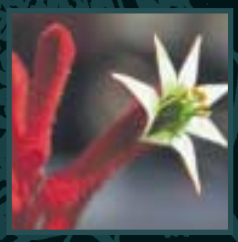
THE WESTERN AUSTRALIAN FLORA

Grazyna Paczkowska and Alex R. Chapman



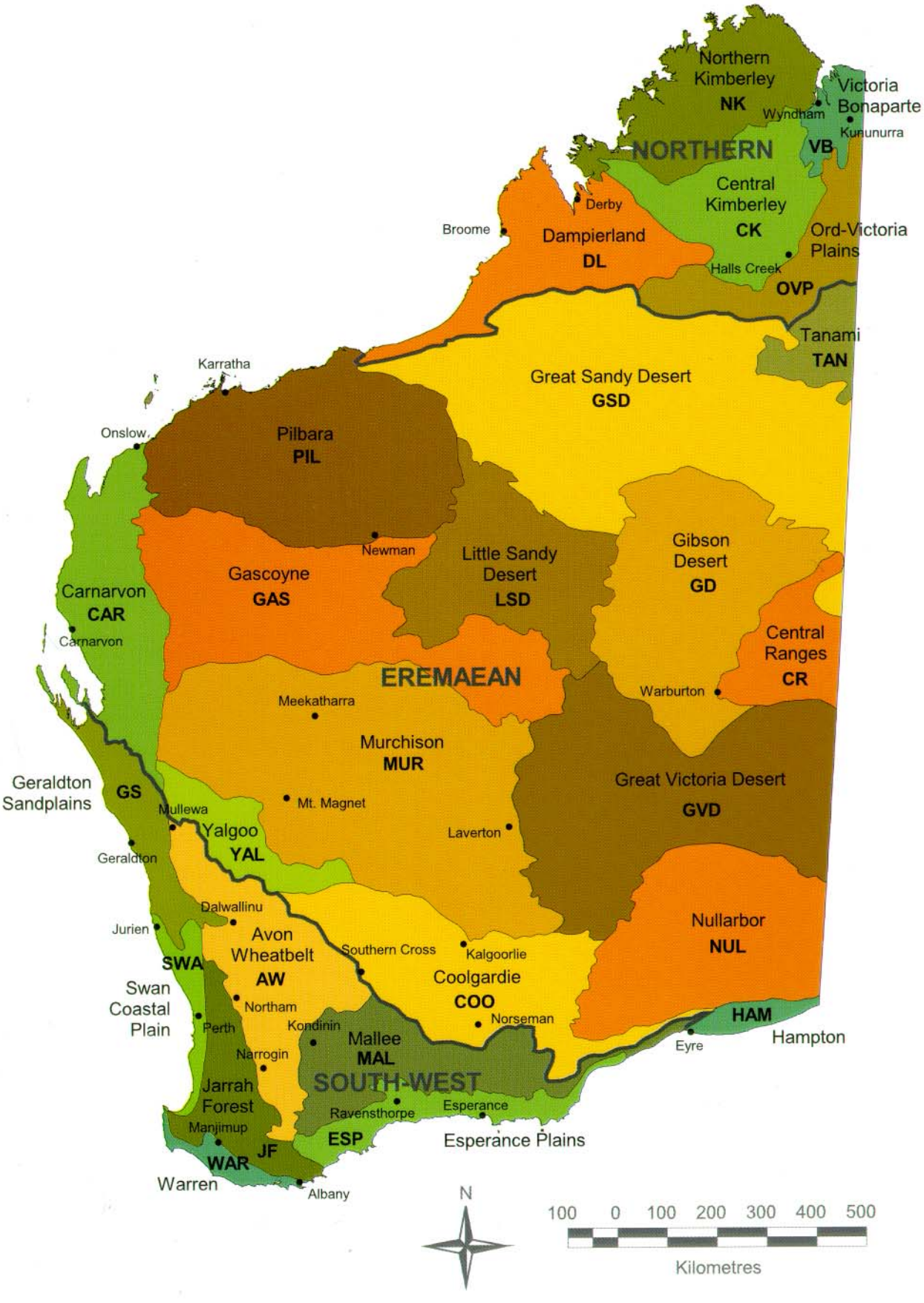


A DESCRIPTIVE CATALOGUE

Figure 1

Western Australian Biogeographic Regions and Botanical Provinces

(after Cresswell & Thackway, 1995)



Map by Paul Gioia, Western Australian Herbarium

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A DESCRIPTIVE CATALOGUE




Hakea bucculenta C.A. Gardner (page 492)

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Front cover: *Banksia lindleyana, Eucalyptus erythrocorys, Anigozanthos rufus, Boronia fastigiata, Hakea francisiana.*

Spine: *Banksia coccinea.*

Back cover: *Cyanicula amplexans, Banksia laevigata subsp. fuscolutea, Banksia cuneata, Swainsona formosa, Xanthorrhoea drummondii.*

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Banksia ashbyi Baker f. (page 465)

Melaleuca coccinea A.S. George (page 392)

FOREWORD

It has been 30 years since a publication has been produced cataloguing the extensive and unique flora of Western Australia.

Since that book, characterising each of our flowers, conifers, ferns and fern allies and summarising their distributions, there has been a considerable increase in the number of species recognised. Also, there have been many changes to the names of familiar plants.

If we are to communicate effectively about plants it is essential to have an up-to-date index to their names and a quick, easy reference to their descriptive features and distribution. This book satisfies just such a need.

I know it will be welcomed by conservation scientists, agriculturalists, foresters, educational institutions and their students, as well as community environmental and horticultural groups.

The data it contains is drawn, in large measure, from the extensive specimen collection, publications and information systems of the Department of Conservation & Land Management's Western Australian Herbarium, assembled over a 100-year period. Staff at the WA Herbarium have provided managerial, computing and technical support throughout the data uptake and preparation of this book. The Kings Park Botanic Gardens and Parks Authority has helped in the work of the Steering Committee and provided advice on the use of vernacular names.

The Wildflower Society of Western Australia has made a major contribution with funding of grants from the Gordon Reid Foundation and has provided the additional funding required for the book's design and publication. Members of the Society have variously participated in the management of the work and proof-reading the text. They have also contributed many hours of voluntary effort in assisting the WA Herbarium in its ongoing work.

This volume is timely, broad in scope and thorough in detail. It is the product of a highly productive working relationship between a community-based organisation and two government agencies. I warmly commend it to all readers.

Cheryl Edwardes, MLA
MINISTER FOR THE ENVIRONMENT

ABOUT THE AUTHORS

Grazyna Paczkowska grew up in Poland and from early childhood held a keen interest in natural history. Since coming to Australia she has developed this interest further and in 1991 completed a Botany/Zoology degree at the University of Western Australia. Grazyna has nine years experience in the environmental field working variously as a research assistant, botanical consultant, botanist and environmental officer. Her biggest passion is travel and she is currently also working towards a Diploma in Arts and Design.

Alex Chapman was born in Sydney in 1959. He studied botany and biochemistry at the University of New England and subsequently at Sydney University whilst working at the National Herbarium of New South Wales on the systematics of *Leucopogon* (Epacridaceae) as part of the *Flora of Australia* project. On moving to Perth in 1987 he worked on the genus *Acacia* (Mimosaceae) also for the *Flora of Australia*, while studying Computer Science at Murdoch University. In 1990 he was employed as a Research Scientist at the Western Australian Herbarium focusing on the development of corporate botanical information systems and in 1998 this work culminated in the launch of the *FloraBase* web site on the internet. During 1998–99 he held the position as 42nd Australian Botanical Liaison Officer (ABLO) at the Herbarium, Royal Botanic Gardens, Kew in London. Alex has two children and lives with his wife Leonie in Coolbellup.

Grazyna Paczkowska and Alex Chapman

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Colour photographs used throughout the publication have been provided by Marion Blackwell or Tom Alford.

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ABBREVIATIONS & SYMBOLS

*****	alien and naturalised to Western Australia
×	hybrid
/	or
cm	centimetres
km	kilometres
m	metres
fl.	flowers
ms	manuscript name
pn	phrase name
sp.	species
subsp.	subspecies
var.	variety

Distr. Distribution, in one or more of the following provinces or bioregions (see Figure 1)

N	**Northern**
CK	Central Kimberley
DL	Dampierland
NK	Northern Kimberley
OVP	Ord-Victoria Plains
VB	Victoria Bonaparte

SW	**South-West**
AW	Avon Wheatbelt
ESP	Esperance Plains
GS	Geraldton Sandplains
JF	Jarrah Forest
MAL	Mallee
SWA	Swan Coastal Plain
WAR	Warren

E	**Eremaean**
CAR	Carnarvon
CR	Central Ranges
COO	Coolgardie
GAS	Gascoyne
GD	Gibson Desert
GSD	Great Sandy Desert
GVD	Great Victoria Desert
HAM	Hampton
LSD	Little Sandy Desert
MUR	Murchison
NUL	Nullarbor
PIL	Pilbara
TAN	Tanami
YAL	Yalgoo

Kingia australis R.Br. (page 59)

PREFACE

The uniqueness and diversity of the flora of Western Australia provides us with much pleasure and many challenges. One such challenge is to increase our understanding of the variety of species—what they look like, where they grow and how they can be conserved. Another is to learn how to cultivate these plants so we can enjoy them in our parks and gardens and conserve them when their native environment is threatened. These issues require constant attention.

The WA botanical community has long nurtured a vision wherein all Western Australians would want to know, grow, understand, be delighted by and therefore wish to conserve, their native plants. This impetus would counter the dominance of exotic plants reflecting a European appearance within our cultivated landscapes. In order to promote a greater understanding and use of our native flora a set of initiatives was developed with the aim of establishing a native flora knowledge base, which would provide the people of Western Australia with an authoritative source of taxonomic and horticultural information.

This cooperative effort involved the Wildflower Society of Western Australia, the Western Australian Herbarium and Kings Park and Botanic Garden (now the Botanic Gardens & Parks Authority). These three parties readily recognised the advantages of combining their resources to achieve the objective and in 1993 formed a joint venture to undertake the task.

The initial stage of this endeavour, which has resulted in this book, has utilised the resources of the WA Herbarium record of the current names of all vascular plants in the State, then for each species summarised its habit, habitat and geographic distribution. The second part of the project will see the Botanic Gardens & Parks Authority responsible for compiling available information on propagation and cultivation. The Wildflower Society has provided complementary funding for both projects, as well as a great deal of voluntary effort by its members in a range of related tasks.

Financial support was sought by the Wildflower Society from the Gordon Reid Foundation for Conservation, a funding arm of the Lotteries Commission of Western Australia. These grants have enabled the work to be undertaken and we are deeply grateful for this support.

The collaborative approach outlined here has delivered a series of outcomes of great value to both botanical science and the people of Western Australia. This book, one outcome of the fruitful liaison between two Government agencies and a dedicated community organisation, is an excellent example of the synergies of such interaction.

Tom Alford
PROJECT CHAIRMAN

ACKNOWLEDGEMENTS

This publication could not have been achieved without the many people who provided their time, knowledge and expertise to this project. We would particularly like to congratulate the four organisations involved for the good will shown in working together to attain the common goal of documenting Western Australia's outstanding flora.

The Wildflower Society of Western Australia has long championed the production of a comprehensive descriptive catalogue of the Western Australian flora. The initial impetus within the Society was borne of the inspiration and concentrated effort of a small band of wildflower enthusiasts in the 1950s and '60s, endeavouring to "know and grow our native plants"—Judy Hamersley, Nan Harper, Barbara and Meg Evans, Fred Lullfitz, Evelyn Humphreys, Bert and Honour Venning, Gwyneth Oxnam, Betty Winzar, Marion Blackwell, Ernie and Magda Wittwer and Mary Hargreaves. Over time this vision developed into a seven staged program which included the publication of a descriptive catalogue. The Wildflower Society successfully negotiated funding to enable descriptive data capture and together with the Lotteries Commission's Gordon Reid Foundation for Conservation has co-funded publication of this book.

Further support provided by the Gordon Reid Foundation has allowed commencement of the next project, building a horticultural database to document methods for growing WA's native flora and help promote a 'Western Australian look' in our cultivated landscapes. The Botanic Gardens & Parks Authority, based in Kings Park will now become the focus for this stage.

The Western Australian Herbarium provided access to nearly half a million collections gathered over two centuries, a State resource which has underpinned research and documentation of the State's flora since its inception in 1928. The WA Herbarium, part of CALM's Science Division since 1988, also made available its extensive botanical library, use of the comprehensive specimen and State plant names databases of which it is custodian, as well as computer expertise fundamental to the project design and management of the data contained in this book.

The members of the Steering Committee successfully guiding this project to completion were Dr Neville Marchant, Senior Principal Research Scientist and director, WA Herbarium, Department of Conservation and Land Management (CALM), Dr Steve Hopper, CEO, Botanic Gardens & Parks Authority and successive presidents of the Wildflower Society of Western Australia—Marion Blackwell, Tom Alford, John Robertson, Anne Holmes and Brian Moyle. Tom Alford acted throughout in the role of project chairperson.

Taking over the main role of capturing species data from the first author who left the project in 1997, were Helen Coleman who completed the fern and gymnosperm data compilation, began the database maintenance phase and explored the use of interactive identification tools followed by Amanda Spooner who has focused particularly on data revision, maintenance and editing in preparation for this book. Helen and Amanda both devoted enormous energy to the project and Amanda deserves special mention for her tenacity in ensuring the integrity of the data through the final stages of publication.

John Beard published two editions of the *Descriptive Catalogue of West Australian Plants*, in 1965 and 1970. These editions served as the initial model for this book and their usefulness provided the impetus to publish an expanded catalogue. The authors would especially like to acknowledge Greg Keighery who acted as custodian of the data for many years subsequent to the Beard publications, and who generously

made available information he had gathered over this long period. In particular his data on a large proportion of the monocots provided a starting point for the present work.

A number of botanists provided data for their specialist plant groups: Andrew Brown (Orchidaceae), Rob Davis (*Ptilotus*), Alex George (*Dryandra*), Elizabeth George (*Verticordia*), Steve Hopper (*Eucalyptus*), Nicholas Lander (*Olearia*), Terry Macfarlane (*Wurmbea*, Poaceae), Barbara Rye (Thymelaeaceae), Leigh Sage (Goodeniaceae) and Paul Wilson (Rutaceae). Bruce Maslin and Richard Cowan provided access to the DELTA-encoded *Acacia* data and also the ABRS *Flora of Australia* unpublished descriptions from the forthcoming Mimosaceae volumes, and Bryan Simon from the Queensland Herbarium made available information on WA Poaceae.

Eleanor Bennett's *Common and Aboriginal names of Western Australian plants* (2nd edn) published by the Eastern Hills Branch of Wildflower Society of W.A. in 1993, was used as the primary source of common names information. At the Botanic Gardens & Parks Authority (Kings Park) thanks go to Roger Fryer for contributing a list of accepted primary common names when more than one was available in the Bennett list, and to Steve Forbes and Kingsley Dixon. Mark Webb, Roger Fryer and Darrell Horrocks now take up the challenge for the horticultural stage of the project.

This project was designed to be database driven from the outset, and has relied on the international Description Language for Taxonomy (DELTA) standard developed by Mike Dallwitz (CSIRO, Canberra). At the WA Herbarium the project has depended on the programming skills of Mike Choo who developed the DELTA conversion software enabling the linking of various data components, Paul Gioia who produced the species distribution data and bioregions map and Ben Richardson who enabled the information presented in this book to be added to the existing datasets comprising the WA Herbarium's *FloraBase* web site.

The Census of Western Australian Plants database has for a number of years underpinned most of the flora information systems in the State and John Green, Nicholas Lander and especially Paul Gioia have all played significant roles in the development of this invaluable resource. Paul Wilson deserves special acknowledgement not only for his knowledge of taxonomy and nomenclature which has informed the Census over many years but for also generously sharing his expertise whenever consulted.

Many more past and present staff members of the WA Herbarium have contributed their expertise in various ways to this project and we would especially like to thank Sue Carroll, Ray Cranfield, Suzanne Curry, John Dorlandt, Chang Sha Fang, Meriel Falconer, Jan Gathe, Vicki Hamley, Wayne Hanks, Karina Knight, Terena Lally, Brendan Lepschi, Margaret Lewington, Beng Siew Mahon, Cheryl Parker, Sue Patrick, Gillian Perry, Phil Spencer, Kaye Veryard, Judy Wheeler, Adam Wincza and Colin Yates. Grateful thanks must also be given to the many WA Herbarium volunteers who provide such excellent assistance in many areas of endeavour within the institution.

Once primary data gathering was completed the task of reviewing and editing the draft publication began and many people provided a keen eye to the work of producing consistent and comparable descriptions, as well as weeding out the inevitable factual and typographic errors. These included Catherine Alford, Barbara and Bob Backhouse, Rob Davis, Alex George, Claire Hall, Mike Hislop, Steve Hopper, Martin Jardin, Antony Konig, Mike Lynch, Terry Macfarlane, Kathy Meney, Phyllis Robertson, Robin Shaw and Juliet Wege.

We are grateful for the support of the Gordon Reid Foundation for Conservation and have worked to ensure a substantial return on their investment. We would particularly like to thank the Foundations' Michael Crouch, Michael Sanford and Anne Rodger who provided administrative expertise for the project, as did Steve Deacon, Mario Taverniti and Andrew Walton from the WA Lotteries Commission.

Thanks are extended to members of the Wildflower Society of WA for their help with various stages of this project. In addition to the many mentioned elsewhere, we would like to acknowledge Jim Barrow, Barbara Dewar, Tony Dickinson, Pauline Fairall, Elizabeth George, Bronwen Keighery and Joanna Seabrook.

Margaret Pieroni created the iconic family illustrations used both on the cover and at the beginning of each plant family within the body of the book and Kath Napier, Alex Williams and Janet Harding helped prepare them for the design team. Many thanks also go to Marion Blackwell and Tom Alford who contributed all the colour photographs used on the cover and within.

Colleagues Nicholas Lander, Terry Macfarlane and Neville Marchant deserve special acknowledgement for ten years of formal and informal discussions from which arose many of the strategies now in place for ensuring the capture, management and dissemination of descriptive taxonomic botanical information.

We are most grateful to the many colleagues who have provided valuable comment on the introductory material. Finally, we would like to thank Tom Alford and Marion Blackwell for championing this publication from outset to completion, for without their continued efforts this book may never have seen the light of day.

Alex R. Chapman and Grazyna Paczkowska
October 2000

Beaufortia sparsa R.Br. (page 350)

INTRODUCTION

INTRODUCTION

Preamble

This publication catalogues the diversity of the vascular flora occurring in Western Australia. In the pages that follow, every native and naturalised alien plant known to occur in the State is listed by family and accompanied by a brief description of its habit, habitat and distribution. Subspecies and varieties are included, as are new entities scientifically recognised but yet to be formally described. In total, this document describes 11,922 vascular plant taxa, as recorded in the information systems of the WA Herbarium on the 20th January 2000.

It has been a guiding principle of this project to only communicate information from verifiable sources of data. Therefore, information presented here is based on three primary data sources—the State's census of plant names, specimen collections in the WA Herbarium and published botanical literature. Anecdotal information not permanently vouchered or otherwise publicly recorded has only occasionally been accepted when there has been a paucity of verifiable information.

A second key strategy has been to adopt and utilise available information systems and methodologies. Linking data capture closely to the Census of Western Australian Plants database was crucial to overcome the constant flow of taxonomic change occurring in our State's mega-diverse flora. The Western Australian Herbarium Specimen database records taxonomic and site data for all of the nearly 500,000 voucher collections it contains and is continually updated with incoming material and new identifications. Its use facilitated access to species data without requiring physical inspection of every sheet. Descriptive information was gathered according to an international standard for coding taxonomic descriptive data (DELTA) which provided both a consistent comparative framework for data capture and a flexible method for transforming the data into various products.

Thirdly, it is our belief that the conservation effort in this State will best be aided by making access to this fundamental information on the State's flora as transparent as possible. For this reason all species that are vouchered with specimens in the State collection are described in this publication, whether its name has been formally published or segregated in specific ways as 'potentially new'. Western Australia is well known for its highly endemic flora, particularly in the south-west and wheatbelt regions. Up to a fifth of the State's flora is considered rare, threatened or has an uncertain conservation status. Many of these species are well recognised by conservation scientists but await a formal taxonomic treatment to be officially named and systematically placed. In the interim informal names provide acceptable handles for communication enabling conservation efforts for these taxa. Information systems are in place to ensure reliable vouchering of these entities as well as a method for tracking the relationship of these names over time.

Similarly, the information for some of the species contained herein is incomplete. Despite the best efforts of workers in this area many species remain poorly known and under-collected. We acknowledge that there is much work yet to be done to document our State's extensive flora adequately and consider it important to communicate the gaps in our knowledge. It is our sincere hope that by making this transparent to users of this catalogue, the missing information will be more readily identified, obtained and made available through the process of permanent vouchering in the State herbarium. Especially important here is the role of community agencies such as the Wildflower Society of WA, Landcare groups and the Regional

Herbarium Network, which are often best placed to add significantly to the body of botanical knowledge for their region or taxonomic area of interest.

The major outcomes of this project have been to:

- compile a brief descriptive statement for every vascular plant taxon known to occur in WA;
- develop a system to allow the ongoing maintenance of this information into the future;
- utilise a data standard which allows this information to be made available in print or online;
- dynamically link this descriptive component to other online botanical information systems in WA;
- encourage community interest and input into developing knowledge of the Western Australian flora.

This publication could be considered simply a static printout of a large and regularly maintained set of botanical databases. Yet by the same token, it signifies the monumental transition from printed to online information sources currently occurring in the world of botany as for every other field of endeavour. Like Beard's *Descriptive Catalogue* published thirty years ago, this book documents the increase in knowledge of our diverse flora. However, the descriptions it contains are already contributing to the next generation of information tools available online via the *FloraBase* website and are dynamically linked to names, specimens, maps and images of the State's flora, as well as providing a form of interactive identification. Whether a hard-copy publication of this nature will be contemplated in another thirty years and what level of information systems might then be available is intriguing to consider. Let us simply hope that our knowledge of the flora, like the plants themselves, continues to flourish.

A Brief Botanical History

It is certain that the various indigenous peoples of Western Australia, over the last fifty-thousand years living and working closely with the natural environment, came to have a highly developed understanding of the native flora. Food, medicines, tools and personal effects were all obtained from native plants and fire was used to manage large areas of vegetation for clearing or to encourage regrowth (Carr 1981, Hallam 1975, Hopkins and Griffin 1989). Aboriginal naming systems necessarily differ from European plant taxonomy and could often be much more discriminating (Peile, 1980). However, much of their verbal tradition has been lost since European occupation or is only slowly being recovered (eg. Aboriginal Communities of the Northern Territory, 1993).

The first verified European collection of Australian plants was by William Dampier at Shark Bay and the Dampier Archipelago in Western Australia during August 1699. At least fifteen of the twenty-four species collected were subsequently published, by John Ray (1704) and Leonard Plukenet (1705), both prior to the advent of the Linnaean binomial system of nomenclature (see George, 1999). The collection is housed in the Fielding-Druce Herbarium at Oxford University, UK.

In 1768 N.L. Burman published names for the first Australian plants to be identified using the new binomial system (Linnaeus, 1753). He described two species from collections now held in Geneva and which are thought to have been collected by Willem Vlamingh on his visit to the Swan River, Western Australia in 1697 (Orchard, 1999).

The French also had an interest in exploring Australia leading to two notable expeditions which left an indelible mark not only on the flora but additionally in the form of place-names, especially along the southern coast of Western Australia. Jacques J.H. de Labillardière was botanist on the d'Entrecasteaux expedition whose ships the *Recherche* and *Espérance* visited Esperance Bay in December 1792, as well as parts of Tasmania (Orchard and George, 1999). Baudin's ships *Géographe* and *Naturaliste* explored much of the WA coast in 1801–1803 and collections were made by Jean Leschenault de la Tour, botanist on this voyage. Labillardière's two volume account, *Novae Hollandiae Plantarum Specimen* published between 1804 and 1807 named many Western Australian genera and species based largely on both these collections. One hundred and five WA species originally named by Labillardière are still recognised today.

The task of cataloguing the WA flora began in earnest with the visit in late 1801 of Robert Brown, who accompanied Matthew Flinders aboard the *Investigator* on his circumnavigation of Australia. Over 600 collections were made by Brown in Western Australia between December 1801 and January 1802 and on his brief return in 1803. Altogether Brown made around 3,900 Australian collections before his return to England in 1805 (Stearn, 1960). Added together with the collections of Banks and Solander on the east coast and the work of earlier collectors, his visit resulted ultimately in the publication of his *Prodromus Florae Novae Hollandiae* (Brown, 1810) which set the foundations for understanding and interpreting the Australian flora. In this and subsequent publications (Brown 1814, 1849) Robert Brown published names for around 800 species still currently accepted and recognised as occurring in WA, while also coining many well known families and genera, including *Caladenia*, *Dryandra* and *Lechenaultia*.

A number of other collectors visited the shores of WA prior to settlement, including Archibald Menzies, who as botanist with the Vancouver Expedition collected at King Georges Sound in 1791, and Allan Cunningham, botanist on King's surveys of the coast between 1817 and 1822, who made significant collections particularly in the north of the State.

Subsequent to the settlement of Western Australia in 1829 European botanists such as Stephan Endlicher (1837), John Lindley (1839–1840) and Johann Lehmann (1846–1847) continued to name the State's unique flora. These botanists depended on the significant collections made by early settlers including James Drummond, George Maxwell and Georgina Molloy as well as visitors such as Baron Karl von Hügel who visited the colony from 1833–1834, and Ludwig Preiss who collected in WA during 1838–1841.

George Bentham's *Flora Australiensis*, published between 1863 and 1878 in seven volumes, was the first comprehensive account of the Australian flora and included descriptions and keys for 8,125 taxa. Although never having visited Australia, Bentham created an exceptional treatment from material held in the collections at Kew and a range of other European herbaria, as well as material loaned to him from Melbourne. The WA flora was well represented in *Flora Australiensis* and Bentham attempted to describe trans-continental relationships in many of the larger plant families.

Ferdinand von Mueller, Colonial Botanist in Victoria ably assisted Bentham in his Flora work by sending him material and manuscripts. Mueller collected widely in Australia and visited Western Australia twice, in 1867 and 1877 and published extensively on the flora. 1,122 species first described by Mueller are still currently accepted as occurring in WA. Mueller subsequently produced a systematic census of Australian plants (1882, revised in 1889) in which he listed 3,560 species as occurring in WA.

Ludwig Diels and Ernst Pritzel visited Western Australia in 1900–1901, making some 5,700 collections and subsequently publishing a detailed account of the flora (Diels and Pritzel, 1904–1905) including around 200 new species. Diels (1906) also pioneered ecological regionalisations in Western Australia, recognising three major botanical provinces within the State.

J.J. East (1912), in an essay on the flora of Western Australia for the *Cyclopedia of Western Australia* provided details of endemism for the State and for the three botanical regions broadly defined by Diels (op. cit.), in which he noted 4,166 WA plant species.

The first two decades of the twentieth century saw the State of Western Australia take custodianship of its native flora. Botanists such as the prodigious collector Alexander Morrison and later Frederick Stoward and Desmond Herbert took charge of various small departmental herbaria. Others such as Cecil Andrews and William V. Fitzgerald published in newly established local natural history journals. Fitzgerald also published a major work on the botany of the Kimberleys (1918).

In 1928 the State's herbarium was formed from the amalgamation of the Forestry and Agriculture herbaria and Charles Gardner was appointed Government Botanist. Gardner published extensively on the flora of the State over the following 40 years. In 1931 he produced an enumeration of plant names which listed around 4,500 WA plant species. Twenty years later he published the solitary volume of a planned *Flora of Western Australia* (1952).

William Blackall and Brian Grieve produced an innovative multi-volume publication entitled *How to Know Western Australian Plants* (1954–1998) which provided illustrated keys to most of the species

occurring in the States' temperate regions. This useful series still continues, with a revision of the second part published in 1998.

The first publication to attempt to publish more than a list of names for all the State's flora was John Beard's *Descriptive Catalogue of West Australian Plants* (1965, 1970). In it Beard presented a concise description using fundamental characters for each of the State's 5,802 indigenous species then known. In this way it served both as a 'thumbnail' Flora for the State and as a simple census of WA plant names.

In the following decade John Green compiled two editions of a *Census of the Vascular Plants of Western Australia* (1981, 1985), the last listing 7,954 currently accepted names to species level, including nomenclatural reference and synonyms. This was the first time that plant census data for the State had been compiled electronically and Green's list was converted to a database and maintained subsequently by Nicholas Lander, Paul Wilson and other staff at the Western Australian Herbarium. Green's database and the *Australian Plant Names Index* (A.D. Chapman, 1991) database together formed the basis for the current Census of Western Australian Plants database.

Contemporary botanists regularly publish in *Nuytsia*, the taxonomic journal of the WA Herbarium founded in 1970. In the following thirty years over 1,200 taxa have been described in this journal and many more recircumscribed or better defined.

Significant portions of the State have now been covered in various floristic treatments, notably the *Flora of Central Australia* (ed. Jessop, 1981), the *Flora of the Perth Region* (Marchant et al., 1987) and the *Flora of the Kimberley Region* (Wheeler et al., 1992) and a new treatment covering the southern forest region is currently in preparation. Similarly, major plant families occurring in the State have been treated in various volumes of the new *Flora of Australia* series, commenced in 1981.

Unlike every other Australian State, Western Australia has never had a State-wide Flora. This lack has been noted by numerous workers over the last hundred years including East (1912), Gardner (1931) and Orchard (1999). While the present book fulfils a number of the functions of a Flora there is still a need for a comprehensive systematic treatment of the plants of this State including taxonomic notes, diagnostic descriptions, keys, distribution statements and illustrations. Given the long history of investigation and the fact that it represents nearly half of the Australian flora, it would be fitting to see a complete *Flora of Western Australia* achieved in the coming years.

Floristics

A comparison of the recorded number of published vascular plant species recognised at intervals over the last 110 years (Table 1) indicates that there continues to be an increase in the number of WA species discovered and formally recognised. The notable increase over the last thirty years can partly be accounted for by improved accessibility into more remote parts of the State as well as a general increase in settlement, the number of botanical surveys and taxonomic effort. However, it also confirms the tremendous biodiversity of the State whereby sustained investigation leads to the discovery of previously unknown plant species at an increased rate.

Table 1
Increase in the number of published vascular plant species recognised as occurring in WA

	Mueller 1889	East 1912	Gardner 1931	Beard 1969	Green 1985	Hnatiuk 1990	Paczkowska & Chapman, 2000
Species	3560	4166	4500	5802	7954	8316	9640

Note. The figure for Beard (1969) represents published native species only; all others include naturalised alien species.

Table 2 summarises the size of various major plant groups at each of the most commonly used levels of the taxonomic hierarchy. Figures were obtained from the Census of Western Australian Plants database as at 20th January 2000, the source of the names used in this current publication.

Table 2
Size of vascular plant divisions to species level

	Families	Genera	Species
Pteridophytes	21	44	95
Gymnosperms	6	7	24
Monocotyledons	51	398	1809
Dicotyledons	148	1094	7712
Total	226	1543	9640

Note. Includes naturalised alien species to maintain comparability with Green (1985).

Unlike many of the previous publications referred to here, this book catalogues taxa below the level of species, as well as yet-unpublished taxa. Table 3 provides a more detailed breakdown of the numbers of taxa for the major vascular plant divisions.

Table 3
Analysis of vascular plant divisions for various categories of name

Category	Pteridophytes	Gymnosperms	Monocots	Dicots	Total
Total records [A]	140	33	3200	13202	16575
Non-current names [B]	36	9	834	2734	3613
Current names [C]	104	24	2366	10468	12962
Current taxa [D]	97	24	2230	9571	11922
Current species [E]	95	24	2084	8652	10855
Manuscript names [F]	0	0	162	458	620
Phrase names [G]	0	0	113	482	595
Published species [H]	95	24	1809	7712	9640
Published alien species [I]	7	5	320	720	1052
Published native species [J]	88	19	1489	6992	8588

Notes. A - total number of records in the database, B - number of synonymous, excluded or misapplied names, C - number of currently accepted plant names including species names for which subspecies are also recorded, D - number of currently accepted taxa (ie. including terminal taxa only), E - number of currently accepted species, F - number of proposed but unpublished species, G - number of assigned but unpublished species, H - number of formally published species names, I - number of published naturalised alien species, J - number of published species native to Western Australia.

Appendix 1 lists all WA vascular plant families by number of species and it is notable that the ten largest families comprise 60% of the flora. Families of woody, sclerophyllous shrubs and trees predominate such as Myrtaceae, Papilionaceae, Proteaceae and Mimosaceae. However, there is also great diversity in certain herbaceous families such as Poaceae, Cyperaceae, Asteraceae and Goodeniaceae.

Climate, Phytogeography and Endemism

Three broad climate regimes can be found in WA. In the northern tropics and the inland north a cyclonic summer rainfall pattern is followed by a mainly dry winter. The majority of the inland portion of the State is arid with intermittent rainfall totalling less than 300 mm per annum on average. The south-western corner of the State follows a typical mediterranean climatic pattern with heavy winter rains and dry summers (Hopper et al., 1996).

Beard (1980) summarised previous work by Diels, Burbidge and Gardner supporting the general recognition of three phytogeographic Provinces in Western Australia—Northern, Eremaean and South-West—each divided into a number of Botanical Districts. Beard & Sprenger (1984) presented definite boundaries for these units, which have become generally accepted. The district boundaries have been incorporated into the Interim Biogeographic Regionalisation for Australia (IBRA) by Thackway & Cresswell (1995) with minor modifications.

Readers should note that the IBRA regions were not hierarchically grouped when published. We have found it useful to aggregate the 26 regions into three phytogeographic provinces broadly following Beard's concepts (refer to Figure 1—inside cover). There are six areas where regional boundaries have changed significantly between the Beard and IBRA classifications.

- *Victoria Bonaparte* (IBRA) incorporates the eastern quarter of *Gardner* (Beard)
- *Tanami* (IBRA) is now equivalent to the northern half of *Mueller* (Beard) and *Canning* (Beard) as *Great Sandy Desert* (IBRA) now continues into the Northern Territory
- *Yalgoo* (IBRA) separates off the south-west corner of *Austin* (Beard)
- *Jarrah Forest* (IBRA) now equivalent to the combined *Dale* and *Menzies* sub-districts of *Darling* (Beard)
- *Coolgardie* (Beard, IBRA) no longer reaches the coast west of the town of Eyre as *Mallee* (IBRA) extends further east
- *Eucla* (Beard) no longer reaches the coast east of the town of Eyre due to the introduction of *Hampton* (IBRA).

Burbidge (1960) defined a 'Southwestern Interzone' corresponding to the Coolgardie Botanical District of earlier authors in which floral elements of the South-West Province and Eremaea are intermingled. For consistency with the previous estimates of flora and endemism for the Provinces, the Southwestern Interzone has been included here in the Eremaea.

A recent re-analysis of species endemism in WA (Beard, Chapman and Gioia, unpublished) noted that estimates of total endemism for the State have decreased over time from 82.0% (East, 1912) and 68.0% (Beard, 1969) to 62.1% at present. The decrease in endemism figures can be attributed to increased knowledge and specifically the greater numbers of collections extending the range of species distributions. The known flora of the whole State has grown from 5,802 (Beard, 1969), to 8,451 published species, representing a 46% increase. Over that same period, while the number of recorded species has increased in all Provinces, species endemism has declined markedly in the Northern Province and to a lesser degree in the Eremaean but has been maintained in the South-West Province.

Table 4 presents the provincial distribution of species endemic to WA and non-endemic species. Both the Northern and Eremaean Provinces share climatic characteristics and hence their floras with other

Australian states and consequently possess low endemism figures (14.3% and 50.4% respectively). The South-West, on the other hand, with its mediterranean climate and historical isolation continues to show a high level of endemism, with 79.2% of the species occurring in that province only found in WA.

In a comparison of species endemism with other areas of temperate mediterranean climate, the South-West is second only to the Cape Floristic Region of South Africa. The California Floristic Province and especially the Italian mediterranean zone, while floristically rich, exhibit lower levels of species endemism.

Table 4
Distribution of endemic vascular plant species in the three Botanical Provinces

	Endemic to WA	Non-endemic	Total
Northern Province	306 (14.3%)	1834	2140
Eremaean Province	2003 (50.4%)	1974	3977
South-West Province	4524 (79.2%)	1186	5710
Whole State	5244 (62.1%)	3207	8451

Notes. Adapted from Beard, Chapman and Gioia (unpublished) and based on Beard's phytogeographic regions. The number of published native species found in WA (8451) differs from the figure given in Table 3 due to difficulties assigning geographical distribution for 137 species. However, it should be noted that these figures were tabulated within the same period and from approximately the same raw data as used for this publication.

Classification

This publication follows the higher level classification of vascular plants by Kubitzki (1990), as outlined in Mabberley (1997). It divides the families among Class Psilotopsida (Fork Ferns), Class Lycopsida (Fern Allies), Class Filicopsida (Ferns), Class Cycadopsida (Cycads), Class Pinopsida (Conifers), Class Magnoliopsida (Dicotyledons) and Class Liliopsida (Monocotyledons). While there is much evidence now arising, largely from phylogenetic studies, for a revised higher level classification of the plant kingdom, we have chosen at this time to continue to use a classification familiar to most of our readers.

The delineation of plant families follows the *Census of Western Australian Plants* (Chapman, Gioia and Wilson, 2000) and based on the system elaborated by Green (1985). The classification of fern and fern allies then adopted by the Western Australian Herbarium was based on advice from P.J. Brownsey, R.J. Chinnock and R.E. Holttum.

The classification and sequence of the Liliopsida (monocotyledons) follows Dahlgren and Clifford (1982) and Dahlgren, Clifford and Yeo (1985). In particular it should be noted that the Liliaceae *sensu lato*, which is well represented in Western Australia is currently considered to comprise the eleven families Alliaceae, Anthericaceae, Asparagaceae, Asphodelaceae, Boryaceae, Colchicaceae, Dasypogonaceae, Hyacinthaceae, Phormiaceae, Smilacaceae and Xanthorrhoeaceae.

The Magnoliopsida (dicotyledons) as presented here follow the classification of Cronquist (1981), modified by our recognition of the families Chloanthaceae, Avicenniaceae and Lobeliaceae. Additionally, the legumes are recognised as the three distinct yet related families Caesalpiniaceae, Mimosaceae and Papilionaceae.

Within Myrtaceae it should be noted that the Western Australian Herbarium accepts taxonomic changes to *Eucalyptus* in which the bloodwood group is formally segregated as the genus *Corymbia*. Hill

and Johnson (1995) published forty nine *Corymbia* species as occurring in WA, thirteen being newly described. Thirty six existing *Eucalyptus* species were also included under *Corymbia* at that time and these are listed in the appended Synonym Index. Blackwell (1997) presented sentiments against this decision and all *Corymbia* species were provided with names under *Eucalyptus* by Brooker (2000). Ladiges and Udovicic (2000) strongly support the continued recognition of the genus *Corymbia* based on evidence from a number of recent phylogenetic studies.

Unlike its predecessor, this book does not attempt to provide descriptions for any taxa above species level. This is in part due to the nature of its preparation and subsequent size, but also due to the better information sources now, or soon to be, available. Morley and Toelken (1983) provide a comprehensive general summary of Australian plant families and genera, while Macfarlane, Watson and Marchant (in prep.) are completing a detailed generic flora of Western Australia using similar computer-aided methods to this current volume.

Plant Names

Formal names for the plants listed in this book follow the *Census of Western Australian Plants* (Chapman, Gioia and Wilson, 2000), which is a companion volume also based on the state of taxonomic knowledge as captured up to the 20th day of January 2000.

Scientific names

A scientific name for each plant consists of the genus and species name, and sometimes also the lowest ranked infraspecific name (ie. subspecies, variety or forma). It is usual to provide the author(s) after the scientific name, often in abbreviated form, to indicate who published the name as well as to verify its validity. An authors name in brackets indicates an earlier combination under a different genus or species (respectively) and is followed by the name of the author who has assigned the taxon to its current placement. Brummitt and Powell (1992) is the standard followed for citing authors of plant names.

Hybrid taxa are indicated by the use of the symbol ×, either preceding the name in the case of formally named hybrids, or conjoining the epithets of the two parent taxa.

This publication follows the *Census of Western Australian Plants* (op. cit.) in cataloguing taxa with as yet unpublished names. These are names that have been proposed or otherwise assigned and may be in use to some extent within the botanical community but are yet to be written up and formally published according to the *International Code of Botanical Nomenclature* (Greuter et al., 2000). We would like to state explicitly that it is not the intention of the authors to publish new taxa or new combinations within this document.

Systems in place at the Western Australian Herbarium track these names and upon publication of the scientific names, unpublished names are treated as informal synonyms. They fall into two distinct categories which generally reflect different stages along the path to publication of a scientific plant name.

Phrase names

The term ‘phrase name’ has traditionally been used to refer to the names given to species prior to the Linnaean system of binomial classification first proposed in 1753. In 1992 the term phrase name was given an updated definition at an early meeting of the Australian Herbarium Information Systems Committee (HISCOM) when a formula was adopted to assist institutions to *assign* a reliable ‘handle’ for putative new species yet to be formally described by taxonomic specialists.

The species phrase name contains four components - the generic name, a rank indicator, a geographic or morphological identifier and a collector’s name and number representing a herbarium specimen vouchering the concept of the new species.

This last component is especially important as it ties the phrase name to a physical representative of the species which is useful when (as is commonly the case in preliminary stages) no other documentation about the new taxon is available. In this respect it has some similarity in purpose to the type concept used in the formal taxonomic naming process. However, it is important to note that there is no actual or inferred connection between the specimen used to voucher a phrase name and any subsequent assignment of type status if the taxon is ultimately formally recognised.

To make it absolutely clear that a phrase name being used is not a published name we append the letters 'pn' to indicate phrase name, in the same manner that manuscript names are noted by the use of 'ms'.

For species:	*Genus* sp. identifier (collector's name and number) pn
Example:	*Pterostylis* sp. crinkled leaf (G.J.Keighery 13426) pn
For infraspecies:	*Genus species* author rank identifier (collectors name and number) pn
Example:	*Acacia mutabilis* Maslin subsp. Young River (G.F.Craig 2052) pn

Manuscript names

During the formal process of researching, describing and publishing a name for a new species, which can often take a number of years, a manuscript name may be *proposed*, usually by the researcher studying the species. This is a name under which information is accumulated during preparation of the manuscript document.

While a manuscript name is commonly the same as the formal name under which a taxon is eventually published, it is still a working hypothesis until that time and can be subsumed into an existing taxon or given another name if desired by the author. A manuscript name is usually in a Latinised form in line with publication requirements. To avoid the possibility that a manuscript name is mistaken for a published one we append an 'ms' after the name to indicate its informal status.

Synonyms

Superseded plant names have been listed together in the appended Synonym Index. This index is intended to help readers familiarise themselves with the latest taxonomic concepts so that known plant names no longer accepted can be looked up and the currently accepted name and placement found. The Synonym Index is sourced with some simplification from the published *Census of Western Australian Plants* (Chapman, Gioia and Wilson, 2000).

The non-current names are categorised here in a manner similar to Green (1985). Taxonomic and nomenclatural *synonyms* have arisen due to the taxonomic changes resulting from systematic research. In addition, some plant names previously used in publications on the State's flora have now been found to have been *misapplied* against different WA species, while others have been found not to occur within the State at all and have been *excluded*.

Common names

Non-scientific names for common taxa were initially sourced from Eleanor Bennett's publication *Common and Aboriginal Names of Western Australian Plant Species* (Bennett, 1993). Subsequently a selection of common names by Roger Fryer (Botanic Gardens and Parks Authority) was used when more than one was available in Bennett's list, on the basis that adopting the same common names set was useful.

However, little work has been done on common names for Western Australian plants with respect to the many significant taxonomic changes since Bennett's book was produced. This publication is therefore not intended to be an authoritative listing of common names and they are given here simply as a general guide for those who find them useful. For a brief recent commentary on the utility of common names see Kanis, Crisp and Orchard (1999, pp. 128–9).

Descriptive Characters

*SHOW Descriptive Catalogue DATE 20/1/2000

*CHARACTER LIST

#1. NameID/

#2. SpCode/

#3. <status in WA:>/
1. alien/
2. <native>/

#4. common name:/

#5. <perennial herbs, mode of perennation:>/
1. bulbaceous/
2. cormous/
3. rhizomatous/
4. tuberous/

#6. <herbaceous plants, life form:>/
1. annual/
2. biennial/
3. perennial/

#7. <habit:>/
1. tree/
2. tree-like monocot <'arborescent'>/
3. shrub/
4. climber/
5. herb/
6. grass-like/
7. <other: eg. mallees, aquatics, bamboo>/

#8. <height of plants, incl. inflorescence:>/
m high/

#9. <comments:>/

#10. fl. <colour of overall inflorescence:>/

#11. fl. <flowering time:>/

#12. <soil types:>/

#13. <habitat:>/

#14. <WA Bioregions: Eremaean Province> ER:/
1. Great Sandy Desert <GSD>/
2. Tanami <TAN>/
3. Pilbara <PIL>/
4. Carnarvon <CAR>/
5. Gascoyne <GAS>/
6. Little Sandy Desert <LSD>/
7. Gibson Desert <GD>/
8. Central Ranges <CR>/
9. Yalgoo <YAL>/
10. Murchison <MUR>/
11. Great Victoria Desert <GVD>/
12. Coolgardie <COO>/
13. Nullarbor <NUL>/
14. Hampton <HAM>/

#15. <WA Bioregions: Northern Province> N:/
1. Northern Kimberley <NK>/
2. Victoria Bonaparte <VB>/
3. Central Kimberley <CK>/
4. Dampierland <DL>/
5. Ord-Victoria Plains <OVP>/

#16. <WA Bioregions: South-West Province> SW:/
1. Geraldton Sandplains <GS>/
2. Swan Coastal Plain <SWA>/
3. Avon Wheatbelt <AW>/
4. Jarrah Forest <JF>/
5. Mallee <MAL>/
6. Warren <WAR>/
7. Esperance Plains <ESP>/

#17. sources and notes/

#18. references/

#19. date of update/

Figure 2
The DELTA character list at the core of the Descriptive Catalogue database

A short list of some fundamentally useful plant characters was used to describe each species, and were largely those used by Beard (1965, 1970). Characters were developed in the DELTA format (Description Language for Taxonomy, Dallwitz et al., 1993). Where relevant, and to allow the possibility of data integration in future, characters were chosen from major existing DELTA data sets such as the Angiosperm Families of the World (Watson & Dallwitz, 1992) and the WAGENERA project (Macfarlane, Watson & Marchant, in prep.).

Most characters could be represented by one or more character states describing the documented range of variation. For characters such as soil type and habitat, where a wide range of descriptive information of varying quality was available, explicit circumscription of states was not feasible and text characters were used to record a descriptive statement.

The individual characters used to record the descriptive data for each taxon are briefly described and explained here. Characters are discussed below in a sequence following the DELTA character list used in the WA Descriptive Catalogue database (Figure 2).

1. NameID. An immutable unique numeric code assigned to the name of every species and infraspecies recognised as occurring in the State. Established at the time that the Census of Western Australian Plants database was created in 1991 to ensure accurate management and computerised tracking of names. The use of the NameID is facilitated when using software such as SEDIT and MAX (Gioia 1992, 1999) and has expanded in use since its adoption to aid the management of other standard species components such as descriptions, maps and images.

2. SpCode. A non-unique six or eight letter code used to enable access to the unique numeric identifier (NameID). It is derived directly from a species or infraspecies name and is utilised so as to minimise the need to remember or directly use the NameID during data entry.

3. Status in WA. Alien taxa are indicated with a prefixed asterisk ("*") denoting introduced or weedy species in the State. All other taxa are naturally occurring in Western Australia.

4. Common name. Non-scientific names sourced from Eleanor Bennett's publication *Common and Aboriginal Names of Western Australian Plant Species* (Bennett, 1993). When more than one was available in Bennett's list a selection of a primary common name was made by Roger Fryer (Botanic Gardens & Parks Authority).

5. Mode of perennation. For perennial herbs, and especially monocotyledonous plants, it is useful to know about the type of underground storage organs they possess. Four states were defined:

1. bulbaceous – with a storage organ, usually underground, made up of a stem and leaf bases, the food reserves being stored in the inner, fleshy leaf bases
2. cormous – with a fleshy, swollen stem base, usually underground, in which food reserves are stored between growing seasons
3. rhizomatous – with an underground stem, usually growing horizontally
4. tuberous – with a storage organ formed by swelling of an underground stem or the distal end of a root.

6. Life form. Plants employ a number of regeneration strategies to ensure their survival. The three fundamental strategies captured here were:

1. annual - a plant whose life span ends within one year after germination
2. biennial - a plant whose life span extends for more than one but less than two years after germination
3. perennial - a plant whose life span extends over more than two growing seasons.

7. Habit. Describes the growth form of a plant, comprising its size, shape, texture and orientation.

1. tree – a woody plant at least 5 m high, with a main axis the lower part of which is usually unbranched
2. arborescent – resembling a tree, especially useful for tree-like monocots such as 'grass-trees' and *Kingia*. Applied to non-woody plants attaining tree height and to shrubs tending to become tree-like in size
3. shrub – a woody plant less than 5 m high, either without a distinct main axis, or with branches persisting on the main axis almost to its base
4. climber – a climbing or twining woody or herbaceous plant
5. herb – any plant that never produces a woody stem
6. grass-like – includes grasses and other monocots resembling grass, such as reeds, rushes, restiads and sedges.

8. Height of plant. Represents the recorded height, or range of heights, including inflorescence, of specimens collected in the field, expressed in metres. Note that it is possible that cultivated material may exceed these measurements. Extreme values, where coded, have been omitted from the species descriptions.

9. Comments. Used to capture additional descriptive information such as diagnostic or other notable features. Depending on the features described here, the information it contributes to the species description may appear out of the expected sequence.

10. Flower colour. Describes the overall colour of the inflorescence or in some cases, what is considered as flower (eg. the bracts of *Darwinia*) in the terms of the basic colour spectrum. Due to the complexity and variety of the floral structures of many plant families, no attempt has been made to relate colour to particular floral organs and colours are in most cases simply listed. This can make it difficult to distinguish plants with multi-coloured floral parts from species where the flowers can exhibit a range of monochromatic colours.

11. Flowering time. Describes the flowering time (phenology) of a taxon as a range of months, or if there is incomplete data, as single instances. A slash mark is used to delineate separate months not forming a continuous range. The data may be incomplete due to a lack of vouchered material collected during the species flowering period. This character was also adapted to record the fertile periods for the fork ferns, fern allies, ferns and gymnosperms.

12. Soil type. Due to wide variation in source material a textual description is used to describe the general soil types, soil conditions and if available, rock types.

13. Habitat. Describes the living environment of a species, such as swamp, creek, sand dune, clay pan, cliff, etc.

14–16. Distribution (refer to Fig. 1 – inside cover). The distribution statements given here have been derived using geographic information system methodologies directly from geocoded specimens present in the herbarium's specimen database. While derivation of geocodes from vouchered material provides many advantages, there are also certain circumstances whereby the distribution statement for a species may be incomplete or absent. These include lack of vouchered specimens across the whole species range, poorly labelled material from which geocodes are unable to be calculated, erroneous geocodes and incomplete or erroneous identifications. Additionally, certain types of species' distributions (eg. for island endemics) may not have been reliably calculated.

17. Sources and notes, 18. References, 19. Date of update. In order to document the reliability and currency of the recorded data, three administrative fields were included to flag the sources of data used during initial data capture. These indicated the use of published literature and/or specimen data from the WA Herbarium collection; recorded the title of any literature references used, and logged when the data for each taxon was entered or updated.

Notes on Project Design and Data Management

The fundamental problem in compiling and maintaining the information in a descriptive catalogue for such a large and diverse flora is the ability to keep up to date with the ongoing taxonomic and nomenclatural changes arising from systematic research around the world. It was concluded that the design of the Western Australian Descriptive Catalogue database required a flexible and extensible approach and this fitted well with other initiatives already in train.

The WA Herbarium was in 1994 completing the databasing of its specimen collection, thereby facilitating access to detailed collection details and geographic data for voucher specimens (Chapman, 1991), now totalling some 500,000 sheets. Likewise the institution was custodian of the plant census data

for the State (Chapman and Gioia, 1995), the direct electronic descendant of census lists by Gardner (1931), Green (1985) and Hnatiuk (1990) and maintained by the collective efforts of many contemporary botanists. A strong core of expertise in managing descriptive data using DELTA—the Description Language for Taxonomy (Dallwitz, 1980; Dallwitz, Paine and Zurcher, 1993) was also available. Finally, and fundamental to the project, ready access to the herbarium's comprehensive botanical library holding current relevant literature was available.

The management of data captured from the above sources was effected with the use of three inter-related applications. Firstly, the project took advantage of a computerised species editing utility called SEDIT (Gioia, 1992) and later MAX (Gioia, 1999) which allowed datasets based on plant names to be easily maintained over time with respect to name currency and status as sourced from regular updates from the authoritative census database of WA plant names. Capturing the descriptive data in a species-based database ensured that the data could be flexibly manipulated and joined with other species-level datasets in the future.

Perhaps the major direct benefit of adopting this methodology was that the time saved by automating the maintenance of name currency could be put into expanding the scope of the original catalogue to score information for infraspecific and unpublished taxa. Similar benefits have been gained by sourcing species distribution data direct from the WA Herbarium Specimen database. Much effort has gone into validating geocodes present in this database over the last seven years and Paul Gioia has used the latest available data to produce the distribution statement given in this book.

DELTA was chosen as the method for codifying the species descriptions for the following reasons. It is an international standard for scoring taxonomic descriptions and is widely supported by a range of software developers. DELTA-coded descriptive data can be readily converted to a variety of output formats, including printed documents, printed keys, data matrices, web pages and interactive computer keys. The WA Herbarium has a number of projects which utilise the DELTA methodologies and is developing applications for the coordination of these projects with the use of core and institutional character lists (see Chapman and Macfarlane, 1999).

The management of institutional characters across an increasing number of projects requires an automated or database approach. Chapman and Choo (1996) briefly outlined the functionality of a 'DELTA Integrator' which would provide a range of tools for creating, checking and coordinating DELTA-based projects. The design also allowed individual projects to work independently yet synchronise their data with the institutional character list at suitable intervals. Thanks to Mike Choo the descriptions that form the major part of this document were translated in this manner, and output by DELTA for final markup into electronic document format and hence to the publishers.

Publication of the data can be achieved in various ways, one of which is the printed output you are now reading. Alternatively, using interactive identification software (Dallwitz, Paine, and Zurcher, 1998), the Western Australian Descriptive Catalogue database could be interrogated, identifications performed and descriptions, maps, illustrations and photographic images presented. The possibility to present images on computer has led directly to the development of an image database project, run largely by WA Herbarium volunteers who manage the systematic electronic capture of images of vouchered WA flora.

The creation of such standard elements as taxon images and distribution maps drawn directly from the specimen database, together with developments in integrating the specimen and census databases made feasible the development in 1995 of a third publication mechanism—the web-based flora information system *FloraBase* (http://florabase.calm.wa.gov.au/).

In *FloraBase* the use of the standard component approach allows pages to be assembled 'on the fly' at the time of record retrieval from the database. Information is accessed via name or specimen queries or, since the addition of the Western Australian Descriptive Catalogue database content, by using simplified form-based interactive identification.

FloraBase was launched onto the web in November 1998, and its adoption as the primary source of authoritative data on the Western Australian flora by 2,000 registered users in the following months has created a new model for the dissemination of flora information in the State.

The Western Australian Descriptive Catalogue database has significantly developed in data handling methodologies since its beginnings in 1993. While the names published here are fixed as at the 20th January 2000, the database has joined the ranks of the State's census and specimen datasets and is now regularly maintained and updated by staff at the Western Australian Herbarium. Current descriptive information is always available as a component of the *FloraBase* website—a lasting legacy of the organisations which came together to coordinate the development of the Western Australian Descriptive Catalogue database.

Alex Chapman
October 2000

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