Mexico City (later Xalapa, Veracruz) under Arturo Gómez-Pompa. Integrated floristic systems were developed by both the Washington and Xalapa teams, the latter with a slight edge and in the end continuing to the present, with *Flora de Veracruz* (1979–) one of its key products.

Interest in the more advanced technology also developed rapidly outside North America wherever there was forward-looking leadership. In Pretoria, South Africa, an important regional database, PRECIS, was created; in time this developed into a full taxonomic information system.<sup>141</sup> From it a first complete checklist of the vascular flora of southern Africa, *List of species of Southern African plants*, was produced in 1984; two further editions have since appeared. At the end of the 1970s, support was found for development of a prototype European floristic information system.<sup>142</sup> A database was also created for *Med-Checklist*. Routines for key-writing and truly comparative descriptions also began their development in the 1970s.<sup>143</sup>

The high overheads and custom software of the 'big iron' era did, however, for several years militate against more extensive application of computer-based information technology, although in the 1970s this was offset by the spread of 'minicomputers'.<sup>144</sup> Effective penetration of the new technology began only in the late 1970s with the widespread introduction of visual terminals, firstly for word processing and then also for data with the rapid spread of personal computers; this will be discussed more fully in Chapter 3. The publication of *Databases in systematics* (1984), based on a 1982 symposium, establishes a useful point of reference encompassing the penetration of information technology (I.T.) from the 1960s through the advent of personal computers in the 1970s to less expensive mass storage for data, the appearance of the CD-ROM, networking, and portables in the 1980s.<sup>145</sup> As we come nearer the present, the use of I.T. in floristic work as well as in other areas of systematics has become all but routine, although effective standardization of packages, data libraries, etc., is far from achieved.<sup>146</sup>

Less obviously, but just as significantly, there have also in recent years been reassessments of several larger flora projects. Not only has progress often been slower than projected, but in some cases the estimates of the numbers of species involved have increased with continuing botanical exploration.<sup>147</sup> At the same time, changing circumstances as well as new technologies have had to be taken into account. This has led to decisions to accelerate production of certain works, notably *Flora of tropical East Africa* and *Flora Zambesiaca* at Kew (with completion of both envisaged by 2005) and *Flora Malesiana* (through simplification of its presentation and recruitment of a greater range of collaborators). At the same time, in at least one institution an increasing emphasis may be placed on monographic studies, including contributions towards a new *Species plantarum*. The 'Age of Floras' may for a time continue, but necessary change may eventually as such limit its run in its present form. What does seem very probable is that in the twenty-first century floras as such will be not merely also on-line but entirely absorbed into floristic information systems, with the more traditional forms comprising just some of its possible products. Already such is the case with some basic checklists as, for example, *Queensland plants* (435) or *Plants of southern Africa: names and distribution* (510). A more elaborate example is *Atlas of endemics of the Western Ghats (India)* (802), with a CD-ROM supplementing the printed work.

## Summary

Floristics as a distinct area of botanical enquiry began with the work of Clusius and Thal in the last third of the sixteenth century. Early floras were largely enumerative or took the form of elaborate documentation of 'exotica'. A more systematic approach, already evident in some late seventeenth century works, became general as the eighteenth century progressed; many basic principles and practices were 'codified' by Linnaeus. Analytical keys were introduced beginning with Lamarck's *Flore française* in 1778; phytography itself gradually became more sophisticated and formal in a style first developed, also by Lamarck, for his *Encyclopédie* (1783 onwards) and in 1805 applied in *Flore française* by Augustin-Pyramus de Candolle. Arrangements of taxa initially followed 'folk' tradition, later progressing through the Linnaean system (which proved very effective at increasing access) to systems based on 'natural' affinities within and among major

taxa.<sup>148</sup> Rapid progress in primary documentation of the flora of northern, central and parts of southern Europe characterized the eighteenth and early nineteenth centuries, and initial lists were compiled for various other parts of the world. In the hundred or so years from 1815 to 1930 most of the rest of the globe became 'covered' with floras, although outside Europe, eastern North America and some other largely temperate regions their basis was relatively sketchy. For the most part, however, they remained purely phyto-graphic. A nineteenth-century innovation derived from the Lamarckian key form and applied mainly in Europe was the field manual-key, a very concise form of a flora aimed at identification and provision of basic information.

The latter half of the twentieth century has seen a great rise in the production of major floras. The bulk of the vascular floras of the north temperate and the two polar zones and, increasingly, the south temperate zone have by and large become reasonably well known with respect to inventory, the available information now variously consolidated into more or less readily accessible forms. The same applies for scattered areas in tropical and subtropical zones, often where a substantial history of local botanical endeavor has existed. On the other hand, over the bulk of the tropics and subtropics, including tropicmontane zones, all or most of the greatest importance to a proper understanding of the earth's vascular flora, floristic progress has been uneven. Efforts by individual persons, institutions, or other organizations have played an exceptional role, more often than not in the absence of general movements as well as official indifference or suspicion. Large areas still remain imperfectly studied and documented. Moreover, what literature is available is often so out of date as to be all but valueless for anything save professional revisionary work. Even so, in these zones significant progress has been made, notably in Africa, various parts of Asia and Malesia, Middle America, and the Pacific but also in Australia (although there it was gradual until the 1970s) and South America. This contrasts very positively with the opinion of Blake and Atwood that, as of 1939, outside of Europe and parts of northern Asia only Greenland, Australasia (in my view partly mistakenly), and some islands could be considered floristically relatively well known.<sup>149</sup> This is all the more so as standards of knowledge and documentation have increased substantially in the past six decades compared with the previous century or more.

Given this situation, as well as for economic, technological and intellectual reasons, it is perhaps not surprising that quite recently voices have been heard advocating a renewed emphasis on monography as a primary basis for floristic accounts. Certainly, in the last decade or so relatively few major new flora projects have been initiated when compared with the post-World War II era; in addition, there have also been reassessments of several of those still current. If, as was earlier suggested, floras do become parts of information systems, then – in addition to on-line access – 'traditional' printed materials can be generated on demand or formally published from time to time, complemented or supplemented by CD-ROMs with, for example, additional illustrations, maps, or interactive keys. This and other issues will be further considered in Chapter 3.

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## Notes

- 1 Stafleu, 1959.
- 2 Thorne, 1971.
- 3 Gómez-Pompa and Butanda, 1973; Gómez-Pompa and Nevling, 1973.
- 4 Jäger, 1978.
- 5 Morin *et al.*, 1989.
- 6 Ng, 1988; Funk, 1993; Jarvie and van Welzen, 1994; Palmer, Wade and Neal, 1995.
- 7 For example, Stace, 1989, pp. 224–226. There has also been a recent decision at a major institution to move away from large-scale floras once current commitments are completed.
- 8 Morton, 1981.
- 9 Sachs, 1875; Wein, 1937. Indeed, Wein argues that historically the meaning and scope of the word 'flora' have varied widely, only taking on more definitively the sense used here following its adoption by Linnaeus for his account of the plants of Sami, *Flora lapponica* (1737). A further attempt to redress the historiographical gap was made by Max Möbius in his paper 'Entstehung und Entwicklung der Floristik' (Möbius, 1938). Written as a supplement to his 1937 book *Geschichte der Botanik* (Jena: Fischer), it has been of considerable assistance in working up the present chapter.
- 10 Linnaeus, 1736 (see also Heller, 1983 [originally publ. 1970], pp. 146–204).
- 11 Brenan, 1979.
- 12 Morton, 1981, pp. 117ff. For early botany see also Reeds, 1991.



- 13 Wood blocks provided a relatively inexpensive means of illustration and became widely used in the sixteenth century (Blunt and Stearn, 1994, especially chapters 4–6).
- 14 Sivarajan, 1991. Of these works, the illustrations (by Johann Weidnitz) in *Herbarium vivae eicones* constitute a significant technical and artistic advance in botanical illustration (Blunt and Stearn, 1994, pp. 61–63).
- 15 The later works of Dodoens, along with those of Lobelius (De L'Obel) and Clusius (De L'Écluse), were all published through the famed Antwerp house of Plantin-Moretus which ensured a wide distribution. Their illustrations were drawn from a common pool – still extant – developed by the firm (Blunt and Stearn, 1994; personal observations, 1997).
- 16 Möbius, 1938, p. 297.
- 17 Gesner's published writings are largely non-botanical. In 1555, however, he produced *De rarior et admirandis herbis* which included plants from Mt. Pilatus near Luzern. Over the last 10 years of his life – cut short by the plague in 1565 – he initiated a *Historia plantarum*, an illustrated work on all known plants similar to his *Historia animalium*. Never published in his lifetime, some fragments were subsequently incorporated in *Opera botanica* (1751–59, edited by C. C. Schmiedel). Additional illustrations, advanced for their time, were lost sight of after his death and only rediscovered in Erlangen in 1929. In 1973–80 a facsimile edition of some 1500 drawings in eight volumes appeared in Zürich as *Conradi Gesneri Historia Plantarum Facsimile-Ausgabe*, edited under the direction of H. Zoller, M. Steinmann and K. Schmidt. For further details on Gesner, see Wellich, 1984.
- 18 For a fuller discussion of the Bauhins and their work, see Reeds, 1991. Of the *Pinax*, William Sherard in Oxford possessed an annotated copy to which Dillenius, as part of his duties, had earlier contributed. Never worked up for publication, this copy remains in Oxford University (Ewan, 1970, p. 27).
- 19 Möbius, 1938.
- 20 The work appeared posthumously as an appendix to *Hortus medicus et philosophicus* by Joachim Camerarius the Younger. For an appreciation, see Greene, 1905.
- 21 As a flora it was highly praised by A.-P. de Candolle (de Candolle, 1813).
- 22 The next attempts would be those of Lamarck in *Encyclopédie méthodique* and A.-P. de Candolle, who in 1812–13 conceived his *Regni vegetabilis systema naturae*.
- 23 Möbius, 1938.
- 24 His personal 'symbol', the twinflower *Linnaea borealis*, appears on the title-page.
- 25 de Candolle, 1813, p. 269.
- 26 Greene, 1905, p. 115.
- 27 First published as pp. xv–xxxii in the second edition of *Flora suecica*.
- 28 This was based on a herbarium left by Paul Hermann, but different from that used for Hermann's own *Museum zeylanicum* (1717).
- 29 A leading opponent was von Haller.
- 30 Williams, 1988. Meritorious features of *Flora gallo-provincialis* included the adoption of Bernard de Jussieu's proto-natural system and a fuller treatment of geographical distribution than customary in Linnaeus's works. Like *Flora helvetica*, it would also be noticed by Augustin-Pyramus de Candolle, who commented favorably on its topographical features, i.e., handling of plant distribution (de Candolle, 1813).
- 31 Stafleu, 1971a.
- 32 Linnaeus, 1753 (see also Heller, 1983 [originally publ. 1976], pp. 239–267).
- 33 *Exoticorum libri decem* contains one of the first known illustrations as well as a good contemporary description of the great banyan fig of South Asia, *Ficus bengalensis*.
- 34 *De plantis Aegypti liber* contains perhaps the earliest illustration of a banana plant in European botanical literature.
- 35 Examples include the island florulas by W. B. Hemsley in the British *Challenger* reports and Heinrich Schenck in the reports of the German *Valdivia* expedition.
- 36 *Flora danica* remains famous, not the least on account of the porcelain based on its illustrations.
- 37 All these were part of the great 'age of botany' which coincided with the Romantic era. Egerton has argued that a catalyst was J. J. Rousseau's letters to Mme. Delessert (posthumously published in 1781, but written from 1771 to 1773 and circulated in contemporary salons). See Williams, 1988.
- 38 de Candolle, 1873.
- 39 Voss, 1952; Stafleu, 1971b. While Lamarck had rejected the suprageneric taxa of Linnaeus, he may have judged the introduction of families, still a relatively new concept, premature or even irrelevant in the context.
- 40 Pankhurst, 1978, 1991; Stace, 1989. A possible motive for Lamarck was the relative size of the French flora, at least double those of, for example, Britain, Ireland and the Netherlands.
- 41 Duris, 1993.
- 42 Cf. de Candolle, 1873. Soon after the publication of *Flore française*, the first edition of Rousseau's *Lettres* appeared which, as already indicated, opened botany to a truly wide popular audience. This promoted a demand for popular floras as well as the already-mentioned fine illustrated works for the salon. The Linnaean system remained widely used for these; it would be another generation before 'natural' arrangements of plants made their way into floras.

- 43 Stafleu, 1971a,b.
- 44 Charles Panckoucke was in 1768–69 a ‘rising young Paris publisher’. His first proposal was for a reprint of the Diderot edition along with a multi-volumed supplement; the latter appeared in four volumes. Though part of the plan, due to a personal offence – expressed in the end in dots – Diderot took no part in the enterprise. See A. M. Wilson, 1972. *Diderot*. New York: Oxford University Press (especially pp. 578–579). His own *Encyclopédie méthodique* followed, an entirely new work – begun just within Diderot’s lifetime.
- 45 de Wit, 1949, p. xcvi.
- 46 This apparent persistence of essentialism has also been discussed in more general terms by Sivarajan (1991, pp. 17–18) and earlier by Hull (1965).
- 47 In the next decade de Candolle would develop his own, rather differently conceived system.
- 48 Curiously, however, de Candolle did not mention analytical keys, in spite of their presence in *Flore française*.
- 49 de Candolle, 1873.
- 50 Boissier’s arrangement of *Euphorbia* in volume 15(2) (1862) has, for example, never been entirely supplanted (M. Gilbert, personal communication).
- 51 de Candolle, 1873, 1880.
- 52 Bentham, 1861, 1874.
- 53 Stevens, 1994.
- 54 van Steenis, 1954.
- 55 These as a genre enjoyed their zenith in the period 1770–1850 with a new wave in the late nineteenth and early twentieth centuries.
- 56 Bentham, 1874.
- 57 McVaugh, 1955.
- 58 Bartling’s work was followed by *Plantarum vascularium genera* (1836–43) by Carl Meisner of Basel and particularly *Genera plantarum* (1836–40; supplements, 1842–50) by Stephan Endlicher in Vienna. The last-named, as head of the Austrian state herbarium, would become the first managing editor for *Flora brasiliensis*. Of these works, Endlicher’s was surely the most influential.
- 59 Sachs, 1875. In many ways this critique was to have an influence which, with reiterations, has in one or another form continued to the present.
- 60 An extended discussion of the work’s merits and defects is presented in Anonymous, 1861.
- 61 Linnaeus, 1753 (see also Heller, 1983 [originally publ. 1976], pp. 239–267).
- 62 These latter found expression in various ways, notably in 1830, 1832, 1848, 1867 and 1871. The process has also been manifest from time to time throughout the twentieth century.
- 63 It was also in Scotland that a professional interest in geographical botany developed (Fletcher and Brown, 1970, pp. 168–171).
- 64 de Wit, 1949.
- 65 A large format was also employed for the results of the U.S. Exploring Expedition.
- 66 W. J. Hooker to Colonial Office, 1857 (quoted in Thistleton-Dyer, 1906). Similar points were made by Anonymous (1863) and with respect to horticulture by Fletcher (1969). They continue to be heard in one or another form to the present day (Hickman and Duncan, 1989; Smocovitis, 1992).
- 67 Desmond, 1999.
- 68 Bentham, 1874.
- 69 Such a view may well have been shared by Alphonse de Candolle who as late as 1880 failed to mention them in his *Phytographie* (de Candolle, 1880). His father likewise had made no reference to keys in his *Théorie élémentaire* (de Candolle, 1813).
- 70 It is noteworthy that no real successor to these works appeared until after World War II. Even in recent years they have been appreciated in some quarters for their method – attributes also to be found in some measure in *New flora of the British Isles* by Clive Stace (1992; 2nd edn., 1997).
- 71 Anonymous, 1863; Thistleton-Dyer, 1906.
- 72 Commitments to *Flora of tropical East Africa* and *Flora Zambesiaca* are scheduled to continue until completion of these works about 2005 (Royal Botanic Gardens, Kew. *Corporate Strategic Plan 1996–2001 and Kew 2020*). A recent single-volume work in the tradition is *Flora of Pico das Almas* (1995), edited by Brian Stannard.
- 73 Burtt-Davy *et al.*, 1925.
- 74 Symington, 1943; Corner, 1946.
- 75 The style was also followed by Walpers in his *Repertorium* and *Annales*, designed as supplements to the *Prodromus* (Stafleu, 1967, p. 75). Most of these works were in their time well received and long remained standard. Miquel’s Indonesian flora was, however, ‘premature’ given the still-low overall level of botanical exploration therein.
- 76 Unavailability of authentically named material has resulted, and continues to result, in many misapplications of names.
- 77 Among the non-Kew works was William Hillebrand’s flora of Hawaii (1888).
- 78 Lamarck was also among the first to challenge traditional ‘linearity’, with particular respect to classification and ‘progression’ of living things (Légée and Guédès, 1981; Stevens, 1994). This challenge has been extended in modern times to intellectual progress in general: not all of it is linearly based, nineteenth and early twentieth century precepts to the contrary (cf. Dolby, 1979).
- 79 In the United States, a partial cleavage was achieved, with a conventional manual–flora such as *Gray’s Manual of botany* containing only relatively limited synonymy in

- comparison with a contemporary work such as *Flora australiensis*. Gray, together with his associate Sereno Watson, evidently believed the full documentation of synonymy was more appropriate to a specialized work. Watson accordingly prepared a synonymized checklist, *Bibliographical index to North American botany* (1878), to accompany Gray's *Synoptical flora*. [Unfortunately only the first volume (Polypetalae) was ever published. Its main functional successor, Kartesz and Kartesz's *Synonymized checklist*, appeared only in the late twentieth century.]
- 80 Lange also published a synonymized 'nomenclator' for *Flora danica*.
- 81 Similar twentieth-century 'pairs' include *Opredel'itel' rastenij Ukrainii/Flora URSS* of the Ukrainian Institute of Botany, *Bestimmungsschlüssel zur Flora der Schweiz/Flora der Schweiz* by Hess, Landolt, and Hirzel and, from outside Europe, *Iconographia cormophytorum sinicarum/Flora reipublicae popularis sinicae* from the Academia Sinica Institute of Botany and *Flora of the Pacific Northwest/Vascular plants of the Pacific Northwest* principally by C. Leo Hitchcock and Arthur Cronquist.
- 82 An extensive exposition on the form and merits of analytical keys appears in von Mueller, 1888. He similarly calls attention to their relatively slow adoption.
- 83 A brief review of checklists and enumerations appears in Wisskirchen and Haeupler, 1998.
- 84 Davis and Heywood, 1963; Stevens, 1994.
- 85 de Wit, 1949, p. cxviii.
- 86 Most North American state and provincial floras in this period were enumerations or checklists. Descriptive floras or manuals were written mainly for larger regions or linguistically distinct areas such as Québec.
- 87 As in North America, descriptive works within British India were effectively regional in scope.
- 88 Forest floras in tropical American lands were, however, rare until after World War II. Standley's *Trees and shrubs of Mexico*, though completed before 1930, is more botanical than dendrological.
- 89 Limoges, 1980; Timler and Zepernick, 1987; Zepernick and Timler, 1990.
- 90 Cf. Desmond, 1995.
- 91 Neither the systems of Hutchinson (at Kew; 1926–34) nor Rendle (at the then-British Museum (Natural History); 1904–25) gained paramount influence, although the original version of Hutchinson's system would be adopted for a number of floras.
- 92 Davis and Heywood, 1963, p. 33; Stafleu, 1981.
- 93 Simon, 1977; Malclès, 1961, p. 84.
- 94 Eckardt, 1966, p. 168; Stafleu, 1981.
- 95 Eckardt, 1966, p. 173.
- 96 Lauterbach, a landowner near Breslau but trained as a botanist under Engler at Breslau University and in the 1890s a New Guinea explorer, was the sponsor; he also completed the *Nachträge* after Schumann's death in 1904.
- 97 Diels, 1921; see also Mildbraed, 1948.
- 98 Anderson, 1991, p. 87. The first 'minorities' to suffer Russification were the Baltic Germans. Russian became compulsory in schools and in 1893 the German-language University of Dorpat (at present-day Tartu, Estonia) was closed, afterwards reopening as the Russian-language University of Jurjew. Russians were also preferred in appointments to positions at the botanical institutions in St. Petersburg.
- 99 Much information on the history of Russian floras may be had from Shetler, 1967.
- 100 This was certainly apparent at the Muséum National d'Histoire Naturelle. The Muséum would enjoy a renewal in the late nineteenth and early twentieth centuries in relation to France's renewed imperial presence, but it never really regained the scientifically prestigious position it had enjoyed in the early part of that century (Limoges, 1980).
- 101 Leandri, 1967.
- 102 These included *Enumeratio plantarum in Japonia sponte crescentium* (1873–79) by A. Franchet and L. Savatier, *Compendium florum atlanticae* (1881–87) by Ernest Cosson, *Flore forestière de Cochinchine* (1881–99, not completed) by L. Pierre, *Flore de l'Algérie* (1888–95; supplement, 1910) by J. A. Battandier and L. Trabut, and *Illustrationes florum insularum maris Pacifici* (1886–92) and *Flore de la Polynésie française* (1893) of E. Drake del Castillo (who also contributed in the same period to the botanical volumes of Grandidier's encyclopedic *Histoire physique, naturelle et politique de Madagascar*). Some of these works enjoyed grants-in-aid from metropolitan or colonial authorities, but all were individually sponsored.
- 103 Jovet, 1954.
- 104 This shortage of resources hampered Adrien Franchet's research on the flora of East Asia at a time when vast collections were accruing from the work of the many French missionary priests and others active there after 1860. After his death in 1900, they were to a large extent neglected as official interest shifted elsewhere (Cox, 1945). Resources for tropical floristic inventory and research were also limited (Gagnepain, 1913), though in fact Indochina fared relatively well in the two decades or so before the economic slump of the 1920s and changing scientific interests.
- 105 These included most if not all of the major overseas floras to which reference has already been made.
- 106 Leandri, 1962; Vidal, 1984. Vidal notes that the order and division of the *Flore* into volumes were those of the *Flora of British India*, save for the inclusion of pteridophytes in the last volume.

- 107 The work was revised and reissued with considerable success by Belin in 1990.
- 108 In the late nineteenth and early twentieth centuries the U.S. National Herbarium was officially a joint undertaking of the Department of Agriculture and the Smithsonian Institution.
- 109 Dupree, 1959; Shinnars, 1962, pp. 14, 19. The pre-eminence of Boston (and New England) as a botanical center was at this time beginning its decline relative to other parts of the country. Moreover, at Harvard itself botanical 'disunity' had become established (Morison, 1937; Hall, 1990).
- 110 The U.S. federal government also adopted the American Code as official for botanical names. This resulted in its use in a great many standard works, including the already-mentioned state and other floras (as well as Paul Standley's *Trees and shrubs of Mexico*) published through the National Herbarium as well as more applied botanical works issued directly by the Department of Agriculture (and the Forest Service) and in publications of the first U.S. Biological Survey.
- 111 Britton, 1894, 1895.
- 112 Sheets-Pyenson, 1988.
- 113 A supplement, *Nihon shokubutsu sôran-hoi* by Nemoto alone, appeared in 1936.
- 114 Within commonly accepted but oversimplified notions of progress in science it evidently has been thought to be of little significance. See Wheeler, 1923; Ravetz, 1975; Stafleu, 1981; Sheets-Pyenson, 1988; Gould, 1989; Stevens, 1994.
- 115 Other historical accounts of this period include Hagen, 1984, Briggs, 1991, and Reveal, 1991. Hagen deals in particular with the rise of 'experimental taxonomy'. With respect to more general contemporary trends in botanical research, see Smocovitis, 1992.
- 116 As successor to the Prussian Academy of Sciences, the rights to the work passed to the [East] German Academy of Sciences. However, its actual and likely contributors were mostly in the 'West'. One fascicle was reissued and two new ones published after 1945, wholly devoted to a revision of Campanulaceae-Lobelioideae by the Austrian cleric and botanist Franz Wimmer. Nothing since has been published. However, there do remain, or have arisen, some good outlets for major monographs or revisions; among them are *Bibliotheca botanica*, *Boissiera*, and *Systematic Botany Monographs*.
- 117 Cf. Corner, 1961; Jacobs, 1973; Mabberley, 1979, p. 274; Toledo and Sosa, 1993. The situation might be eased by improvements in research tools, better access to sources including digital imagery of collections, and methodological changes including a more 'industrial' philosophy.
- 118 Stafleu, 1959; see especially the map therein, p. 67. See also Thorne, 1971; Gómez-Pompa and Butanda, 1973; Gómez-Pompa and Nevling, 1973; Jäger, 1978.
- 119 Smocovitis, 1992. The 'watershed' for the evolutionary synthesis was *Genetics and the origin of species* (1937) by Theodosius Dobzhansky. At the same time, the synthesis provided an intellectual framework for Ernst Mayr's defenses firstly of the study of biological diversity (Mayr, 1982) and – paradoxically – of the autonomy of biology (Mayr, 1997). Good reviews of the penetration of population biology, experimental taxonomy, karyology and molecular biology into plant systematics include Huxley, 1940 (for plants see chapter by Turrill, pp. 47–71); Stebbins, 1950; Davis and Heywood, 1963; Raven, 1974, 1977; Hagen, 1984, 1986; Stuessy, 1990; and Soltis, Soltis and Doyle, 1992. Standard textbooks may also be consulted (e.g., Radford *et al.*, 1974; Stace, 1989; Sivarajan, 1991; Woodland, 1997; Judd *et al.*, 1999).
- 120 Heywood, 1974; Stevens, 1994; Ghiselin, 1997.
- 121 Shinnars, 1962, p. 22; also Rosenberg, 1985; Briggs, 1991; Reveal, 1991; Ghiselin, 1997. In the United States, the biosystematics movement developed most significantly in the West and Midwest through the work of Frederic E. Clements and Harvey M. Hall, the Carnegie Institution group under Jens Clausen, Edgar Anderson, and G. Ledyard Stebbins (Hagen, 1984). Notable exponents elsewhere included W. B. Turrill in Britain, H. H. Allan in New Zealand, G. W. Turesson in Denmark, and B. H. Danser in Indonesia and the Netherlands.
- 122 The greater part of an English translation was also realized and published.
- 123 Ma and Liu, 1998.
- 124 For example, Heywood, 1964, 1989.
- 125 These include *Atlas florae europaeae*, *Med-Checklist*, the aborted European Floristic, Taxonomic and Biosystematic Documentation System (ESFEDS), and the Euro-Mediterranean Initiative in Plant Systematics (now Euro+Med PlantBase). A revision of the first volume of *Flora Europaea* was published in 1993.
- 126 Progress is documented in the ABRS newsletter *Biologue* (now bi-annual) and in the *Australian Systematic Botany Society Newsletter* (quarterly).
- 127 The *Flora of North America Newsletter* (nominally quarterly) furnishes reports of progress. Prior to award of its first grant, the National Science Foundation had sponsored a participants' workshop. Held in 1988, the proceedings appeared the following year as *Floristics for the 21st century* (Morin *et al.*, 1989).
- 128 Prosecution of these works continues to be advocated by individuals and in symposia. They are seen as contributing not only to advances in documentation and knowledge

- but also to the formation of young systematists. They may also be the best we can hope for in situations when monographic studies are not possible or practicable. Some decades ago van Steenis (1954) called them 'creative' as opposed to the largely 'routine' floras of Europe (and parts of North America). Their merits or otherwise will be further examined in Chapter 3.
- 129 van Steenis, 1954.
  - 130 De Wolf, 1963, 1964; Polhill, 1990.
  - 131 Cf. Department of Science, Australia, 1979; Morin *et al.*, 1989.
  - 132 Polhill, 1990.
  - 133 Shetler *et al.*, 1973; Shetler and Read, 1973. A fuller description of the events is given in these references and in the original edition of this *Guide*. It needs only to be added that a proximal cause was a refusal on the part of the Department of Botany of the host institution any longer to accommodate the project. It should also be said, however, that by then six or more years had already elapsed without the appearance, in the public view, of definitive 'product': the first volume of a 'conventional' printed flora.
  - 134 Rodman, 1989.
  - 135 The primary emphasis has since remained on text production although over time efforts have been directed towards database development and in communication through the World Wide Web. On the other hand, organizational overheads began again to increase, a factor contributing – along with a slower than expected rate of publication – to the loss in 1999 of renewed National Science Foundation funding.
  - 136 Malyshev, 1975; Jäger, 1976.
  - 137 Jäger, 1976. A revision of Jäger's map appears as Map I of this *Guide*.
  - 138 Gould, 1958.
  - 139 Gould, 1962, 1968–72.
  - 140 Walters, 1954. A significant part of the equipment used for this project is now in the Computer Museum, Boston, Mass., U.S.A. The records remain available through the Environmental Information Centre of the U.K. Natural Environment Research Council. For the *Atlas* see 660.
  - 141 PRECIS has been documented in several contributions, e.g., Gibbs Russell and Gonsalves, 1984.
  - 142 Heywood and Derrick, 1984; Heywood, 1989. The European Floristic, Taxonomic and Biosystematic Documentation System (usually known as ESFEDS) was executed in a basic form between 1981 and 1987 but did not become permanently established.
  - 143 Pankhurst, 1975, 1978, 1991.
  - 144 A strong sense of caution was advanced by Shetler (1974*b*) with particular reference to the then-recently terminated Flora North America Program.
  - 145 Allkin and Bisby, 1984. Reports from more recent symposia on biological information handling include Bisby, Russell and Pankhurst, 1993, and Hawksworth, Kirk and Dextre Clarke, 1997.
  - 146 Among recent developments are a greater demand for supporting data as well as more color imagery and artwork. There is also an increasing interest in interactive keys. For practical and financial reasons, these demands are best accommodated by electronic media.
  - 147 Polhill, 1990.
  - 148 More recently there has been an increasing, somewhat fundamentalist emphasis on the monophyly of major taxa; with this have come debates on the relationship of phylogenetic approaches to the traditional, hierarchically based 'Linnaean' structure of biological classification. In floras, however, the impact of these developments has so far been relatively limited, reflected mainly in the adoption of more narrowly defined 'Jussieuan' families (a notable feature of the latest version of the Takhtajan system, as opposed to that of Cronquist). No totally worked-out cladistically based system of families of flowering plants has, however, yet been published (that in Judd *et al.*, 1999, pp. 166–167, does not cover all families). Floras, at least in the near future, have still perforce to follow one or another of the more traditional Gisekian genealogical/geographical ('Dahlgrenogrammic') or Steiner-tree (Haeckelian) schemes (cf. Judd *et al.*, 1999, pp. 37–38).
  - 149 Blake and Atwood, 1942.

## Floras at the end of the twentieth century: philosophy, progress and prospects

It happens that nearly every tropical flora is fundamentally unsuited to its subject . . . they not merely discourage the aspirant by so aggravating his difficulties but they expose their authors to unlearned ridicule.

Corner, *New Phytol.* **45**: 187 (1946).

The Flora of the future will be a standardized data bank. It will be open-ended, dynamic and ever-growing. . . . Thus [it] will become a huge memory or series of linked memories available on-line to all users at any place and time.

Shetler, 'Flora North America as an information system'; *BioScience* **21**: 524–532 (1971).

The whole question of the design of Floras requires considerable attention. Little advance has been made in practice during the last century.

Heywood, 'European floristics: past, present and future'; in *Essays in plant taxonomy* (ed. Street), p. 288 (1978).

A regional flora is not the place to propose a new family classification, but the Flora writer serves botanical knowledge well if attention is drawn to the pitfalls that can result from a misuse of available characters.

Hedge, in *Contributions selectae ad floram et vegetationem Orientis* (eds. Engel *et al.*), p. 313 (1991).

The current method of Flora writing employed . . . satisfies only specialists, who are generally not living in the geographical areas where information is quickly required for practical purposes. . . . Floras currently leave it to the end users to do as best they can in interpreting their highly technical content.

Jarvie and van Welzen, *Taxon* **43**: 444 (1994).

In the late 1990s a new Flora is not simply a book, but a means of structuring and delivering botanical information.

Blackmore, 'Aspects of the design for a Flora of Nepal'; in *International seminar-cum-workshop on the flora of Nepal* (coord. Jha, Adhikari and Shrestha), p. 4 (1997).

### Introduction

In the preceding chapter emphasis was placed on substantive developments in flora-writing. Here an attempt is made to consider the range of aims, styles and content which are encompassed by the term 'flora' – a diversity with many stages<sup>1</sup> – and to relate this to methodological, philosophical and historical movements in botany and beyond. Both orthodox and alternative styles will be examined, with reference to both professional respectability and user experience, and some suggestions put forward. Some themes advanced here are: (1) that different needs call for different approaches; (2) that too many key data have been 'lost' in translation from research to publication; (3) that many so-called 'research' floras are sometimes as much political statements as they are substantive contributions to knowledge; (4) that effective but judicious use should be made of available information technology and current methods of communication; and (5) that documentary treatises apart, floristic works should be written in non-technical language and well illustrated.

As indicated in Chapter 2, a major focus in plant taxonomy in the last half-century has been the writing of floristic works. With the spread of professionalism from late in the eighteenth century, floras became one of the principal forms of contact between *savants* and users. Indeed, such has been their predominance since 1945 that several commentators have been moved to speak of the post-World War II era and beyond as an 'Age of Floras'.<sup>2</sup> The activities of most larger botanical research groups have featured one or more 'big', often tropical flora projects – be they for countries, lesser polities or supranational regions – along with 'domestic' national, state or local floras or manuals. Very often these projects have involved extensive collaboration

among botanists, so facilitating the writing of individual family accounts by specialists. Management of flora projects has taken various forms; sometimes they have been the work of one (or more) individuals while others have been the collective work of one or more institutions, often over many years or even decades. For long, however, relatively little was said about how they should be written, the way in which their message can best be spread, and their relationship to the political and social environment as well as the needs of the different countries concerned.

Yet since publication of the original edition of this work in 1984, more attention has indeed been given to the principles and practice of flora-writing and presentation. This arose from four general developments: firstly, a greater awareness of, and intercommunication with, potential users; secondly, an increasing need effectively to justify projects in relation to changing funding and management practices; thirdly, internal reviews of existing and projected programmes, and finally – but not the least – the great spread and rapidly falling relative costs of information technology.

Floras have also acquired a more distinct warrant within systematic botany. They formed, for example, a distinct area of enquiry at International Botanical Congresses in 1987 and 1993.<sup>3</sup> In 1988 a workshop, 'Floristics in the 21st century', was held in the United States as part of the development process for the new *Flora of North America*.<sup>4</sup> In 1986 and, more fully, in 1989, floristic inventory in the tropics was extensively reviewed,<sup>5</sup> and in the latter year a workshop was held at Leiden as part of a re-examination of the *Flora Malesiana* programme.<sup>6</sup> In 1990 a conference on plant species information handling took place at Delphi, Greece.<sup>7</sup> Individual contributions have appeared with respect to such issues as accessibility, presentation of information, new electronically based techniques, and actual or potential applications of floras.<sup>8</sup> Changes in institutional planning and agency support patterns have also taken place. Nevertheless, there remains scope for a continuing examination of the content, form and purpose of floras. These topics form the main focus of the present chapter.

### **Philosophy and purpose of floras**

The design and writing of floras and related works has long been a rather conservative sphere of activity. Often there has been an unquestioned acceptance of stereotyped formats and sets of questions,

regardless of the real worth of current floristic content and styles. As discussed in Chapter 2, these formats largely became crystallized between 1805 and 1870 although the descriptive flora as such dates back to Linnaeus. The subsequent passage of time has been marked chiefly by changes in content, more illustrations, and improved keys. Some classes of works such as manual-keys, excursion guides, works on trees and shrubs, and 'applied' floras evolved to meet particular practical needs. At another level, the large-scale enumeration was introduced to meet particular needs, such as the inventorying and classification of the often large floras of humid tropical lands within limited means and times.

An examination of the relevant literature as well as personal observations suggest the existence of two views – both of long standing and to some extent at odds – concerning the central purpose of floras and related works. This dichotomy, prompting the belief by van Steenis<sup>9</sup> that most floras were 'dualistic' in nature, is a result of contrasting aims. One is communication (through keys, descriptions, illustrations and commentary), while the other is archival or encyclopedic.<sup>10</sup> Van Steenis believed the problem could be resolved in north temperate regions but, due to the sheer size of the flora in most areas, not so in the tropics.<sup>11</sup> The question is more general, however, as was recognized long ago in Europe and, to an increasing extent, in North America and elsewhere.<sup>12</sup> Indeed, it may be regarded as a natural intellectual development as a flora becomes better known and documented.

The first philosophy – one which sees floras as tools for communication (through identification and basic information) – recalls the first aphorism of Bentham quoted in Chapter 2: 'The principal object of a Flora of a country, is to afford the means of determining (i.e. ascertaining the name of) any plant growing in it, whether for the purpose of ulterior study or of intellectual exercise'. The relative value of this philosophy has several times been emphasized by Heywood as well as by other authors.<sup>13</sup> Heywood argued that floras were not necessarily intended to serve as sources of strictly comparative data; their main function was to address themselves to certain questions about the plants of a given area: (1) what there is, (2) how they may be recognized, and (3) where they may be found. To this end floras should include keys, descriptions, necessary auxiliary information, and essential nomenclature, synonymy, and citations. With modifications – notably the

use of illustrations – several other authors have adopted this point of view, among them Shinnars and (more recently) Palmer, Wade and Neal in North America, Brenan and Jacobs for, respectively, Africa and Southeast Asia, and, in Malaysia, the editors of *Tree flora of Sabah and Sarawak*.<sup>14</sup>

The second philosophy – in which floras are seen as essentially archival or encyclopedic – has its modern origins in such works as *Nova genera et species plantarum* (1815–25) and *Flora brasiliensis* (1840–1906). This approach rests in turn on the herbalist tradition (and predilection for detail) of Central Europe – manifest in such works as Fuchs' *De historia stirpium commentarii insignes* (1542) – wherein also lie the philosophical origins of such late seventeenth century works as Rheede's *Hortus malabaricus* and Rumphius's *Herbarium amboinense*.<sup>15</sup> Current manifestations include many recent and current large-scale flora projects, their justification being, according to Shetler, that floras should be 'a physical repository of descriptive data about plants which are organized and formatted, usually in book form, so as to answer a time-tested set of prescribed questions'.<sup>16</sup>

The differences between these two philosophies as related to developments in the nineteenth and twentieth centuries have been discussed, with many examples, in Chapter 2. It was there noted that for floristically lesser-known parts of the world the encyclopedic flora has been much favored, but that the realization of such works – commonly still by traditional means – involved a great investment of time and manpower, with gradually falling productivity (often as larger or more 'difficult' families, such as the Rubiaceae, were addressed). In the words of one commentator, such works were veritable botanical 'booby-traps', with progress measurable in decades, not years.<sup>17</sup> Later commentators have spoken of *centuries*.<sup>18</sup> By contrast, projects with more limited objectives stood a better chance of successful completion within reasonable time-spans, and more often than not were in spirit 'tighter'. As David Webb noted in his *Flora Europaea* valediction, close editorial control was at all times essential.<sup>19</sup>

Sometimes, though, the two philosophies have been confused. In the 'introductory notes' to one flora project underway at the time in the region where these words were originally written, it was stated that, in order to make available 'information' on the flora (then very scattered), the sponsoring institutions have 'embarked

on a project to produce, in a handbook format, a *concise Flora*' [*italics added*]. By contrast, the first volume of the flora concerned suggests that the work, even with some information having been relegated to 'technical supporting papers', is somewhat expansive. In one small family, four pages of text are required to deal with three relatively easily recognized species. Rather than being 'concise' this flora brings to mind larger-scale works such as *Flora of Panama* or *Flore d'Afrique centrale*. Other examples demonstrating confusion of objectives or the more underlying effects of academic tradition could be given. Such a situation may have (at least partly) contributed to an impression that there is an 'uninterrupted continuum' among floras.<sup>20</sup>

These criticisms notwithstanding, it remains true that without a strong taxonomic and documentary foundation the achievement of conciseness in floras of tropical areas has been difficult and but rarely overcome. Works such as the second edition of *Flora of west tropical Africa*, *Flore des plantes ligneuses du Rwanda*, *Flowering plants of Jamaica*, *Flora of Java*, *Tree flora of Malaya*, *An excursion flora of central Tamilnadu, India*, *Flora of Pico das Almas* and *Flora of central French Guiana*, all published since World War II, have generally depended upon antecedents. These latter comprise major parent works or a long tradition of externally based or local botanical work or any combination thereof.<sup>21</sup> Yet even with an actual or potential higher impact the concise works have remained fairly traditional or feature traditional elements. Awkward compromises have not rarely been apparent, with the result that key information is lost or very scattered.<sup>22</sup>

### Content, style and methodology of floras

In Chapter 2 the substantive evolution of floras and related works was described, with examples. It was there noted that their basic principles and practice had largely been formulated by Linnaeus<sup>23</sup> and afterwards Lamarck and, in the nineteenth century, by A.-P. de Candolle, the Hookers, Bentham, and A. de Candolle.<sup>24</sup> Further contributions were made in the mid-twentieth century by, among others, van Steenis, Brenan, Turrill, and Heywood.<sup>25</sup> For North American workers important early precedents were set by Torrey, Gray, Britton, Fernald, A. S. Hitchcock, S. F. Blake, Lawrence, and Radford.<sup>26</sup> The last few decades have seen the introduction and spread of information technology, a major phenomenon more appropriately dealt with in the next section.



### General developments

The influence of the many discoveries and developments from so-called 'general botany' (*allgemeiner Botanik*) and other areas of biology from the mid-nineteenth century onwards on the actual writing of floras was only gradual. The inclusion of analytical keys (save in most enumerations and checklists) became a norm, along with more critical commentary and a greater emphasis on geographical and ecological data. This reflected a growth of interest in field botany as well as in plant geography and ecology.<sup>27</sup> Twentieth-century refinements have included additional categories of biological and other data (notably chromosome numbers), simplification of nomenclature, discussion of phyletic relationships, and more explicit expositions of taxonomic philosophy along with other topics such as increased consideration of habitats, variability, hybridism, introgression, clines, and conservation status.<sup>28</sup> Information from pollen analysis, comparative phytochemistry, anatomy, and reproductive biology have also been introduced but these are as yet mainly at generic and family level, especially in the larger 'research' floras.

A notable development of the last four decades has been the provision of 'guidelines' for contributors, such as the *Flora Europaea* 'Green Books' and *Tree flora of Sabah and Sarawak: guide to contributors*.<sup>29</sup> The writing of floras having now become largely a collaborative process, such handbooks are now essential.<sup>30</sup> Guidelines on the content and writing of floras have also appeared in textbooks of taxonomy. A noteworthy exposition of general principles appeared in Davis and Heywood's 1963 textbook, *Principles of angiosperm taxonomy*.<sup>31</sup> For 'traditional' manual-flora writing in North America (and other areas under North American intellectual influence) a number of the previously mentioned authorities published definitive and widely used treatises.<sup>32</sup>

What was prescribed in the most recent of these (Radford's *Vascular plant systematics*, 1974) would, it is fair to say, have been clearly recognizable to the leading nineteenth-century writers on floristics. A similar point was made by Meikle in a consideration of contemporary British floristic writing.<sup>33</sup> Indeed, until comparatively recently many floras could be seen as not so very different from those written by Torrey, Gray, Bentham, J. D. Hooker and their contemporaries.<sup>34</sup> The main differences are, as already indicated, the almost universal use of analytical keys and the inclusion of many more classes of data. Notable among the latter

was the indication of detailed distribution, particularly in U.S. state floras where the use of county dot maps for all species – first introduced by Deam in his *Flora of Indiana* (1940) – became widely popular.<sup>35</sup>

It is thus evident that, consciously or not, the 'classical' formula was one that was widely accepted, even after more than 150 years. It represented a successful combination of scientific objectivity and literary style, and its keys provided means of identification. Even by the 1950s it was passionately defended by van Steenis who argued that 'besides . . . ecology and distribution, and nomenclature, nothing needs to be added to Bentham's classic exposition of a purely descriptive Flora'.<sup>36</sup> Variations introduced by the Britton 'school' in North America, especially in *North American Flora* (1905–57, series II, 1954–), never gained lasting popularity and after 1930 the older precepts imparted in the name of the nineteenth-century masters enjoyed renewed support.<sup>37</sup>

For the larger 'research' floras more or less amplified versions of the classical formula, following the precepts of *Flora brasiliensis* but now presented in convenient octavo or quarto formats, have become standard.<sup>38</sup> Examples of mostly post-World War II works include the greater part of those written for the tropics, both by European authors (e.g., *Flore du Gabon*, *Flora of Thailand*, *Flora Zambesiaca*, *Flora de Cabo Verde*) and by Americans (e.g., *Flora of Guatemala*, *Flora of the Lesser Antilles*, *Flora of Panama*, *Flora de Colombia*), as well as several temperate-zone works. Among the latter are *Flora SSSR*, *Flora reipublicae popularis sinicae* (in style and philosophy modeled after *Flora SSSR*), former Soviet-republican and Chinese provincial floras, *Flora of Japan*, the regional floras of the Argentine, and *Flora of Southern Africa*. Among the more concise of this genre – and at the same time very true to the Benthamian tradition – are *Flora of Turkey* by Davis and collaborators (1964–88), *Flora of Australia* (1981–), *Flora of Somalia* edited by Thulin (1993–), *Flora Mesoamericana* (1994–), and *Flora of the Venezuelan Guayana* (1995–).

### Enumerations, checklists and 'manual-keys'

Apart from those already discussed, other long-established and stereotyped formulae of flora-writing have also remained in vogue despite some criticism, especially of the enumeration.<sup>39</sup> Practical considerations, however, dictate that for many areas enumerations will continue to be produced. These moreover

lend themselves particularly well to electronic methodology. Among notable recent works in this genre are *Prodromus einer Flora von Südwestafrika* (1968–72) edited by Merxmüller, *Enumeration of the flowering plants of Nepal* (1978–82) by Hara *et al.*, and the electronically supported *Vascular plants of British Columbia: a descriptive resource inventory* (1977) by Taylor and MacBryde, *Provisional checklist of species for Flora North America (revised)* by Shetler and Skog (1978), *Med-Checklist* (1984–), *Énumération des plantes à fleurs d'Afrique tropicale* (1991–97) by Lebrun and Stork, *Catalogue of the flowering plants and gymnosperms of Peru* (1993) by Brako and Zarucchi, *Catalogue of the vascular plants of Ecuador* (1999) by Jørgensen and León-Yáñez, and *Plants of southern Africa: names and distribution* (1993) by Arnold and de Wet. The first-named among the above contains keys, a feature unusual in an enumeration but much to be commended, while the last two respectively account for 16 087 and 21 397 species. Less critical works also continue to appear, some merely based on source extraction. A list of desirable criteria has been furnished by Wisskirchen and Haeupler in their *Standardliste der Farn- und Blütenpflanzen Deutschlands* (1998).<sup>40</sup>

With respect to 'manual-keys', this formula likewise remains in wide use for works of identification. Examples include the greater part of the 'routine' floras of Europe, the *opredel'iteli* of Russia and neighboring states, and similar works in other continents such as *Flora of the Sydney region* by Beadle *et al.* (1963; 2nd edn., 1972; 4th edn., 1994), *Flora of the Pacific Northwest: an illustrated manual* by Hitchcock and Cronquist (1973), and the unillustrated three-volume *Flora of Java* by Backer and Bakhuizen van den Brink, Jr. (1963–68). These should not, however, be regarded as substitutes for more definitive descriptive floras or information systems.

#### 'Biosystematic' information and 'critical' floras

Among the most important developments in biology of the first half of the twentieth century were the rise of ecology (plant geography), population biology, experimental taxonomy and 'biosystematics'.<sup>41</sup> From the 1920s onwards they brought in a return to broader species concepts (as well as renewed efforts towards 'objective' definitions of genera). A prevailing conservative approach to floras, however, evidently delayed or limited the consistent incorporation of 'biosystematic' information in some parts of the world.

This was particularly evident in the United States, a seemingly curious phenomenon to which Raven drew attention in the 1970s in a review of progress in these subdisciplines.<sup>42</sup> Among the first manual-floras demonstrating consistent use of the new classes of information associated with experimental taxonomy and biosystematics were *Flora of the British Isles* by Clapham, Tutin and Warburg (1952; 2nd edn., 1962) and the first volume of *Flora of New Zealand* by Allan (1961). With its substantial commentary covering hybridism, introgression, and other patterns of variability, the latter became almost a 'critical' flora. An early North American work of this type was *A California flora* by Munz and Keck (1959; supplement, 1968). More widespread incorporation of 'biosystematic' data in that continent came only around the end of the 1960s, with representative works of the period being *Flora of the Queen Charlotte Islands* by Calder and Taylor (1968), *Manual of the vascular flora of the Carolinas* by Radford *et al.* (1968), *Manual of the vascular plants of Texas* by Correll and Johnston (1970), *A flora of tropical Florida* by Long and Lakela (1971), and *Utah plants: Tracheophyta* by Welsh and Moore (1973). However, only the Queen Charlotte Islands flora was truly a 'critical' work along the lines of *Flora of New Zealand*.

It was in Central Europe, however, that the first real 'critical' floras appeared, some as complements to field-manuals. Although not representing a distinct stylistic class, such floras give particular emphasis to variation, infraspecific forms, and agamic 'microspecies', and usually also make reference to more detailed treatments of taxonomically 'difficult' groups.<sup>43</sup> Among the earliest was *Flora der Schweiz* by Schinz and Keller (1900), whose *Kritische Flora* had by 1914 appeared as a separate volume; this latter remains something of a landmark.<sup>44</sup> A similar, though more recent, key work is Rothmaler's *Exkursionsflora von Deutschland*. Its part IV (*Kritischer Band*), based upon extensive cooperative research from the 1930s to the 1950s (and continuing to the present), first appeared in 1963 (with several subsequent revisions). In 1996, the first of the five projected volumes of Sell and Murrell's *Flora of Great Britain and Ireland* was published, reviving an idea first expressed with Moss's *Cambridge British Flora* (1914–20). Some floras have also incorporated a significant amount of chorological and phytosociological data; notable among these is Oberdorfer's *Pflanzensoziologische Exkursionsflora* (7th edn., 1994). A complementary, but specialized, genre was the series

of cytotaxonomic conspectuses prepared and published for various groups and areas by Áskell Löve and collaborators beginning in the late 1940s. On the whole, however, the influence on floristic writing of what Merritt L. Fernald once termed ‘camp-ing’<sup>45</sup> has come through gradual diffusion into traditional flora formats. Radical departures have been uncommon.

### ‘Generic’ floras

A less common approach to the problems of time and resources in areas of high diversity has been the ‘generic’ flora. From a historical point of view, they had antecedents in the *genera plantarum* of the eighteenth (Linnaeus, de Jussieu, Lamarck and Poirét) and nineteenth (de Candolle, Endlicher, Bentham and Hooker, and later Engler and Prantl) centuries. Such works were developed as a form of communication about the floras of continents where a full account (to species level) was not practicable but where a desire for a descriptive account existed. Important early examples were *Genera of North American plants* (1818) by Thomas Nuttall, *Genera florum americana boreali-orientalis illustrata* (1848–49, not completed) by A. Gray (with drawings by I. Sprague), and *Genera of South African plants* by W. H. Harvey (1838; 2nd edn., 1868, by J. D. Hooker). Afterwards, in the wake of *Genera plantarum* and *Die natürlichen Pflanzenfamilien* generic floras largely fell from favor. Save for one major Asian work (the incomplete *Handleiding tot de Kennis der Flora van Nederlandsch-Indië* of 1890–1900 by J. Boerlage), the genre became largely Afro-Malagasy. The leading African exemplar of the first half of the twentieth century is a successor to Harvey’s work, *The genera of South African flowering plants* by E. P. Phillips (1926; 2nd edn., 1951; 3rd edn., 1975–76, by R. A. Dyer), while in Madagascar after World War II the French forest botanist R. Capuron produced *Introduction à l’étude de la flore forestière de Madagascar* (1957). However, interest continued elsewhere, with the Austrian-American botanist Theodor Just in the 1950s making a strong plea for more ‘genera’ in place of (or in addition to) big semi-monographic ‘research’ floras.<sup>46</sup> This may have at least partly inspired what became the *Generic flora of the southeastern United States*, initiated at the Arnold Arboretum of Harvard University and published in installments since 1958 (currently in *Harvard Papers in Botany*).

In more recent years, a renewed role for ‘generic’ floras has emerged with the realization that they are

suitable vehicles for illustrated keys to floras of lesser-known regions. This is manifest in *A field guide to the families and genera of woody plants of Northwest South America (Colombia, Ecuador, Peru) with supplementary notes on herbaceous taxa* by A. Gentry (1993). More recently, this approach has been extended to Madagascar where a revision and expansion of Capuron’s manual to cover all vascular genera is in progress. Inclusion of selected references to monographs, revisions and other pertinent works as ‘aids’ would, however, make the works more useful for those interested in seeking further information.

### Illustrations and maps

While among recent floras the *Flora of Java* was unusual in being without illustrations, most modern works have at least some figures; those billed as ‘illustrated floras’ attempt to depict every species covered. As already noted, technological changes from late in the nineteenth century made possible, at a lower unit cost, a greater dissemination of figures (although color reproduction in print remains more expensive).<sup>47</sup> Illustrations are in fact often more effective than descriptions in conveying information about plants and their characters.<sup>48</sup> For the humid tropics this is of particular import in view of the presence of so many different kinds of plants (relative to the cool-temperate zones where most botanical thought has been shaped) – and where the perception of most people is rather more visually than literarily oriented. This was early recognized by Asian writers, notably Tomitaro Makino who, after some uncompleted series of plant portraits (1888–1911), many critical taxonomic papers, and (with K. Nemoto) a conventional manual (1925), produced in 1940 a fully illustrated work, *Nippon shokubutsu zukan (Illustrated flora of Japan)*.<sup>49</sup> This and similar East Asian works are atlas-floras comprising small figures with parallel text, any analytical keys playing a supporting role.<sup>50</sup> The more costly early floras by European authors, like the sixteenth- and seventeenth-century herbals, also were well illustrated, the figures lending an element of prestige, and following the introduction of lithography in the early nineteenth century figures gradually became more common in humbler guides and reference works, good examples being the illustrated edition of Bentham’s *Handbook of the British flora* (1865) and Bonnier and Layens’ *Nouvelle flore du nord de la France et de la Belgique* (about 1887) as well as the latter’s slightly later

*Tableaux synoptiques des plantes vasculaires de la flore de France*, this last with 5291 small figures.

It thus remains surprising that Cornelius Backer, a leading early twentieth century Dutch authority on the Javanese flora, was so opposed to them in a formal flora.<sup>51</sup> Paradoxically, however, his manuals for weed identification are abundantly and well illustrated. Backer, however, was not alone; in Macbride's *Flora of Peru* figures similarly are wanting and in Ridley's *Flora of the Malay Peninsula* they are incidental. Gradually, however, their value became more widely recognized and, as the costs of reproduction fell in the face of further technological developments, their use became widespread. By the 1970s some tropical as well as temperate works illustrated most if not all species. Among the former are *Flora del Ávila* (1978) by Steyermark (Venezuela) and Huber and *Flora of the Rio Palenque Science Center* (1978) by Dodson and Gentry (Ecuador). This trend has by and large continued to the present; even major works such as *Flora of North America* now feature illustrations (as well as distribution maps) of all species, while in *Flora da Reserva Ducke* (1999), from Amazonian Brazil, all the illustrations are in color. On the other hand, they are absent from *Flora Mesoamericana* – potentially a serious problem in attempting to key out closely related taxa in areas of high diversity such as Mexico and Costa Rica. They were also at first omitted from *Flora of China*; however, pressure from users has since led to the issue of companion atlas-volumes. Good illustrations are in the author's view very important to field botanists and others without ready access to a large herbarium. With the spread of virtual media, their consistent use becomes even more feasible.<sup>52</sup>

Another feature of floras which has now become widespread is the use of distribution maps. Their application has paralleled the growth of interest in biogeography and chorology, but until the 1930s they were largely confined to monographs and revisions or specifically biogeographical papers. Moreover, they had not yet attained recognizably modern forms. For this reason, Lebrun and Stork in their index of distribution maps of African plants (see **Division 5**) took 1935 as a base line. In North America, the publication of Deam's *Flora of Indiana* (1940) marks the beginning of their continuing use there, although a first uniform application of county-based distribution maps dates from the end of the nineteenth century (in *Flora of Kansas*, 1898–99, by A. S. Hitchcock). The spectacular devel-

opment of computer-assisted mapping technology in stages since World War II as well as in printing has also manifested itself in many ways, both through the production of national and state cartographic atlases and within more conventional floristic documentation. Distribution maps have now become widely used, even in large-scale works. Indeed, in *Flora of Australia* and *Flora of North America* all species are being mapped. There have also been attempts to combine layers of information in print (with more possibilities using color), by the use of overlays, or virtually as a product of a computerized geographic information system (GIS). The latter is among the facilities offered by FloraBase in Western Australia.<sup>53</sup>

### Floras and information technology

While there has been much progress in recent decades with respect to the style and substance of floras and related works – particularly following their re-examination as potential sources of comparative data – it is the development of information technology which can now be seen as having had the greatest impact, particularly by the 1990s with the large-scale spread of public networks with graphical interfaces. Earlier, it had come to be seen not only as offering new ways of storing and handling information but also as having the potential to provide some relief from what was coming to be seen as its version of the 'information crisis'. The introduction, growth and spread of information systems as aids to the handling of floristic information, and – more recently – as vehicles for its dissemination, furnishes the theme of this section; it will be argued that in effect traditional floras and checklists have now become manifestations in space and time of what is a continuously changing source of data – a view first espoused by S. G. Shetler in 1969 and quoted at the beginning of this chapter.

#### *The 'information crisis'*

As we have seen in the preceding section, the manifold developments in biology in the twentieth century not unnaturally led to a veritable explosion in the kinds of data appropriate to a flora. Indeed, by 1971 systematics as a whole was seen by Heywood as facing an 'information crisis'.<sup>54</sup> All this made the question of what to include in a given work still more acute. A 'universal flora' came to be seen as no longer practical if ever it was. The introduction of computers and advances in information technology over the previous

decade or so also effectively made possible more quantitative approaches to classification which, in addition to supposedly more 'objective' philosophies, also required – as far as possible – uniform setting-out of characters in descriptions. With coverage of the plant world in revisions and monographs very spotty, attention turned to floras as supposedly being rich sources of comparative data. Only then did the question of objectives in floras again impinge seriously on systematics: were they documentary, or were they – as Lamarck, Bentham and Hooker had seen them – primarily a means for identification?

It was Leslie Watson who, also in 1971 – after exercises with the large genus *Salvia* (Lamiaceae) as well as higher taxa in Lamiaceae and other families – first seriously argued that floras – even the more elaborate ones – were, after all, objectively limited (and ideally should remain so).<sup>55</sup> For this reason, he called for a return to the Benthamian tradition of 'concise' works for practical use; the kind of information which went into elaborate 'archival' floras was in reality more appropriate to other kinds of taxonomic publication or for storage and retrieval through data banks or other non-print media.<sup>56</sup> Seriously comparative systematic studies really required more elaborate, specialized data sets. Similar ideas were mooted in the original Flora North America (FNA) Program, which planned for the establishment of an information system along with publication of a relatively concise conventional flora.<sup>57</sup>

Necessary choices of information on the part of individual scholars or groups for floras were for the most part pragmatic, depending on means and circumstances, although, as we have seen, tradition was often followed. Some kinds of potentially useful data, however, would inevitably be omitted and at a later date might not even be retrievable.<sup>58</sup> Watson believed that information selection and presentation should be more explicit and defined, in a not dissimilar fashion to Britton 75 years before. In arguing for a start that the two main philosophies of flora-writing – the 'archival' and the 'practical' – should be separated and that a given work should follow one or the other, he considered that confusion of objectives in current floras was frequent and that many represented unhappy compromises. They were neither definitive sources of comparative data nor practical tools for identification. There was little recognition of the desirability under modern conditions to separate these functions. Watson's closing challenge was: 'we have all these advantages

[computerization, philosophical analysis, masses of data, etc.], yet have more difficulty in getting to grips with real problems than Bentham did'.<sup>59</sup> This conundrum has in various forms continued to the present notwithstanding the great advances in information technology over the intervening three decades. Paradoxically, however, with the functional separation of print and information system now seriously possible it may become less of an issue. Indeed, with floristic descriptions and other information organized in the form of defined fields, blocks or hypertext-links, automation of such features as key generation, data analysis and map generation, and the provision of (as far as possible) consistent content, the design and implementation of the information system along with 'report generation' (i.e., the formulation of virtual or printed products) are arguably now of greater importance than mere choice of styles or, as we shall see, concern for an 'ideal flora'.

#### *Technological and methodological developments*

Increased exploitation of computers and software – here referred to as 'information technology' – was not unsurprisingly seen by its advocates as the best way forward in the face of Heywood's postulated 'information crisis'. But, as will be seen, its real promise has taken more than a generation to become manifest. Not only was progress inevitably constrained by questions of cost-effectiveness – which became more of an issue as the relative worth of science budgets began to fall in the 1970s, a time generally of high inflation – as well as technical developments but, as was contemporaneously suggested by Heywood, 'until very recently any suggestion that information processing was a major role of taxonomy was vigorously repudiated as being a pursuit unworthy of scientists in this evolutionary age'.<sup>60</sup> The termination in 1973 of the original FNA Program shortly after commencement of its operational phase not unnaturally also caused some soul-searching.<sup>61</sup> Since then, advances in information technology have played an important if not always leading role in the field, given financial as well as conceptual and other constraints.<sup>62</sup>

The first major computer-assisted flora programmes were not mounted until after the introduction of 'third-generation' mainframe computers (with enhanced central memory and greater speed but still using punch-card and paper tape input and magnetic tape storage). As well as the already-mentioned FNA,

there were *Flora de Veracruz* and *Flora of British Columbia*. The original FNA (1966–73) was the most ambitious but ultimately was premature and not cost-effective; as already mentioned, it was terminated very early in its operational phase. Its two major offshoots in Canada and Mexico continued, and additional systems began their development in other parts of the world. While the British Columbian project was ultimately reduced in scope to a checklist, *Vascular plants of British Columbia*,<sup>63</sup> that in Veracruz, with a vascular flora of some 8000 species, became a serious floristic information system – the first in a tropical polity as well as among the earliest worldwide.<sup>64</sup> Its principal goal – a descriptive *Flora de Veracruz* – began publication in 1978.<sup>65</sup> About the same time, the concept of an information system as a complement to *Flora Europaea* began to be explored; a central idea was the application of the then-new ‘Videotex’ system of passive visual display pages running on the more compact and less costly ‘minicomputers’ by then entering the market.<sup>66</sup> A generally closer relationship between floras and information technology would, however, not develop more seriously until the 1980s.

Significant advances in such areas as key generation and computer-assisted identification,<sup>67</sup> collections data,<sup>68</sup> taxonomic text compilation, storage, retrieval and generation using custom routines,<sup>69</sup> and geographical information systems nevertheless continued, while the formation of biological data banks has remained one of the priorities for systematic biology.<sup>70</sup> The advent of desktop and, somewhat later, portable microcomputers along with greatly increased storage capacity including magnetic ‘hard’ disks and, subsequently, CD-ROMs promised further advances which began to be exploited as the 1980s progressed.<sup>71</sup> With the spread of database, word-processing and text-formatting software the production in particular of documented enumerations and checklists became much easier, and by the mid-1980s several examples, some substantial, had appeared.<sup>72</sup> But until the spread of networking, floristic information systems perforce remained solitary entities; external communication was largely limited to paper or transferable magnetic or optical media.

#### *Floras on-line: an ontological revolution*

An entirely new dimension, however, opened after 1986 with the advent and expansion of the modern Internet and the appearance of hypertext, markup

language, navigation protocols, browser software and, in 1992, the World Wide Web. The arrival shortly afterwards of browsers with graphical user interfaces and interactive capability (firstly Mosaic, then Netscape and Internet Explorer) has since enabled the ‘Net’ to develop into its present form and attract worldwide interest.<sup>73</sup> Continuing evolution, including falling relative costs and wide availability of suitable media and their operating devices, ensures that the technical possibilities for information structuring, exchange and integration have, and will become, effectively unlimited.

With respect to floristic and systematic botany, these latest developments mean in effect that computer- and network-based floristic information systems ontologically are now definitive, as Shetler had predicted. In the space of only a few years, they arguably have overtaken and enveloped traditional approaches to floristic information and documentation – including discussions of the relative advantages and disadvantages of particular formats.<sup>74</sup> The adoption of this or that style for a given floristic publication is now purely a matter of choice. Any printed materials – which for many purposes remain essential – can be based upon, and are produced from, an information system. Moreover, the advent of the Convention on Biological Diversity and the formation of the Biodiversity Information Network/Agenda 21 (BIN21) have also brought into being the formation or enhancement of national networks which may include floristic databases.<sup>75</sup>

There have not unnaturally been technical, social, legal, intellectual and, especially, financial obstacles: some new, some continuing. Technology continues to evolve rapidly, methodologies are still developing, expectations have increased, issues of authorship, copyright and intellectual property remain open, and – last but not least – the interested community still includes ‘unrepentant supporters of print’.<sup>76</sup> These have all complicated provision of, and access to, on-line floristic information. In addition, there may be questions of how new technologies and approaches are perceived among decision-makers in institutions and agencies.<sup>77</sup> Not surprisingly, the creation – and maintenance – of data banks requires long-term institutional commitment as well as substantial funding.<sup>78</sup> Finally, there may remain – as we have seen – resistance to the idea that effective information handling in systematics and floristics is as important an intellectual

goal when compared with more traditional directions such as analyses, revisions, monographs and floras. Yet taxonomic information systems *are* important, not only because potential sources for a given problem or situation are now far more fragmented than in the so-called 'golden age' of Bentham and his contemporaries, but also as under Articles 7 and 17 of the Convention on Biological Diversity contracting parties now have standing obligations respectively to identify components of their biological diversity and to facilitate exchange of information relevant to its conservation, management and sustainable use.

There are at present perhaps three possible levels of commitment to 'on-line floras'. The first, and simplest, is a Web page (or pages) advertising printed publications with only a limited amount of information conveyed on-line in basic text format. The second is represented by the provision of on-line material which attempts to be comprehensive but essentially remains processed text which has also appeared, or will appear, in print. The third, and most advanced, is the presentation of on-line information in its own right. Text, maps and graphics are carefully organized and presented and are based on links to structured data. Keys are interactive, descriptions are truly comparative, nomenclature is lexical (allowing entry to data via synonyms), and supporting information (including specimen records) is searchable. The underlying data are regularly updated and authorship is distributed. Associated print materials, while having their uses as well as status, become in effect temporal cross-sections of a dynamic system, or 'virtual flora', rather than independent entities.<sup>79</sup>

*Paper or virtual, or paper and virtual? that is the question*

The advent of the virtual flora not unnaturally raises the question: what future for printed floras and checklists? There remains considerable public demand for 'hard copy', not only for practical and symbolic value but also for citation records and personal *curricula vitae*. Printed matter – which remains independent of extrinsic modes of delivery such as software and is classically measurable – continues to carry weight as a record of progress.<sup>80</sup> Attempts at moving some larger flora projects entirely to electronic delivery have so far been successfully countered and, at least with respect to *Flora of North America* and *Flora iberica*, parallel dissemination has become current practice. This pattern

could, however, change in future with new projects developed without primary reference to printed formats, such as FloraBase in Western Australia.

A significant factor favoring a shift to virtual floras, be they delivered on-line or on transferable media, is increasing public interest in illustrations and maps. In addition, a greater range of questions is now being asked of floras, which require inclusion of more classes of comparative data or *Zeigerwerte*.<sup>81</sup> Inclusion of all these features would, however, greatly increase the bulk of printed floras (of which *Illustrierte Flora von Mitteleuropa* is perhaps an extreme example) and may in some cases, such as interactive keys or geographic information system (GIS)-based maps, simply be impossible. As already indicated, the effective limit for a traditional, single-volume, concise manual-flora is about 5000 species. Choices have thus to be made if demand continues for some form of printed publication, whether for practical or symbolic reasons.

Various approaches to this problem suggest themselves. The first is to continue primarily with print, with preparation by electronic means. This may remain the only possible option in the absence of a suitable framework for a floristic information system, or where time is limited.<sup>82</sup> A second is to develop mixtures of hard copy and electronic media wherein the latter would contain material and functions not available in the former.<sup>83</sup> Both these options would be compatible with situations where preparation of a large-scale flora forms part of bilateral or multilateral cooperation programmes, although given the requirement for a floristic information system the latter has advantages over the longer term.<sup>84</sup> A third is to adopt different styles and kinds of content relative to the number of taxa covered. Thus, for full coverage of a large national or regional flora one would produce a checklist or enumeration – of which revisions at relatively frequent intervals would be feasible – while smaller areas would become the focus of manuals.<sup>85</sup>

It is in pursuing the possibilities of simultaneous use of different media and forms of dissemination that the issues of 'common standards' become important and thus the choice of information for a given situation. This in turn relates to the recognition respectively of 'core' and 'non-core' data as proposed by Wilken *et al.*<sup>86</sup> The availability of an information system, whether on-line or on a transferable medium, makes economically feasible the inclusion of valuable

but specialized information along with color illustrations and sophisticated maps which otherwise would not have been possible. Manuals which are derived from an information system might then be limited largely to 'core' material such as botanical and common vernacular names, key synonyms, diagnoses or descriptions, distribution and ecology, and pertinent notes as well as keys and (where necessary) critical figures. 'Non-core' data and materials – as well as the 'core' – would reside on-line or on disk along with software which would make possible searches and data combinations as well as interactive identification simply not feasible in print. The introduction of slimline, lightweight 'virtual books' with enhanced battery life may further facilitate the spread of virtual floras as a primary information source on vascular plants along with monographs, revisions and world checklists which, independent of political boundaries, represent the intellectual ideal.

I thus foresee, at least over the next decade, some coexistence of media and methodologies, both traditional and advanced, but believe that in time the 'virtual flora' or floristic information system will ultimately offer more flexibility in acquisition, processing, dissemination and maintenance of what is essentially *dynamic* data. The plant world, as is well recognized, is never static and currently is under more pressure than ever; treaty obligations also stipulate that information has as far as possible to be kept up to date. Yet a place is likely to remain for print, to furnish historical cross-sections as well as visible records of personal and collective progress. Dynamism and stasis are indeed contrasting concepts, but the former is not necessarily always 'better'.

### Critiques of floras

As already noted, floristic works, large and small, have been a major feature of taxonomic botany since World War II. They remain as a whole the most recognized means for conveyance of botanical information to the public; in addition to their primary roles of inventory and identification they include data which have been applied in many different ways both within and without the biological sciences.<sup>87</sup> There have been, however, a number of criticisms of their content and presentation, particularly in recent years as the number and diversity of their users has increased.<sup>88</sup> I shall focus here on two questions: (1) the relative merits and difficulties of large- and small-scale floras, and (2) the relationship of floras with their users.

### Large- vs. small-scale floras

Large-scale floras, some with more or less natural phytogeographical limits, remain important in the programmes of many botanical research groups. They are sometimes also seen in terms of the fulfillment of cultural or national goals.<sup>89</sup> On the other hand, at the same time – and in spite of past criticism – there remains a strong demand from professionals and the public for concise one-volume country, state or local manuals for reference or field use.<sup>90</sup> Each has had their advantages and disadvantages, as I shall discuss below.

It is the smaller-scale, one- (or two-) volume works with which most users of floras are by and large likely to come into contact. As recounted in Chapter 2, such inventories have been part of the botanical canon in one or another form for more than 400 years, and currently comprise a wide range of checklists, enumerations, manuals or floras. They are designed to be more or less readily portable and are oriented to students as well as professionals and other users. Not unnaturally, however, they vary considerably in quality, and several proposals with respect to content and style have been made.<sup>91</sup>

The **smaller-scale** flora, manual or checklist is here taken as covering up to 5000 species of vascular plants. With compact writing and tight editing, it is possible to encompass such a number within a single volume. Several good examples have appeared in recent decades, all with 3000 or more species: *Manual of the vascular plants of Texas* (1970), *Flowering plants of Jamaica* (1972), *Exkursionsflora von Deutschland: Gefäßpflanzen* (15. Aufl., 1990), *The Jepson Manual: higher plants of California* (1993), and *Flore de la Suisse et des territoires limitrophes: le nouveau Binz* (2nd edn., 1994). Many more covering lesser numbers could be cited; here, compactness is easier to achieve even with the inclusion of figures for many or most species. Of these the *Jepson Manual* is perhaps the most ambitious: although in format less compact than others, it features keys, descriptions and much ancillary information including cultivation potential.

It is perhaps fortunate that in many or most temperate regions, recognized political or physical limits of nations or states generally encompass fewer than 5000 species. This has facilitated more or less regular revisions of manuals.<sup>92</sup> In many parts of the tropics, however, species numbers are simply too great relative to human and other resources and their taxonomy moreover often not or but poorly known. Lesser areas



have therefore come to be seen as suitable foci for floras and manuals, with national or state inventories taking the form of checklists such as Brako and Zarucchi's *Catálogo de las angiospermas y gimnospermas del Perú* (1993), Arnold and de Wet's *Plants of southern Africa: names and distribution* (1993), or Turner's *A catalogue of the vascular plants of Malaya* (1996–97). Several significant 'focused' tropical florulas have in such wise appeared; among them are *Flora of Barro Colorado Island* (Croat, 1979), *Flora of Pico das Almas* (Stannard, 1995), *Flora of Central French Guiana* (Mori *et al.*, 1997), and *Flora da Reserva Ducke* (1999), with several others in preparation.<sup>93</sup> Smaller tropical islands or island groups provide natural foci; for these an outstanding recent work has been *Manual of the flowering plants of Hawai'i* (Wagner, Herbst and Sohmer, 1990).<sup>94</sup> Yet none of these covers more than 2000 species, with all having required several years of work as well as a solid organization. Even then, the time required for their preparation has sometimes been seriously underestimated; intensive research at 'focus' sites has often led to numerous range extensions as well as the discovery of new taxa.<sup>95</sup> Alternative objectives in temporally circumscribed projects on tropical 'focus sites' or small polities have been the tree flora, as was partially done in *Los árboles del Arboléum 'Jenaro Herrera'* (1989–90) by Spichiger *et al.* in Peru or, more recently and fully, in *Flora da Reserva Ducke* (1999) by Hopkins *et al.*, or well-documented enumerations such as *A checklist of the flowering plants and gymnosperms of Brunei Darussalam* (1996) by Coode *et al.* and *Plants of Mount Cameroon: a conservation checklist* (1998) by Cable and Cheek.

Small-scale works in themselves have certain scientific as well as practical advantages. A work covering a relatively small but key area can encompass a significant percentage of the known species in a given polity, even in Africa.<sup>96</sup> Moreover, geographically focused work can itself be rewarding, with the discovery of new species or significant range extensions.<sup>97</sup> Another 'local' flora, *Flora of the Río Palenque Science Center* by Gentry and Dodson (1978), is now one of the few records we have of the much-destroyed lowland wet forest flora of western Ecuador.<sup>98</sup> For Barro Colorado Island in Gatun Lake in Panama, created by the construction of the Canal early in the twentieth century, there have been two florulas (1933 and 1979), thus creating a record of actual or potential changes to the flora over time. A similar record – but with its two poles nearly

100 years apart – is now available for Singapore, clearly showing the great losses as well as survivors in the face of massive urban and other development over the last century. There is thus little doubt that for well-circumscribed areas they can be valuable management as well as informational tools.

There are, however, also disadvantages with such smaller-scale, relatively tightly circumscribed works. Most objections have been legitimately scientific. Taxonomically, not all families (and genera) may benefit from specialist or other forms of first-hand review, leading to perpetuation of long-standing mis-identifications as well as taxa which should really be in synonymy (where a recent revision or monograph is not available). More generally, the ratio of species to genera is usually relatively low, making more difficult any attempt at building a picture of diversity in a larger or widely distributed genus where good separate revisions or reviews are wanting; at the same time, they may be of less value than a large-scale flora or enumeration for some kinds of biogeographic analyses. And finally, there is an element of sentiment as well as challenge: can – in spite of the seemingly ever-greater presence of micro-management in science and the inherent anonymity of the virtual world – the present generation create new, identifiable large-scale 'classics'? Or are such 'transcendental' notions of no value in a world of sometimes protracted negotiations along with decisions by committee?

It is **large-scale** floras which have long represented a *beau ideal* in plant taxonomy: at once a major contribution to knowledge, a form of social expression, and a source of recognition – sometimes permanent – for their authors or organizations. Some, such as *Hortus malabaricus* in the seventeenth, *Herbarium amboinense* and *Flora danica* in the eighteenth, *Flora australiensis*, *Flora brasiliensis* and *Flora orientalis* in the nineteenth, and *Flora SSSR*, *Flora Europaea*, *Flora of Turkey* and the almost-complete *Flora iranica* in the twentieth centuries achieved all of these aims in greater or lesser degree and have become recognized classics in the genre.<sup>99</sup> Others were grandly planned but in their time not or but little realized; such was the fate of the floras of the late eighteenth century Spanish royal botanical expeditions (including *Flora peruviana, et chilensis*) or, in the twentieth century, *Genera et species plantarum argentinorum* and the original FNA Program. Still others have been seemingly too elaborate, particularly in proportion to the area or size of flora covered – such

as *Flora de Cabo Verde* – or too ambitious in relation to available resources or the state of existing knowledge and documentation (examples being *Flore générale de l'Indo-Chine*, *Flora of Panama*, and *Flora of Southern Africa*).

#### *Project times and taxonomic productivity*

Where the flora is large, the area great, means limited, or much detail or a luxurious format demanded, long project times have been usual.<sup>100</sup> Examples initiated in the first half of the twentieth century include the first series of *North American Flora* (1905–57, not completed), *Illustrierte Flora von Mitteleuropa* (1st edn., 1906–31; 2nd (and 3rd) edns., 1935– ), the already-mentioned *Flore générale de l'Indochine* (1907–51) and *Flora of Panama* (1943–81), *Flora of Suriname* (1932–84, not completed), *Flora SSSR* (1934–64), and *Flora de Madagascar et des Comores* (1936–). Post-World War II examples include *Flora Malesiana* (1948–, now some 20 percent complete), what is now *Flore d'Afrique centrale* (1948–, presently about 50 percent complete), *Flora reipublicae popularis sinicae* (1959–, now more than two-thirds complete), *Flore du Cambodge, du Laos, et du Viêt-Nam* (1960–, yet still not that far advanced), *Flora Zambesiaca* (1960–, now about 65 percent complete), *Flora of Southern Africa* (1963, now 10–20 percent complete), *Flora iranica* (1963–, now all but complete), *Flora Europaea* (1964–80), and the monographic series *Flora Neotropica* (1966–, about 10 percent complete). In the 1970s and 1980s came *Flora of Ecuador* (1973–), *Flore des Mascareignes* (1976–), *Flora of Australia* (1981–, now some 45 percent complete), *Flora of the Guianas* (1985–), and the successors to *Flora SSSR* in eastern Europe, Siberia and the Far East. The 1990s have seen the commencement of *Flora of North America* (1993–), *Flora Mesoamericana* (1994–), *Tree flora of Sabah and Sarawak* (1995–) and *Flora of the Venezuelan Guayana* (1995–), although most of these projects had actually been initiated in the previous decade – and all of them before the rise of the Web.

Such prolonged times inevitably have raised questions – notably in more recent years – about financing as well as institutional and individual motivation.<sup>101</sup> Note was taken in Chapter 2 of the 66 years taken by *Flora brasiliensis*, but against this must be set its coverage of over 22 000 species at a time when available manpower was very much less than today. Even the energetically pursued *Flora SSSR*, with something

over 17 000 species, required over 30 years for completion, and *Flora reipublicae popularis sinicae*, faced additionally with a decade of political disruption, will have taken at least half a century by its conclusion.<sup>102</sup> The time necessary to realize *Flora of Australia* will perhaps be double the 20 years originally estimated. *Flora of Southern Africa* (1963– ) was in the 1990s even suspended for a time.<sup>103</sup> Some projects, among them *Flora Malesiana* and *Flora reipublicae popularis sinicae*, have furthermore been faced with significant increases in estimates of the total number of species to be covered in comparison to when they began.<sup>104</sup> Only those works with sharply limited objectives, defined parameters, or relatively well-known floras in terms of size have been fully realized within a generation or less. Among these are, besides *Flora Europaea*, *Flora of west tropical Africa* (1927–36; 2nd edn., 1954–72), *Flora of Turkey* (1964–88), and *Prodromus einer Flora von Südwestafrika* (1966–72). It is likely that *Flora of the Venezuelan Guyana* (of which five volumes have appeared) and *Flora iberica* (now about a third complete) will also make relatively rapid progress; with rather more variables, however, such a pace may be harder for *Flora of North America* (of which just three of 30 volumes had appeared by 1999, with one more in press).

A corollary to the increasing length of time taken per species in most 'research' floras is an evident decline in average taxonomic productivity. Whereas in the nineteenth century perhaps 250 species per year could be written up for a handbook-flora by one author (Bentham achieving a still higher rate), by the 1930s the optimum for critical semi-monographic floristic work was estimated at 80 species per man-year.<sup>105</sup> This had by 1963 further declined to 50 species,<sup>106</sup> and by 1979 was down to 15–20.<sup>107</sup> More recently, it has been suggested that the 160 species of Malesian Sapindaceae consumed the efforts of 15–20 people over 20 years.<sup>108</sup> Among the few mid-twentieth century works with comparably high productivity levels covering only partly known ground was *Flora SSSR*, but its symbolic status as well as its founders' advocacy ensured a full deployment over a generation of its host institution's taxonomic resources.

It is not to be wondered, then, that De Wolf and Jacobs<sup>109</sup> and, more recently, a workshop at Leiden<sup>110</sup> have questioned the wisdom of many large-scale projects, suggesting that more attention be paid to the preparation of 'target' as well as 'concise' works. More attention is now being paid to these suggestions, partly

through force of circumstances but also on account of changing needs and interests.<sup>111</sup> Indeed, in the world at large relatively few new 'grand' flora projects have been commenced in the last 15–20 years as compared with the mid-twentieth century, and some have been abandoned or modified (e.g., *Genera et species plantarum argentinarum*, *Flora brasiliica*, *Flora Malesiana* and *Flora of Southern Africa*).<sup>112</sup> Moreover, as we have seen, the advent of the Web has made possible 'virtual floras' such as FloraBase in Western Australia in which varying degrees of completeness or reliability are recognized and accepted in the interests of availability of information – much more of a priority or even requirement than in the past.

Yet for many botanically lesser-known areas (below stage 3 on Jäger's map) where existing documentation is poor and/or scattered, any general flora would in Symington's sense<sup>113</sup> represent 'first' or 'second' coverage and should therefore possess adequate documentation and references. Some would still argue that such works should always have priority. On the other hand, the objection would also be raised that for 'first' floras, a substantial amount of basic monographic and revisionary work is required and this must be expressed in some way in the published work, because there may be no alternative. Thus, with any advocacy of conciseness in floristic publication, careful consideration must be given to the satisfactory disposal of what is not included; too often in the past this has been relegated to a plethora of scattered outlets or even lost.

With respect to 'traditional' large-scale tropical floras a good compromise has been struck by *Flora Zambesiaca* with its relatively concise descriptions, selected specimen citations, and supporting data and references. By contrast, the inadequate specimen, distributional and bibliographical data characteristic of *Flora Malesiana* – originally conceived as a 'final' product – necessitates access to, ideally, a considerable file of associated precursory papers and other records for effective use.<sup>114</sup> At a more local level, *Flora of Java*, a 'second' flora like *Flowering plants of Jamaica* and *Flora of west tropical Africa*, similarly is not well documented; it notably lacks any consistent citation of taxonomic sources (standard revisions, monographs and other precursory papers). By contrast – and usually with a stronger historical foundation – conciseness is more easily achieved in extra-tropical works, although a larger-scale form of presentation may be desired for

reasons of prestige or thoroughness, as in *Flora boreali-americana*, *Flora of Texas* or *Illustrierte Flora von Mitteleuropa*. Even so, however, many manuals have been in the past deficient in documentation; one of the better postwar ones was Willis's two-volume *A handbook to plants in Victoria* (1960–72).<sup>115</sup> More recent manuals have, however, become less 'authoritarian'; among more 'user-friendly' features now becoming more common is the inclusion of standard taxonomic references in family and generic headings. All this is part of the question of information content and handling in floras and related works: a question never seriously considered at the beginning of the 'modern' era but which, as Heywood pointed out already in the 1970s, has grown in the last 60 years to acute proportions. The advent of the Web, the realization of 'virtual floras', and changing social demands will also, as has been suggested, bring about further discontinuities in practice, with current arguments relating to content, style and presentation becoming obsolete or taking new forms.

#### *Floras and the user*

The relationship between floristic publications and their users is among the most important in plant taxonomy and thus has frequently been a topic for discussion, with a variety of viewpoints being expressed.<sup>116</sup> In the more distant past, however, the content and style of floras were largely the prerogative of the *savant*, with generally a one-way relationship with users. The works were moreover often viewed in terms of a pedagogical setting.<sup>117</sup> Indeed, innovations such as analytical keys, diagnoses or concise descriptions, critical figures, and the use of vernacular names were all devised as study aids.<sup>118</sup> Works for purely popular consumption were derived from the more formal floras, often by enthusiasts, and did not necessarily enjoy a comparable status.

In the twentieth century, increasing demands on curricular time as well as changes in fashion have led to a relative decline or even disappearance in classroom and excursion use of floras with the result that people may be less conversant with the language of botany. What was once a relatively common currency over several generations has, like Latin, become rarer. This has for many made the more traditional floras harder to use and thus less accessible. Yet, in the same century, the growth of plant geography (or 'ecology' in the anglophone world) and its applications (including land

and wildlife research and management, environmental impact surveys, and conservation assessments) has made new demands on floras and checklists. Field data are seen as particularly important not only as an aid to applied work but also for their intrinsic value as biology has become less exclusively museum-oriented. Nevertheless, to a considerable degree the new classes of data were simply incorporated into the formats inherited from the eighteenth and nineteenth centuries. It was mainly in dendrological works where an atlas-format was gradually adopted, with considerable use of figures and photographs.

A relatively close relationship between producer and users generally existed in temperate regions, including those colonized subsequent to the Columbian and da Gama voyages. The more enterprising writers made efforts to ensure that floristic information was effectively presented, sometimes themselves preparing works for extra-scientific consumption. In recent years, collaboration among different constituencies has – as already noted – become more common; such a course governed preparation of *The Jepson Manual: higher plants of California* (1993). Similar directions have guided the development of some contemporary floristic information systems, including FloraBase in Western Australia.

It was the spread of more intensive studies of tropical floras, including the diversity and potential of forest trees, that led to problems with the use of the run of floristic literature. Until the late nineteenth century (and the advent of relatively convenient surface travel along with an improved understanding of tropical diseases) the investigation of tropical floras was largely seen as an extension of metropolitan activities; conventional styles of organization and presentation in floristic works were deemed suitable, and indeed to a considerable extent have remained so. The first potential users of tropical floras beyond their traditional ‘Banksian’ botanical constituency<sup>119</sup> were the functional plant ecologists of the late nineteenth century.<sup>120</sup> Their primary interest was, however, in processes rather than floristic diversity as such. In only a few areas of enquiry was there the potential for comparative observations which could usefully be incorporated into floras.<sup>121</sup> With respect to vegetation, their approach was largely physiognomic; the taxonomic identity of constituent species generally was of secondary interest. It was the growth and spread of community plant ecology (‘synecology’) and an increasing interest in

tropical forestry in the four decades prior to World War II – along with the beginnings of the tropical conservation movement and, not least, the greater ease of travel offered by the automobile as well as improved bus and rail services – which led to a greater appreciation of tropical floristics, particularly after 1920.<sup>122</sup> Yet much if not most of academic botany remained temperate in its orientation, notwithstanding contributions by such tropical pioneers as Adanson, the Banksian ‘circle’, Griffith and other Indian botanists, Beccari, and Warming as well as the ‘functional ecologists’.<sup>123</sup> Curricula remained conservative,<sup>124</sup> while fashions in research lay elsewhere – exemplified by the rise of population genetics and experimental taxonomy.<sup>125</sup> Indeed, it was not until after World War II and publication of Paul Richards’ *The tropical rain forest* that a renewed awareness of the tropics began to manifest itself in the field at large, at least in plant ecology.<sup>126</sup> As for the herbaria, they appeared to some still all but Linnaean and – in spite of their undoubtedly great contributions – thus a world apart, remote from contemporary concerns.<sup>127</sup>

With respect to floras, there was – perhaps not surprisingly – relatively little innovation. ‘Official’ British thought on tropical flora handbooks, as exemplified in recommendations for African research by E. B. Worthington, remained traditional;<sup>128</sup> they would largely be produced by botanists at the then-Imperial Forestry Institute in Oxford, at Kew, or in Edinburgh, with local collaboration where possible.<sup>129</sup> In France and its territories, tropical floristic research remained almost entirely centered on the Muséum National d’Histoire Naturelle, with comparatively few initiatives elsewhere.<sup>130</sup> Only in temperate North Africa were significant autochthonous resources built up through the work of R. Maire and others, continuing activities begun before World War I. Few if any significantly distinctive floras or manuals arose in other cultural spheres, though Backer’s well-illustrated weed floras for Java deserve mention.

It was thus not from academia or the herbarium but from the rain forests of Malaya, Africa and the Americas that the first radical critiques of traditional flora formats arose. From experience obtained during careers respectively in the Federated Malay States and the Straits Settlements – both beginning in 1929 – C. F. Symington and E. J. H. Corner<sup>131</sup> independently argued that ‘standard’ handbook-floras were in fact of comparatively little use to persons in the field.<sup>132</sup>

Indeed, Symington claimed that much of the admittedly extensive tropical botanical (and ecological work) of the interwar period – some of which had attracted official criticism – lacked definition, while Corner believed that the existing corpus of publications only contributed to what he called ‘the enormous humbug of tropical botany’.<sup>133</sup> Similar problems were faced by other pioneer forest botanists such as André Aubréville in Ivory Coast and elsewhere in French Africa, Adolfo Ducke in Brazil, and W. D. Francis and (later) B. P. M. (‘Bernie’) Hyland in Australia.<sup>134</sup>

While progress in the design and production of floras has indeed been made in the past half-century or more,<sup>135</sup> problems remain. One is the continuing need, sometimes by default, for accounts to be written by outside specialists, at times with limited field opportunities (although this is now less the case than formerly). Another is the great length of time now required by major flora projects, which often have had to follow formats established a generation or more before. Finally, there remains the question of effective access to floristic information, still often problematic for technical, linguistic, conceptual or financial reasons.<sup>136</sup> Symington’s remark that with respect to flora schemes ‘the main defect was to imagine that the European herbarium worker could solve the field biologist’s problem without the latter’s full co-operation’ thus to a certain extent still holds.<sup>137</sup>

Particular criticisms made by Corner of contemporary works included (1) ignorance of vegetative characters, (2) ambiguous descriptions, (3) faulty nomenclature, and (4) errors resulting from repeated copying and/or lack of critical investigation.<sup>138</sup> Similar situations have been faced by other writers of tropical field-manuals (although the growing number of smaller ‘local’ herbaria has improved the availability of reference material, reducing the possibility of misidentifications and furnishing a foundation for description-writing and local key construction). There is now, however, an increased acceptance of the value of ‘field floras’ complementary to the larger, scholarly works, and more support has been forthcoming. Yet, as with *Wayside trees of Malaya* and, more recently, *Flora da Reserva Ducke*, these are not necessarily compilations; they should (and do) incorporate substantial additional field work and research. For the team of Jarvie, Ermayanti and Mahyar in central Borneo, preciseness, comparability and transparency of information – necessary for multi-access or interactive keys –

have been paramount. Close attention was, however, at the same time paid to potential users as Symington or Corner would have wished. Four points were in particular expressed: (1) availability of the local flora in Bahasa Indonesia as well as English; (2) understandable text, with inclusion of a glossary; (3) adequate illustrations; and (4) orientation to the needs of each user group with the information required.<sup>139</sup> These authors also found that there were practical limits to the number of dichotomies in a single analytical key.

Beyond the tropics, there have also been significant recent contributions on the relationship of floras and users, as much on substance as on style and presentation. Wilken *et al.*, with reference to numerous examples, reiterated that floristic information was widely used beyond the world of pure biology and that this had to be taken into account in flora projects.<sup>140</sup> Palmer, Wade and Neal, in a study of an extensive sample of floras large and small in North America, renewed long-standing arguments for common standards and with respect to content made explicit proposals including a distinction between the ‘essential’ and the ‘desirable’.<sup>141</sup> Schmid, from the viewpoint of a user and reviewer, has given a detailed list of desiderata with respect to content and style along with a plea for statistical information.<sup>142</sup> To this latter I would like to add some indication of the area covered with, for floras of larger entities, an internal breakdown covering individual provinces, states, counties or similar smaller polities with their numbers of species. Given modern database and spreadsheet capabilities this should be feasible. As has long been recognized, such statistical and geographical data are invaluable to ecological and biogeographical theory and, in more recent years at least, to public interest and awareness.<sup>143</sup> Indeed, they could be considered among the most important by-products of any flora project.

### Is there an ‘ideal flora’?

The preceding sections have reviewed various aspects of contemporary floras including recent methodological and other developments and have drawn attention to some continuing as well as recent problems with their writing and use. Emphasis has been given to the rapid development of information technology over the last decade which has at last – from initial attempts in the 1960s and 1970s – effectively allowed floristic information and tools to be developed and maintained as a ‘virtual system’ without reference

to print.<sup>144</sup> Thus, traditional printed floras, manuals and enumerations – and their content – have ontologically become matters of essential or discretionary choice rather than absolute necessities. The parameters of what constitutes an ‘ideal’ flora, long a matter for debate and reviewed in the first edition of this book, have therefore changed and now may be seen as largely functional.<sup>145</sup> The issues relate as much to presentation as to content: is the floristic work in question useful for identification or essential information and is it comprehensible to a wide range of users? Moreover, given the existence of some form of floristic information system, what selection of tools and information is best also presented in print, relatively a more expensive medium? Finally, what scope is there for a traditional ‘ideal’, the ‘classical’ descriptive flora?

The ‘classical’ descriptive flora of a country or region has for some two centuries been perceived as a key intellectual or practical goal of many a systematic or floristic botanist, and – as outlined in Chapter 2 – has at least until recently largely followed parameters set by leading eighteenth- and nineteenth-century writers. However, there has been over the last decade or so an increasing recognition of the need on the part of floras and related works for more effective communication with a wider audience along with marked changes in methodologies.<sup>146</sup> It thus may be (and has been) argued that the ‘classical’ descriptive flora has no real place in the contemporary world, and that users are best served with checklists, keys and illustrated guides. The latter is often all that may be possible given current project-oriented funding practices. Moreover, the descriptions in many ‘standard’ floras are not truly comparative, nor were they so intended.<sup>147</sup>

Yet, as some authors have pointed out, there remains merit in the ‘classical style’ of flora-writing as an art form.<sup>148</sup> An elegant ‘effect’ may still be achieved in presentation through discerning phytography, carefully chosen synonymy, references, vernacular names, selected *exsiccatae*, concise indications of status, distribution, phenology, habitat, altitudinal range, substrates and sociology, and well-thought-out commentary. A ‘classical’ description should be individually prepared and be thus distinctly diagnostic while still embodying a ‘feel’ for a plant; this is more than can be achieved from mere application of a computer-driven descriptive language system.<sup>149</sup> Its making and user comprehension does, however, require a certain amount of formal education and experience. Indeed, it may now

be best suited to situations where a local, state or national flora is relatively well known and alternative ‘research’ sources (including critical floras or monographs) are available.<sup>150</sup> Other ‘traditional’ formats, among them the ‘manual-key’ with its heavy use of abbreviations and symbols, may similarly at first be rather hard to use, particularly if one has had no training. Many authors of such works have, however, recognized that illustrations are essential aids to identification. Such is not new; Bonnier and Layens did this consistently over 100 years ago, initially in their already-mentioned *Nouvelle flore du nord de la France et de la Belgique*. Among contemporary manuals, at least one is now also issued as a CD-ROM (making potentially possible links to more comprehensive floristic information therein or elsewhere).<sup>151</sup>

With respect to the function of floras, it has gradually become more widely recognized that for a given polity or region no single ‘ideal’ flora was possible.<sup>152</sup> Multiple products or systems were seen as necessary, with some kinds of information best represented in ‘information banks’. This gave rise to discussions – now partially academic – over what was best included in printed works and what best was stored electronically.<sup>153</sup> In the late 1980s, ‘core fields’ were seen as including scientific names, authors, concise descriptions, notes on relationships, indication of phenology, habitat and distribution, literature citations, and illustrations along with general ease of use. Keys were not specifically mentioned, nor were synonymy, vernacular names or ethnobiology. More appropriate to a ‘data bank’ were: a GIS, supplementary morphological data, bibliographic references, specimen-based data, illustration sources and cartographic information. Yet this distinction could be seen as analogous to that long made between ‘synoptic’ and ‘comprehensive’ forms of floristic communication – a question which, as discussed in Chapter 2, has existed since the late sixteenth century.<sup>154</sup> Moreover, the ‘core fields’ are comparable to those of A.-P. de Candolle and other nineteenth-century advocates of concise floras.

It is the increasing range – and greater complexity of – ‘extended’ material which came to be seen by the 1980s as best handled in an information retrieval system. The advent of new technologies and their deployment have since effectively ended any *primary* need for such distinctions. Output can be designed and produced as matters of record or for particular functions. If there is any single ‘ideal’ national or regional

flora, it has ultimately to be in the form of a dynamic, accessible and generally intelligible information system or 'metaflora'.<sup>155</sup> How completely this happens depends, however, on human resources and commitment, and thus decisions over objectives and priorities are still required. It should moreover not be overlooked that many large-scale scientific works – though in practice read only by a few – traditionally also have had humanistic functions; indeed, they are, or have become, expressions of social, cultural and political identity.<sup>156</sup>

### Prospects

With the transmutation of floras into information systems, perhaps the major issues now – in contrast with 20 years ago – are less with products *per se* but more about effective access to and dissemination of particular functions centering on inventory, information and identification. The 'classical' parameters and styles, long generally accepted as definitive,<sup>157</sup> have become in themselves rather less adequate in the face of expanded horizons, audiences and requirements. Change has, however, sometimes come but slowly; questions raised already in the 1940s were still being asked in the mid-1990s.<sup>158</sup> Much more attention has to be, and is being, paid to users; floristic works – particularly the larger ones now requiring extensive collaboration – cannot now be prepared in isolation. In addition, larger projects must consider shorter temporal parameters, with one response being identification of the plant groups of greatest difficulty (or for which there was no specialist) and making some information on them available – if in a less definitive form than a 'final product'.

As for the functions of floras, several key areas remain as important as ever irrespective of the form of delivery (save for dynamic interaction, not possible in print, and family arrangement, less relevant in the virtual world). These include identification, nomenclature, descriptions, documentation, illustrations and maps, commentary, arrangement of taxa, links, and presentation. Each of these is considered below.

**Identification** is best addressed through artificial dichotomous, multi-access or (increasingly) interactive keys, preferably with figures or key characters and states. In large floras or in well-represented taxa with scores or even hundreds of species in a given area, illustrations are essential; a similar consideration applies where, for example, a given leaf arrangement or flower type is widespread. The more traditional synoptic key, even in analytical form, has to be seen as primar-

ily an academic exercise although it has merits in being able to focus on principal differentiating characters.

With respect to **nomenclature**, floras show wide variation. In the more documentary undertakings accepted names, synonymy, references and applications may be rather fully treated. In more or less concise works only selected synonymy may be given, with or without references. The publication of two worldwide synonymized species checklists in addition to many at supranational and national level may bring about an increasing amount of control. This may well lessen the need for elaborate synonymies in floras, although this goes against those who see a flora as 'self-contained'.

**Descriptions** have their place in a concise flora but should be largely diagnostic, as aids to identification, and emphasize key features. Elaborate 'primary' descriptions, characteristic of many large documentary floras, may be seen as important components of training of young systematists but are more the province of the monograph or revision of a given taxon or part of an information system. The importance of truly *comparative* descriptions was long ago emphasized by Watson<sup>159</sup> but floras are not the place for them.<sup>160</sup>

**Documentation** is an extremely important part of systematics, both for the record and for analysis, but is only partially congruent with the main functions of a flora (or related work). Enumerations and checklists fundamentally are documentary, and should be encouraged.<sup>161</sup> By their nature, however, they can cover only a portion of the potential range of published or unpublished material; they should therefore contain 'pointers' to sources, or be part of an information system.<sup>162</sup> With the rise of the latter, however, the issue of choices of data for dissemination becomes relevant only for printed products; past problems such as loss of locality and specimen data as well as more extended taxonomic and biological observations due to space constraints in theory cease to exist.<sup>163</sup>

**Illustrations and maps** are increasingly sought after and should now be seen as essential in a flora. Not only have people become more visually oriented, but with this has come a greater appreciation of the value of practical as well as aesthetic botanical art. Maps are also extremely important visual tools. Provision of both should be systematic, and for identification illustrations have to be well thought out. There are presently few technical limitations on the storage and retrieval of images.<sup>164</sup> Floras (and related works) should be, and are being, accompanied by CD-ROMs with color images

otherwise collectively too costly for print.<sup>165</sup> If maps are also available on CD-ROM, there should be software for interrelating them as part of a GIS.

It is hard to suggest definitive guidelines on **topographical, taxonomic and biological commentary** including distribution, ecology, phenology, karyotypes, chorological classes, fidelity (in a phytosociological sense), variability, and biology as well as opinions on taxonomic limits and relationships. The scope of such material varies widely. Basic distribution, habitat and phenology are generally seen as 'core data' and will always have a place in a concise flora, enumeration or checklist. Likewise, where distinct differences of opinion exist with regard to taxa, such should be noted. Where a flora is poorly known or available materials are scattered, representative specimens should be cited.<sup>166</sup> 'Peripheral' data are, however, better left to specialized works or to information systems.

The **arrangement** of taxa in printed floras varies widely. In part this is because of differences in opinion over higher-level relationships among flowering plants. For strictly practical purposes alphabetical or artificial arrangements may suffice; but with differing ideas about the limits of many families care has to be taken. Intellectually a systematic order may be more informative, but here again a choice among different, sometimes widely diverging, schemes has to be made.

All of the above leads to the importance of **links to and among sources**. A good flora today should as far as possible include reference to monographs, revisions and supporting papers on a consistent basis. Among other things, this acknowledges the idea of a flora as a statement of current knowledge and not an all-encompassing 'authority'. In recent years, this practice has become more common. Source references are also important in introductory general keys to state, national and supranational floras.

Last but not least is **presentation**. The appearance and ease of use of a work have become important factors in their acceptance. Though the latter problem was early addressed by writers of forest floras, the result was mainly the additional provision of keys based on vegetative features rather than a serious answer to arguments that conventional floras were to many all but impenetrable. In defense of the latter, however, it should be said that such works have always required some training; indeed, floras originated in, and were in many ways designed for, the academic world. The loss or reduction in many universities (let alone secondary

schools) of course modules in identification and taxonomy, and the greater diversity of users, have now brought the 'language' of floras into greater relief.

### Concluding remarks

In summarizing the above – and closing this chapter – the author believes that the best roles for a 'traditional' flora (or enumeration or checklist) in the present age are practical: inventory, identification and provision of essential related data. To Bentham's 'essential data' should be added ecological information and a good range of illustrations, as well as a clear indication of where taxonomic problems exist. Where botanically lesser-known areas are concerned there is room for some extra data and commentary.<sup>167</sup> Systematic provision of references to sources should be standard practice. Documentary floras – unless possessing biologically or biogeographically based parameters – are, by contrast, basically symbolic or humanistic. Much of their content – and the effort that goes into them – ideally should be directed elsewhere, for example into revisions or monographs.<sup>168</sup> Their data, while in scientific terms essential, are to a goodly extent of relatively specialized interest, and – as Stephen Blackmore has suggested in the last of our opening quotations – are in modern terms best presented as part of an information system. That said, however, it should be admitted that without sponsored larger-scale floras a great deal of raw data might never be synthesized. Much of the relatively limited support for plant systematics as a whole is ultimately public and often is related to specific national, developmental or environmental goals.

With respect to the place of print in a world of rapidly spreading electronic media, I believe that with respect to floras a place remains for handbooks for practical use. They should be concise and communicative, with defined parameters but associated with a floristic information system (either on-line or distributed on a CD-ROM or other electronic medium) which may carry additional, more specialized data, images or such features as interactive keys and GIS capability. All this presupposes a team effort, the necessity for which is now widely recognized. Such a multidimensional approach calls for organization, effective cooperation and use of limited human resources (particularly family specialists), adequate funding, and an enlightened use of information technology and electronic communication.<sup>169</sup> Similar approaches could be (and from time to



time have been, with varying degrees of integration) taken with respect to advancing basic taxonomic knowledge of, for example, large families or genera.<sup>170</sup>

In the original edition of this book, I concluded this chapter with four points: (1) floras and manuals should be written in a way as will have a wide public appeal; (2) floras should be the products of collective effort; (3) monographs and revisions should be promoted, with larger efforts becoming similarly collegial; and (4) the language of floras should 'not be permeated with learned and prosy dullness'. Taking a lead from the historian and philosopher of science Jerry Ravetz, I wrote at the time of the need for a 'new ethic' for floras.<sup>171</sup> Progress on these fronts has since been varied, perhaps more in method than in language, but in the last half-decade or so all else has been overtaken by an ontological revolution: the effective transmutation of floras into information systems, with print an option rather than a necessity. Nevertheless – and whatever the medium – standards of content and presentation in any future floristic works should ultimately, as ever, be guided by 'correctness and clearness of method and language [as] the first qualities requisite',<sup>172</sup> with more-over an eye to 'care and coordination, and a clear sense of the priorities both from the producer's and user's point of view'.<sup>173</sup> Twenty years on, users are even more important; their interests should be firmly accounted for within any contemporary philosophy of floras, with a 'stress on access'.

## Notes

1 For example Stafleu, 1959; Brennan, 1979.

2 Jäger, 1978, p. 413.

3 The 1999 Congress (St. Louis), however, featured a session entitled 'Species diversity information systems on the Internet'. This represents a possible future direction for large-scale floras, as will be shown later in this chapter.

4 Morin *et al.*, 1989.

5 Prance and Campbell, 1988; Campbell and Hammond, 1989.

6 Baas, Kalkman and Geesink, 1990; Polhill, 1990. Further workshops on *Flora Malesiana* have since been held, most recently in 1998.

7 Bisby, Russell and Pankhurst, 1993.

8 Gómez-Pompa and Plummer, 1990; Sivarajan, 1991, p. 5; Funk, 1993; Jarvie and van Welzen, 1994.

9 van Steenis, 1962.

10 Similar themes have recurred in subsequent discussions; see in particular Heywood, 1984; Sivarajan, 1991, p. 5; Jarvie and van Welzen, 1994. Sivarajan in particular pointed out the potential problems which might arise from the creation of 'non-uniform matrices', the result of developments oriented to given projects. With the spread of often uncoordinated, grant-based 'biodiversity surveys', this phenomenon has in the author's opinion become a real concern.

11 van Steenis, 1962.

12 Twentieth-century examples include, in Europe, the Hegi *Illustrierte Flora* vs. national manuals and, in North America, the two floras of the Pacific Northwest (191) coordinated by C. L. Hitchcock and A. Cronquist. In tropical countries with large floras, the focus of some recent one-volume manuals and checklists has been on relatively small areas, often reserves with research stations.

13 Heywood, 1973*a*, 1984, 1988; Watson, 1971; Palmer, Wade and Neal, 1995.

14 Shinners, 1962; Palmer, Wade and Neal, 1995; Brennan, 1963; Jacobs, 1973. The editors of *Tree flora of Sabah and Sarawak* adopted *Tree flora of Malaya* and *Flora Malesiana* as models; see Forest Research Institute of Malaysia, 1992.

15 *Herbarium amboinense* was, as indicated in Chapter 2, not actually published until the mid-eighteenth century.

16 Shetler, 1971.

17 Jacobs, 1973.

18 For example Polhill, 1990.

19 Webb, 1978.

20 Palmer, Wade and Neal, 1995; p. 339.

21 Symington, 1943. *Flora of central French Guiana* had, probably, the fewest antecedents; indeed, very few collections had been made around Saül before 1965 (Mori and Gracie, 2000). This likely contributed to the underestimate of the time needed for the project, as indicated by Mori and Gracie.

22 The *Flora of Java* is a noteworthy example. A more satisfactory solution would have been the production of a work like *Flore française*, with a volume of analytical keys (accompanied by illustrations) and two (or three) enumerative volumes with diagnoses.

23 In *Flora lapponica*, *Flora suecica* and *Philosophia botanica*.

24 de Candolle, 1813; Bentham, 1861, 1874; de Candolle, 1873, 1880.

25 van Steenis, 1954; Brennan, 1963; Turrill, 1964; Heywood, 1964.

26 Britton, 1896–98 (2nd edn., 1913); Hitchcock, 1925; Blake, in Blake and Atwood, 1942; Lawrence, 1951; Radford, in Radford *et al.*, 1974.

- 27 The growth of interest in field botany, perhaps in large part because of greater ease of transportation, led to an increased appreciation of plant variation and of the distribution of plants in relation to habitat factors as well as to each other. The latter area of enquiry became known in continental Europe as plant geography, with ecology – a term first introduced by Ernst Haeckel in 1866 as *Ökologie* and which came into English in 1873 – referring more narrowly to plant–habitat relations, including the study of morphological adaptations. Its extension in scope to the whole of plant geography (except floristics) initially took place in Britain and North America at the end of the nineteenth century.
- 28 All these reflect successive developments of new areas of botanical enquiry, their application to systematics, and evaluation of their worth in floras.
- 29 Heywood, 1958, 1960; Forest Research Institute of Malaysia, 1992.
- 30 Radford *et al.*, 1974; Yü, 1979 (publ. 1980).
- 31 Davis and Heywood, 1963.
- 32 Hitchcock, 1925; Lawrence, 1951; Radford *et al.*, 1974.
- 33 Meikle, 1971. Meikle's own *Flora of Cyprus* (1977–85; see 772) is a good example of a 'modern' flora still very much in the nineteenth-century tradition.
- 34 In comparing some mid- to late twentieth century North American floras with Torrey's *Flora of the state of New-York* (1843) one might almost think that the modern works had been written by descendants of Rip van Winkle.
- 35 With advancing technology, some more recent works, such as *The atlas of the vascular plants of Utah* by B. J. Albee, L. M. Schutz and S. Goodrich (1988), have been able to use localized dot maps.
- 36 van Steenis, 1954. For another view of the art of description, see Jacobs, 1980.
- 37 Cf. Britton, 1896, pp. v–xii; 1898, pp. iv–v. There was no clear philosophy in the Britton 'school' except perhaps its attempts at more or less uniform descriptions and, more particularly, its narrow generic concepts and nomenclatural ideas. Its seeming façade of 'authority' was also of a piece with the architecture of the era. With respect to nomenclature, the *North American Flora* and other works of the 'school' were not unnaturally important vehicles for propagating use of the so-called Rochester Code (also known as the 'American Code'). Formulated in 1892, it was applied in Britton's own works and those of many others but finally consolidated with the 'International Rules' in 1930, at a congress which also saw a serious consideration of plant population biology – with the noted California botanist H. M. Hall active in both movements.
- 38 A 'quarto' format was used for *Illustrierte Flora von Mitteleuropa* and its contemporaries on account of their many plates. It is also more amenable to two-column text, used in, for example, *Flora Europaea*, *Flora Mesoamericana*, and the English-language *Flora of China*.
- 39 van Steenis, 1954; Davis and Heywood, 1963, p. 299.
- 40 Wisskirchen and Haeupler, 1998, p. 12.
- 41 Hagen, 1984.
- 42 Raven, 1974a. This was in spite of efforts in the 1930s and 1940s by W. H. Camp and others to emphasize the importance of 'biosystematic' information.
- 43 Examples include *Alchemilla*, *Rubus*, *Sorbus*, *Taraxacum* and *Hieracium*.
- 44 Endress, 1977; Hj. Eichler, personal communication, 1980.
- 45 After the already-mentioned Wendell H. Camp.
- 46 Just, 1953.
- 47 Indeed, current technology enables incorporation of line drawings and gray-scale figures at little or no additional cost beyond an inevitable rise in the number of pages.
- 48 Fisher, 1968.
- 49 This work was fully revised in 1961 as *New Illustrated flora of Japan*.
- 50 For example *Dai shokubutsu zukan* (1928) by M. Murakoshi; *Cay-co Viêt-Nam* by Pham Hoàng Hô (1960; 2nd edn., 1970–72; 3rd edn., 1991–93); and *Iconographia cormophytorum sinicorum* from the Botanical Institute, Beijing (1972–76; supplements, 1982–83). While the form of these manuals may have been influenced by 'Western' models, notably (for Makino) Britton and Brown's *Illustrated flora*, the author believes them also to reflect something of the autochthonous East Asian botanical tradition (and, in Japan, its particular development in the Edo period). At the same time, their conciseness owes something to the traditions of Bentham and his contemporaries.
- 51 Backer, a former secondary-school teacher, saw his floras in pedagogical terms. Like J. D. Hooker and his reaction to analytical keys (see Chapter 2), he believed that figures distracted students from careful reading of descriptions.
- 52 With the introduction of more floras and identification works at least partly on CD-ROMs there will be additional opportunities for illustrations, particularly in color.
- 53 Chapman and Richardson, [1998].
- 54 Heywood, 1973a.
- 55 Watson, 1971.
- 56 Watson was by then at the Australian National University; there he had access to a mainframe computer, statistical and other software, and peripherals including tape-writers, keypunches and card- and tape-readers. With the CSIRO entomologist Mike Dallwitz he would in the later 1970s develop DELTA (DEscriptive Language for TAXonomy), a program

- designed to ensure (and generate) uniformly comparable taxonomic descriptions; this led to the preparation of 'uniform' accounts of genera (and species) in selected families.
- 57 Shetler, 1971; Krauss, 1973. The FNA Program had a database software package as well as a mainframe computer at its disposal.
- 58 Such information might include, for example, detailed geographical records for a species or infraspecific taxon, useful to local workers.
- 59 Watson, 1971. The issue posed was subsequently examined by several writers, among them Cutbill, 1971*a*; Heywood, 1972, 1973*a*, 1974; Morse, 1975; and Raven, 1977.
- 60 Heywood, 1976, p. 267.
- 61 Shetler, 1974*b*.
- 62 Useful landmarks may be found in Cutbill, 1971*b*; Shetler, 1974*a,b*; Brenan, Ross and Williams, 1975; Allkin and Bisby, 1984; Bisby, Russell and Pankhurst, 1993; and Hawksworth, Kirk and Dextre Clarke, 1997.
- 63 Taylor and MacBryde, 1977 (see 124). The projected descriptive flora never materialized.
- 64 Shetler, 1971; Gómez-Pompa and Butanda, 1973; Gómez-Pompa and Nevling, 1973.
- 65 By 1999 some 100 fascicles had appeared and a complementary 'ecological flora' was also well advanced.
- 66 Heywood, 1978. Major commercial or parastatal applications, still in use, were Ceefax (United Kingdom) and Minitel (France).
- 67 Pankhurst, 1975, 1978.
- 68 Brenan, Ross and Williams, 1975; Forero and Pereira, 1976; Gibbs Russell and Gonsalves, 1984; Johnson, 1991.
- 69 Pankhurst, 1991. Current taxonomic information packages on the market include ALICE (Kew), BRAHMS (University of Oxford), LINNAEUS-II (Free University of Amsterdam/ETI), LucID (CSIRO and University of Queensland, Australia) and SysTax (Universität Ulm).
- 70 Raven, 1974*b*; Systematics Agenda 2000, 1994*a,b*.
- 71 Turning points were the introduction in 1979 of the Tandy TRS-80 Model II, the first personal computer with sufficient disk capacity for a modest floristic database, the advent of dBASE II for CP-M and subsequent operating systems, and, in 1981, the arrival of the IBM PC (with the AT following in 1984, effectively ensuring the universal spread of the 'PC-standard').
- 72 These include *Vascular plants of British Columbia: a descriptive resource inventory* (1977) by Taylor and MacBryde (see 124), *List of species of Southern African plants* (1st edn., 1984; see 510), and *Med-Checklist* (1984–; see 601). Additional examples are reviewed in Allkin and Bisby (1984).
- 73 Literature on the Internet and its tools is now abundant. Worthy of note are A. J. Kennedy, 1996. *The Internet and World Wide Web: The Rough Guide*. Version 2.0. London (and its successors); and B. M. Leiner *et al.*, 1998. *A brief history of the Internet*. The Internet Society (electronic publication; at <http://www.isoc.org/internet/history/brief.html>). Its original basis was ARPANET, established in 1969 by the U.S. Department of Defense Advanced Research Projects Agency to connect universities and research institutes. Other major networks followed and 'Internet' accordingly came into use around 1974 as a 'collective' term. In 1986 the U.S. National Science Foundation, in funding a major 'super-computer initiative', created the open-access NSFNet and so laid the foundation for the Internet's exponential expansion. From 100 networks in 1985 (L. R. Shannon, *New York Times*, 26 October 1993) the number of networks worldwide by 1996 was thought to have risen to at least 50000 (Canhos, Manfio and Canhos, 1997); increase continues to be rapid.
- 74 A useful analogy here is the subsumption of Newtonian mechanics by relativity theory.
- 75 Canhos, Manfio and Canhos, 1997. Examples of such networks are ERIN (Australia), CBIN (Canada), NBII and ITIS (United States), and BIN-BR (Brazil); they may be governmental, non-governmental or collaborative.
- 76 All this reflects a still-imperfect grasp of the intellectual and cybernetic aspects of taxonomic information systems, with further research and modeling needed (cf. Bisby, Russell and Pankhurst, 1993).
- 77 Maxted (1992) has written that 'the full potential of contemporary computing technology is, however, not used in taxonomy, although its use in a revision . . . would seem to be appropriate'. Computers, he noted at the time, were 'commonly used' in fairly specific contexts.
- 78 Not only are there as yet relatively few full floristic databases, but the number of wholly databased herbaria remains small. Yet some have viewed specimen databases in terms not merely of a single collection but of a *network*: functional rather than institutional. These are in effect floristic information systems in the making. North American examples include SMASCH in California and SERFIS in the southeastern United States.
- 79 I thank Alex Chapman (Perth, Western Australia) for suggesting these 'levels of commitment'. It may be additionally noted that the third level corresponds to that aimed for by the original FNA Program, while the present *Flora of North America* has operated mainly at the second.
- 80 Alex Chapman, personal communication.
- 81 Palmer, Wade and Neal, 1995.

- 82 An example is *Flora of Somalia*.
- 83 An example is furnished by the *Flora of Ecuador* programme, where for two decades an information system has been developed as a complement to the published *Flora*. See P. Frost-Olsen and L. B. Holm-Nielsen, 1986. *A brief introduction to the AAU-Flora of Ecuador information system*. 39 pp., illus. Aarhus. (Reports Bot. Inst., Univ. Aarhus 14.)
- 84 It should also be noted that availability of CD-ROM players continues to spread, and newer storage technologies – such as the ‘e-book’ – will inevitably follow. This consideration may have guided the authors of the revision (as *Australian tropical rain forest trees and shrubs* of *Australian tropical rainforest trees* (430), issued in 1999 as a wholly electronic publication (disseminated on a CD-ROM). Apart from an accompanying 60-page manual, no print version was planned.
- 85 This situation in effect exists in Western Australia and is developing in southern Africa, to give two examples. In Western Australia FloraBase is complemented by a state checklist and two regional manuals, *Flora of the Kimberley region* (1992; see 452) by Wheeler *et al.*, covering 2085 species, and *Flora of the Perth region* (1987; see 455) by Marchant *et al.*, covering 2057 species. In South Africa there are two very concise regional floras complementary to the national checklist and the PRECIS information system: *Plants of the northern provinces of South Africa: keys and diagnostic characters* by Retief and Herman (1997; see 515), covering 5700 species, and *Plants of the Cape flora* by Bond and Goldblatt (1984; see 511), covering 8579 species. (The latter is currently under revision.)
- 86 Wilken *et al.*, 1989b.
- 87 Palmer, Wade and Neal, 1995.
- 88 For example Jarvie and van Welzen, 1994; Palmer, Wade and Neal, 1995; Schmid, 1997.
- 89 Anderson, 1991. A corollary has been their inclusion as a part of some development assistance programmes.
- 90 With respect to Malesia, however, van Steenis (1949, 1954) was, at least initially, a notable critic of ‘local’ floras. Nevertheless many botanists therein have strongly supported their preparation (Ng, 1988; Rifai, 1997 (publ. 1998)). By the 1960s, even van Steenis lent his encouragement in a call for a new flora of Taiwan (van Steenis, 1967).
- 91 For example Lawrence, 1951; Radford *et al.*, 1974; Palmer, Wade and Neal, 1995.
- 92 Cf. Garnock-Jones and Breitwieser, 1998.
- 93 Preparation of such ‘focused’ works has also for some time enjoyed official or peri-official encouragement (cf. Committee on Research Priorities in Tropical Biology, 1980).
- 94 Like Meikle’s *Flora of Cyprus* (1977–85), this work is in two volumes, but in addition to relatively substantial descriptions it features a considerable number of illustrations. It furthermore does not account for the large naturalized flora.
- 95 Mori and Gracie, 2000.
- 96 M. Cheek, personal communication; based on the experience of Cheek, S. Cable and others with the flora of Korup National Park, western Cameroon.
- 97 M. Hopkins, personal communication; based on the work of Hopkins and others on *Flora da Reserva Ducke* (near Manaus, Brazil).
- 98 This work, along with *Flora of Jauneche* by the same authors (with F. de M. Valverde), was part of a series of florulas projected by Gentry to illustrate his ideas on the relationship of species diversity to rainfall levels and distribution.
- 99 *Flora of Australia* and *Flora reipublicae popularis sinicae* are among current projects likely to become future ‘classics’.
- 100 Polhill, 1990; Jäger, 1993.
- 101 De Wolf, 1963, 1964; Polhill, 1990; Jäger, 1993. For *Flora Neotropica* a period of more than 300 years was projected; however, it also encompasses non-vascular plants and fungi.
- 102 The *Flora* was begun in the mid-1950s and, after the interruption of the Cultural Revolution and its aftermath, was originally projected for completion in 1985 (Yü, 1979 (publ. 1980)). Progress is continuing steadily, however; when completed it will be the largest of descriptive floras. Many large as well as smaller families have now been published, and four volumes of an English edition (accompanied by a series of volumes of illustrations) have also appeared.
- 103 Limited manpower and means were given as the reason.
- 104 A notable example is the *Flora Malesiana* area, for which a total of 40000 vascular plants is now estimated, substantially higher than the estimate of 25000 made by van Steenis in the 1940s (van Steenis, 1949, and in *Flora Malesiana*). A similar increase is known to have occurred in China. Such estimates are, however, dependent upon whatever definition of a species is generally accepted at any given time.
- 105 van Steenis, 1938; recalled in van Steenis, 1979, p. 73.
- 106 De Wolf, 1963.
- 107 van Steenis, 1979, p. 73.
- 108 Jarvie and van Welzen, 1994.
- 109 De Wolf, 1963; Jacobs, 1973.
- 110 George, Kalkman and Geesink, 1990.
- 111 Mori, 1992.
- 112 The sumptuous *Genera et species plantarum argentinarum* (1943–56) was physically even larger than *Flora brasiliensis*. After losing its patronage in the wake of political changes, it was succeeded by several ‘regional’ flora pro-

- jects – though such was then the state of floristic documentation that even these were often ‘primary’, with no antecedents. A new national flora, in octavo fascicles, commenced publication in the 1990s.
- 113 Symington, 1943.
- 114 Based on the author’s own experience in Papua New Guinea.
- 115 This has now been complemented by *Flora of Victoria* by Foreman and Walsh (1993– ), with three of the planned four volumes published by 1999.
- 116 It has also been a topic for textbooks of taxonomy, e.g., in chapter 9, ‘Presentation of taxonomic data’, of Davis and Heywood, 1963. Most floras also feature expressions of their philosophy and presentation in their general sections.
- 117 As students required them, they had to be more or less compact. Indeed, Linnaeus (1753; see also Heller 1983 [originally publ. 1976], pp. 239–267) strongly criticized ‘sumptuous’ books, published in relatively small editions and affordable only by the wealthy. On the other hand, however, such works were themselves sources for more compact floras as Linnaeus himself acknowledged.
- 118 Not always, however, were such developments looked upon favorably; indeed, learning the naming and characteristics of different plants as well as the associated terminology was seen as a form of mental exercise and so intellectually beneficial. It thus comes as no real surprise that many, if not most, of those responsible for advances in phytography – including the writing and presentation of floras – were teachers. Linnaeus, Lamarck, A.-P. de Candolle, W. J. Hooker, Asa Gray, Sergei Korshinsky, Hans Schinz, Nathaniel L. Britton, Alexander Tolmachev and C. G. G. J. van Steenis, to name but some, all held university lectureships or professorships.
- 119 A ‘Banksian’ botanist here refers to the kind of eighteenth- or nineteenth-century *savant* responsible for all areas, pure and applied. They were usually responsible for a botanical garden, and could refer questions to metropolitan establishments for advice. Notable representatives included Roxburgh, Griffith, Jenman, Mueller and Ridley. The advent of professional specialization reduced or changed their scope of activities.
- 120 Cittadino, 1990; see also McIntosh, 1985, pp. 30–38.
- 121 Nevertheless, Eugen Warming, one of the founders of tropical plant ecology (and, indeed, plant ecology in general) was faced while in Brazil in the 1860s with an imperfectly known flora; at the time, *Flora brasiliensis* was not yet far advanced. He thus prepared, with the aid of specialists, a long series of floristic contributions. These formed a partial basis for his classic monograph, *Lagoa Santa*, which appeared only in 1892. The functional botanists who traveled to South and Southeast Asia were somewhat more fortunate as the local network of literature and resident botanists was somewhat better developed; their plants could be named at Calcutta, Peradeniya, Singapore, Bogor or (after 1900) Manila.
- 122 Natural history societies, along with handbooks, had already come into existence in the nineteenth century, particularly in India with its large potential audience, and the ‘hill stations’ not unnaturally became centers of local investigations by enthusiasts and others. However, *Flora simlensis* and similar works from before World War I – including the most ambitious, *Exkursionsflora von Java* – followed traditional formats.
- 123 For Adanson, see Stafleu, 1971a, pp. 310–320; for the Banksian ‘circle’, see McCracken, 1997, and Frodin, 1998; for Griffith, see Burkill, 1965; for Beccari, see Pichi-Sermolli and van Steenis, 1983; for Warming, see Cittadino, 1990.
- 124 Wheeler, 1923.
- 125 Hagen, 1983.
- 126 McIntosh, 1985, p. 38; see also Janzen, 1977 (publ. 1978). Richards’ book had in turn been inspired by A. F. W. Schimper’s great monograph, *Plant geography upon a physiological basis* (1898; English edn., 1903), a summation of the work of the ‘functional ecology’ school.
- 127 Such a reaction had been expressed by the pioneer Swedish experimental taxonomist Göte Turesson, who further suggested that in botany field and herbarium workers had become more widely separated than in zoology (G. Turesson, 1922. The genotypical response of the plant species to the habitat. *Hereditas* 3: 211–350; cited by E. M[ayr], 1980 [1998].).
- 128 Cf. Worthington, 1938, p. 197.
- 129 Cf. Hill *et al.*, 1925.
- 130 For example Aubréville in West Africa, Perrier de la Bâthie in Madagascar, Pételot in Indochina, and the Stehlés in the Antilles. The most notable work was Aubréville’s *Flore forestière de la Côte d’Ivoire* (1938–39).
- 131 Symington, 1943; Corner, 1946.
- 132 From a Nigerian perspective, Symington’s immediate example was *Flora of west tropical Africa* (1927–36); at the same time, it was to him the best of its kind. Among forest floras, the major anglophone example then available was *Indian trees* (1906) by Dietrich Brandis.
- 133 Corner’s response was *Wayside trees of Malaya* (1940; 2nd edn., 1952; 3rd edn., 1988).
- 134 Aubréville wrote two forest floras (one in two editions) while Ducke was responsible for a lengthy stream of Amazonian novelties in *Arquivos do Jardim Botânico do Rio de Janeiro*.
- 135 Heywood, 1984.
- 136 Jarvie and van Welzen, 1994; Jarvie, Ermayanti and Mahyar, 1997 (publ. 1998); Rifai, 1997 (publ. 1998).
- 137 Symington, 1943, p. 16. This view in fact went back to the Hookers, particularly J. D. Hooker; see P. F. Stevens,

1997. J. D. Hooker, George Bentham, Asa Gray and Ferdinand Mueller on species limits in theory and practice: a mid-nineteenth-century debate and its repercussions. *Hist. Rec. Austral. Sci.* 11: 345–370.
- 138 Corner, 1946.
- 139 Jarvie, Ermayanti and Mahyar, 1997 (publ. 1998), p. 130.
- 140 Wilken *et al.*, 1989*a*.
- 141 Palmer, Wade and Neal, 1995.
- 142 R. Schmid, ‘Some desiderata to make floras and other types of works user (and reviewer) friendly’, in Schmid, 1997, pp. 179–194; R. Schmid and A. R. Smith, ‘Some new floras that are statistically deficient: why this unrelenting annoyance?’, in Schmid, 1997, pp. 168–178.
- 143 For example Williams, 1964, especially fig. 38; Barthlott, Lauer and Placke, 1996. The attractive colored map in the latter furnishes an example of effective translation of research into public perception.
- 144 Shetler, 1971; Gómez-Pompa and Butanda, 1973; Gómez-Pompa and Nevling, 1973; Keller and Crovello, 1973; Heywood, 1984; Heywood and Derrick, 1984; Bisby, Russell and Pankhurst, 1993; Hawksworth and Mibey, 1997.
- 145 Cf. Heywood, 1984.
- 146 Cf. Heywood, 1988.
- 147 Watson, 1971; Funk, 1993.
- 148 van Steenis, 1954; Jacobs, 1980.
- 149 The differences between descriptions written directly from observation and synthesis and those formed from a computer-driven descriptive language generation system soon become evident, at least to the author.
- 150 It is these, or information systems, which can (and should) contain, for example, fuller synonymy, citations of nomenclatural usage, and all specimen and other records.
- 151 The work in question is *Flora helvetica* by Lauber and Wagner (see 649); this moreover has a ‘pocket’ version containing only the keys. From here, it becomes possible to visualize floras as ‘e-books’ for the new eBook readers (B. Macintyre, ‘Is that a library in your pocket?’, *The Times*, 27 November 1999, p. 22).
- 152 Davis and Heywood, 1963; Frodin, 1976 (publ. 1977); Heywood, 1984, 1988.
- 153 Cf. Wilken *et al.*, 1989*b*. What is ‘central’ and what ‘peripheral’ in a floristic information system continues to be much discussed, though more now in terms of priorities.
- 154 In 1583–84 Charles de l’Écluse had, for his pioneer account of the flora of the Hungarian basin, produced both a larger-scale illustrated work (through the great Antwerp firm of Plantin–Moretus) and a simple, handily sized enumeration of plants.
- 155 Cf. *Biologue* (ABRS, Environment Australia) 20: 7 (1999).
- 156 Cf. Anderson, 1991. The eighteenth-century Spanish royal botanical expeditions, which included published floras in their programmes along with exploration, education and extension, contributed for example to the formation of national identity in Mexico, Colombia, Peru and other Iberoamerican countries. Other projects, such as *Flora SSSR* and *Flora iberica*, may be said to represent expressions of identity or renewal.
- 157 Cf. de Candolle, 1880; Hitchcock, 1925; Lawrence, 1951; Benson, 1962; Radford *et al.*, 1974.
- 158 Symington, 1943; Corner, 1946; Jarvie and van Welzen, 1994; Palmer, Wade and Neal, 1995; Jarvie, Ermayanti and Mahyar, 1997 (publ. 1998). Practically oriented works have, however, had a long tradition in forestry. Some key early examples are *Geslachtstabellen voor Nederlandsch-Indische boomsoorten naar vegetatieve kenmerken* (1928, 1953; English edn., 1956) by F. H. Endert (910–30) as well as Allen’s *Rain forests of Golfo Dulce* (236). Others have since followed, including *La forêt dense d’Afrique centrale: identification pratique des principaux arbres* (1990) by Y. Talifer and, as already noted, *Australian tropical rainforest trees* (1994) by B. P. M. Hyland and T. Whiffin.
- 159 Watson, 1971.
- 160 A prime role, as Watson suggested, is in taxonomic and phylogenetic analysis. They also have a role in a floristic or taxonomic information system, as their role is therein less circumscribed.
- 161 As discussed in Chapter 2, their importance has received renewed recognition with the growth of concern for the environment. Information technology has greatly aided their preparation and maintenance, even where numbers of 10000 or more taxa are involved.
- 162 Several countries (or lesser polities) now have official botanical information systems with greater or lesser detail. FloraBase in Western Australia (Chapman and Richardson, [1998]) is among the most advanced.
- 163 An information system can, for example, include not only specimen data but also ‘intermediate documentation’ of the kind proposed for the *Flora Malesiana* programme in the absence of more definitive family treatments.
- 164 Their capture to a good standard, however, takes time, manpower, and electronic capacity.
- 165 Some works are already appearing exclusively in CD-ROM format.
- 166 *Flora of the Venezuelan Guayana*, in addition to representative specimens in the main work, is also issuing a parallel series of documentation featuring all *exsiccatae* with their localities.
- 167 Good modern, relatively ‘concise’ conventional floras include *Flora Zambesiaca*, *Flora of Turkey*, *Flora of Australia*, *Flora of the Venezuelan Guayana*, and *Flora of Somalia*.

- 168 Grimes, 1998. An ideal would be the development of 'preferred outlets' for monographs and revisions with established parameters. In the past, series such as *Monographiae phanerogamarum* and *Das Pflanzenreich* served in this capacity; modern equivalents include *Flora Neotropica* and *Systematic Botany Monographs*.
- 169 Cf. Allkin, 1997; Chapman and Richardson, [1998].
- 170 Jacobs, 1969. Since then 'family conferences' or symposia have become relatively numerous, and the growth of electronic mail, specialized newsletters, and news groups has promoted communication among specialists of like interests.
- 171 Ravetz, 1975.
- 172 Bentham, 1874.
- 173 Brenan, 1979, p. 57.



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## Part II

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Systematic bibliography