# Orchids
## OF WESTERN AUSTRALIA

Andrew Brown
Pat Dundas
Kingsley Dixon &
Stephen Hopper

University of Western Australia Press

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Cover: Winter donkey orchid (*Diuris brumalis*) was the first orchid the author, Andrew Brown, remembers seeing as a child growing up in the semi-rural town of Kelmscott. It was common in bushland opposite his house and initiated an interest in native orchids that led him on a journey of discovery that has continued to this day. Although now long gone from those areas, it is still common in the Darling Range near Perth, where its colourful yellow and brown flowers add a splash of colour to the often drab winter landscape.

Endpapers: A Year of Orchids
Although the concentration of Kimberley Region species flower in summer and South-West Region species in late winter and spring, at least some Western Australian orchids can be seen in flower every month of the year. Shown here is a selection of species illustrating a year of orchids.

| | |
|---|---|
| January | *Calochilus caesius*, *Thelymitra fuscolutea*, *Diuris heberlei* |
| February | *Dipodium ammolithum* ms, *Habenaria joesmithii* ms, *H. triplonema*, *Cryptostylis ovata* |
| March | *Praecoxanthus aphyllus*, *Leporella fimbriata*, *Corunastylis tepperi* |
| April | *Prasophyllum* sp. 'early', *Eriochilus dilatatus* subsp. *dilatatus* |
| May | *Rhizanthella gardneri*, *Pterostylis vittata*, *Caladenia drummondii*, *Eriochilus pulchellus* |
| June | *Pterostylis rogersii*, *Thelymitra apiculata*, *Pterostylis scabra. P.* sp. 'broad petals' |
| July | *Pheladenia deformis*, *Corybas recurvus*, *Diuris brumalis*, *Caladenia hirta* subsp. *rosea* |
| August | *Cyrtostylis huegelii*, *Caladenia incensa. C. reptans* subsp. *reptans*, *C crebra*, *Pterostylis barbata*, *Elythranthera brunonis* |
| September | *Caladenia longicauda* subsp. *eminens*, *C. flava* subsp. *flava*, *Pyrorchis nigricans*, *Caladenia footeana*, *C chapmanii*, *Drakaea glyptodon*, *Thelymitra speciosa* |
| October | *Caladenia harringtoniae*, *Cyanicula gemmata*, *Caladenia lobata*, *Thelymitra graminea*, *Pterostylis frenchii* |
| November | *Diuris pauciflora*, *Epiblema grandiflorum*, *Caladenia radiata*, *Gastrodia lacista*, *Paracaleana dixonii* |
| December | *Nervilia holochila*, *Caladenia pholcoidea* subsp. *pholcoidea*, *Spiculaea ciliata*, *Caladenia ultima*, *Prasophyllum brownii* |

# FOREWORD

It is with great pleasure that I write a foreword for this lovely book, full of beautiful orchids painted by Pat Dundas, and complete with interesting facts about their history, habitat and important place in our world, researched and written by Andrew Brown, Kingsley Dixon and Stephen Hopper.

I feel that Western Australians are so lucky to live in a place of such rich beauty with its unique and diverse natural history. I get a thrill realising that of all the *Banksia* species nationwide, the vast majority are found only in the south-western corner of the state and that the giant Tingle tree is found only near the south coast within a 50 km radius of Walpole. But surely what put us on the botanical map are the queens of the plant world – our orchids.

For many, they form part of our earliest memories. In their preface the authors reminisce about childhood summers spent eagerly awaiting the first blooms of the new orchid season, and the joyous discoveries that followed – to find a spider orchid in the wild was one of the great joys of my own childhood.

Andrew, Pat, Kingsley and Stephen, staying true to their childhood passions, have become leaders in their field and produced the wonderful book you now hold in your hands – the first modern text to cover all known species of Western Australian orchids. Never before has the totality of our orchids been described and illustrated with such depth and clarity.

I came to know Pat through the Botanical Artists' Group of Western Australia. I was first introduced to the BAGS, as they call themselves, when UWA Press published Katie Syme's and Neale Bougher's book *Fungi of Southern Australia* in 1998. Katie lives in Denmark where we visit as often as we can. She introduced me to Pat Dundas and they asked me to open their beautiful exhibition at the Kingfisher Gallery in Perth. It was stunning and made me grasp the very important role botanical art plays in helping us appreciate the science, ecology and conservation of our natural world, all the while highlighting its beauty.

Pat came with me to the Kimberley last year on the trip of a lifetime. Together we walked through the El Questro gorges, drove along the Gibb River Road, camped out under the stars and walked across the Mitchell Plateau. We were awestruck by the Wandjina and the Bradshaws. We searched eagerly and anxiously for tree orchids, were welcomed into Aboriginal communities and talked about how important this place was for us with our different interests.

Our passions united around preserving these unique Western Australian environments for the children of the future. We realised that having such wonderful places in such pristine condition was not only related to issues of the environment, but also nourished our spirits. Orchids are 'spirit food' and this book will feed your soul as well as inform your mind. *Orchids of Western Australia* is a remarkable achievement and one that I sincerely hope will contribute to the preservation of our state's natural beauty for generations that follow.

Professor Fiona Stanley AC

# ACKNOWLEDGEMENTS

We wish to express our sincere thanks to the many people and organisations that have helped us during the preparation of this book. They freely gave us information on orchid localities, distribution, abundance, biology, ecology, conservation status and taxonomy, collected or assisted in collecting many of the specimens that were used to illustrate this book and provided companionship during field trips. Many organisations provided sponsorship for trips into the Kimberley Region. Without the assistance of this dedicated group of people and the financial assistance of these organisations the book would not have been possible.

The intrepid and supportive station people of the Kimberley Region have been instrumental in making a success of the project to paint all the orchids of the area. Butch Maher (a helicopter pilot) his wife Robin, Matt and Russell Barrett (formerly of Beverley Springs Station) and Chris and Debbie Holt (formerly of King Edward River Station) were responsible for finding and collecting many of the Kimberley orchid specimens used for the paintings in this book. They also provided invaluable logistical and practical support and generous hospitality. Ann and John Koeyers (Drysdale River Station), Jim Kelly of Derby and Peta and Russell Timms (formerly of Theda and Doongan Stations) were instrumental in the success of the orchid surveys. The combined efforts and vigilance of these people helped enormously in developing a more comprehensive understanding of the diversity and biology of Kimberley orchids.

For the collection of specimens of south-west orchids used for the paintings in this book, special mention must be made of Meredith Crossley for champagne and barbecues in the bush, the Scott family, Greg and Mary Bussell, Fred and Jean Hort, Eric Chapman, Joff Start, Chris French, Garry Brockman, the late Ron Heberle, and the late Bill Jackson and his wife Gloria. These people went above and beyond the call of duty and showed such generosity by taking us on field trips, collecting special orchids that were needed, or providing hospitality.

We are also grateful to Robert Bates, Andrew Batty, Wally Bettink, Mark Brundrett, Bevan Buirchell, Noel Elliot, Nye Evans, the late Millie Ford, Delys and Keith Forrest, Joan Start, Mike Griffin, Noel Hoffman, Wayne Merritt, Ryan Phillips, Margaret Pieroni, Charles Strahan, Liz Sutherland, Nigel Swarts, Alan Tinker and members of the West Australian Native Orchid Study and Conservation Group who passed on the knowledge they gained during the many field trips they made into the Western Australian bushland to study these fascinating plants.

We would like to acknowledge the valuable contribution made by Wesfarmers, Argyle Diamonds, EG Green and Sons, BHP Minerals, Poseidon-Bow River Diamonds and Kings Park and Botanic Garden (Botanic Gardens and Parks Authority) whose sponsorship enabled the surveys of the little-known Kimberley orchids to be done over a period of several years. The paintings of Kimberley orchids in this book are a record of these surveys.

We are also extremely grateful to the Western Australian Herbarium for providing access to specimen information and allowing us to use specimens to paint rare orchids that we were not able to locate in the wild.

# PREFACE

Orchids have fascinated man since the earliest of times. Beguiling, intriguing, beautiful and mysterious are some of the superlatives given to orchids. From the orchid mania of the nineteenth century when new orchid species had pop star status, to today where orchids are the king of horticultural crops, orchids continue to capture people's imagination. Western Australian orchids are no exception – from the bluest orchid of all to one of only three of the world's fully underground species, Western Australia is a cornucopia of orchid delights. With common names such as hammer, duck, elbow, spider, dragon and fairy, Western Australian orchids have embarked on evolutionary wanderings that evoke mystery and intrigue. It is this very mystery coupled with their extraordinary beauty that led the authors of this volume on a life-long fascination with our bushland orchids, culminating in this first modern text of all the known temperate and tropical orchids of Western Australia.

During our earliest forays into the bush as children growing up in largely rural and semi-rural communities, bush orchids were just a short stroll from home. In these areas we saw the colourful spider orchids, shiny enamel orchids, dainty fairy orchids and unusual greenhoods that were often abundant. Each year as the summer heat abated we could hardly contain our excitement for the first blooms of the early flowering hare and bunny orchids, heralding the start of a new orchid season.

This interest soon extended to a love of the Western Australia bush and its diverse flora and we began to learn of the intricate relationships found in all ecological communities. In particular, we observed the many unusual and sometimes bizarre ways in which insects and flowers interacted. In no plant family is this more pronounced than in the orchids, where the zenith of floral evolution has occurred. Some orchids such as the unusual hammer orchids have evolved to such a degree that they not only resemble female flower wasps, they also emit sexual floral odours to dupe the unsuspecting male wasp into the pollination snare. We also noticed that many orchids occurred only in particular habitats and were not able to survive if these habitats were extensively modified. Some orchids for instance occur only in shallow soil pockets on granite rocks, while others prefer winter-wet areas or always live in association with particular native plants. The underground orchid for example occurs only under broom honey myrtle, where an associated mycorrhizal fungus forms a nutritional link between the orchid and the root system of the honey myrtle.

Unfortunately, we have come to see many of our favourite places cleared or degraded with weeds, fire and rising salinity. We hope that by sharing with you the beauty of our native orchids, we can together work to conserve these remarkable and fragile bushland plants. We also hope that this book enables you to identify and find out more about the native orchids that you encounter during forays into the Western Australian bushland.

We are in a particularly active period of orchid taxonomy. Currently, some thirty-nine genera and 317 species of orchid are named in Western Australia, with over eighty of these named since 1998. However, at least a further ninety-four unnamed species are known and, more are being discovered every year. During preparation of this book a series of detailed surveys of the Kimberley orchids was conducted resulting in many new species being found, described and illustrated here for the first time and searches are continuing in the south-west. Once complete, the number of Western Australian orchid taxa is likely to be well over 450.

The genera and species of Western Australian orchids are treated in two chapters based on geographical distribution – 'Orchids of the South-west Region' and 'Orchids of the Kimberley Region'. In each chapter the genera are treated alphabetically; however, species are placed in taxonomic groupings. This is designed to make it easier for the reader to differentiate between closely related species that may be difficult to tell apart in isolation, but are distinctive when seen together.

For each orchid species, illustrations are provided of the whole plant and sometimes several plants of the same species, including flowers, stems and leaves. While flowers are usually used to identify the plant, leaves are often distinctive and can be used to differentiate species when the plant is not in flower. Text for each Genus and species includes the meaning of its scientific name (shown in brackets under the genus/species name), its flowering period (in abbreviated form), who described it and where it was first collected, its distribution and habitat, and a short description of the plant, including how it differs from close relatives. There is often added information on pollination, conservation status and additional historical accounts of interest to the reader.

Many orchid species have colour forms. In the case of some *Thelymitra* species for instance, flower colour may vary from white through blue to purple, violet and pink. *Caladenia* species may have flowers that vary from white to yellow or red and may contain varying suffusions of all of those colours. Plant height and flower size also vary significantly. This can make identification difficult, particularly as most orchid books rely largely on a single photo or illustration to identify a species. As a consequence, it is often not easy to determine if the plant you are viewing is the same species as that illustrated in the book. To overcome this problem we have included multiple representations of species that illustrate the range of variation, including height, size and colour, making it easier to correctly identify the orchid you have found. A selection of many named and commonly encountered hybrid orchids has also been included, as these can be quite distinctive and are often thought to be new species when first encountered.

We hope this book will guide and inspire for many years to come so that future generations will marvel as we have, at the diversity and beauty of Western Australian orchids.

Andrew Brown, Pat Dundas, Kingsley Dixon and Stephen Hopper

# ABOUT THE ARTWORK

Orchids are the jewels of the botanical world. Often small and unobtrusive, yet sometimes brightly coloured or strongly perfumed – to come upon them in our Western Australian landscape is akin to finding hidden treasure.

As a child, I endeavoured to preserve these 'treasures' by drawing, painting and then pressing them. Our farm north of the Porongurup Range contained a wonderful variety of orchids but it was not until many years later, when I joined the West Australian Native Orchid Study and Conservation Group and met Andrew Brown, Kingsley Dixon and Stephen Hopper, that I realised just how many orchids there were and how few I had seen. Andrew Brown and Noel Hoffman were just about to publish their first book *Orchids of South-West Australia* with photographs of all the orchids known at that time, most of which I had never encountered in the bush. Some years later, in 1991, with the encouragement and assistance of Andrew, Kingsley and Stephen, I began to paint orchids in earnest with the intention of painting all the Western Australian orchids – a project I estimated would take two or three years, and which Andrew and I thought could be used for a new book on these orchids. In the meantime I had attended a talk by Kingsley about the amazing orchids of the Kimberley Region, and it was obvious that these also needed to be included.

Although only a small proportion of Western Australian orchids occurs in the Kimberley Region, little was known about them at that time, because the majority flower during the wet season, when the region becomes inaccessible by road. Kimberley trips were made from the months of October to February and modes of transport included bicycles delivered via mail plane (on the Mitchell Plateau), charter planes, four-wheel-drive motorbikes, bull catchers (minimised Suzuki cars), helicopters and four-wheel-drives. Due to the intense heat and humidity of the Kimberley Region at that time of year, it was difficult to paint orchids *in situ* or to preserve them to paint later. In one instance, *Nervilia holochila*, which had not been seen in flower for many years, was collected by Matt and Russell Barrett from their pastoral lease, put on the mail plane to Derby that afternoon and painted in the studio in Perth that night. When you understand the conditions and distances involved, this is extraordinary! There are many such stories of the wonderful people met while orchid hunting in the Kimberley Region.

Many field trips were also made to collect and paint the South-West Region species and while some were common and widespread, and therefore easy to locate, others were much more difficult to collect as they flowered only in the season following fire, or grew only in remote areas. Locating them would not have been possible without the generous assistance of many people who provided locations or specimens, often from their own property.

Over a sixteen-year period, 185 paintings (plus cover and endpapers) were completed. The orchids were painted life-size, as the size and the relationship to one another was of paramount importance for this book. In good seasons, the orchids chosen to paint were perhaps more robust than in a normal year, and conversely, in poor years were smaller. Where possible, the variability in form, size, and colour has been shown. In the case of rare orchids, sometimes only one specimen is illustrated.

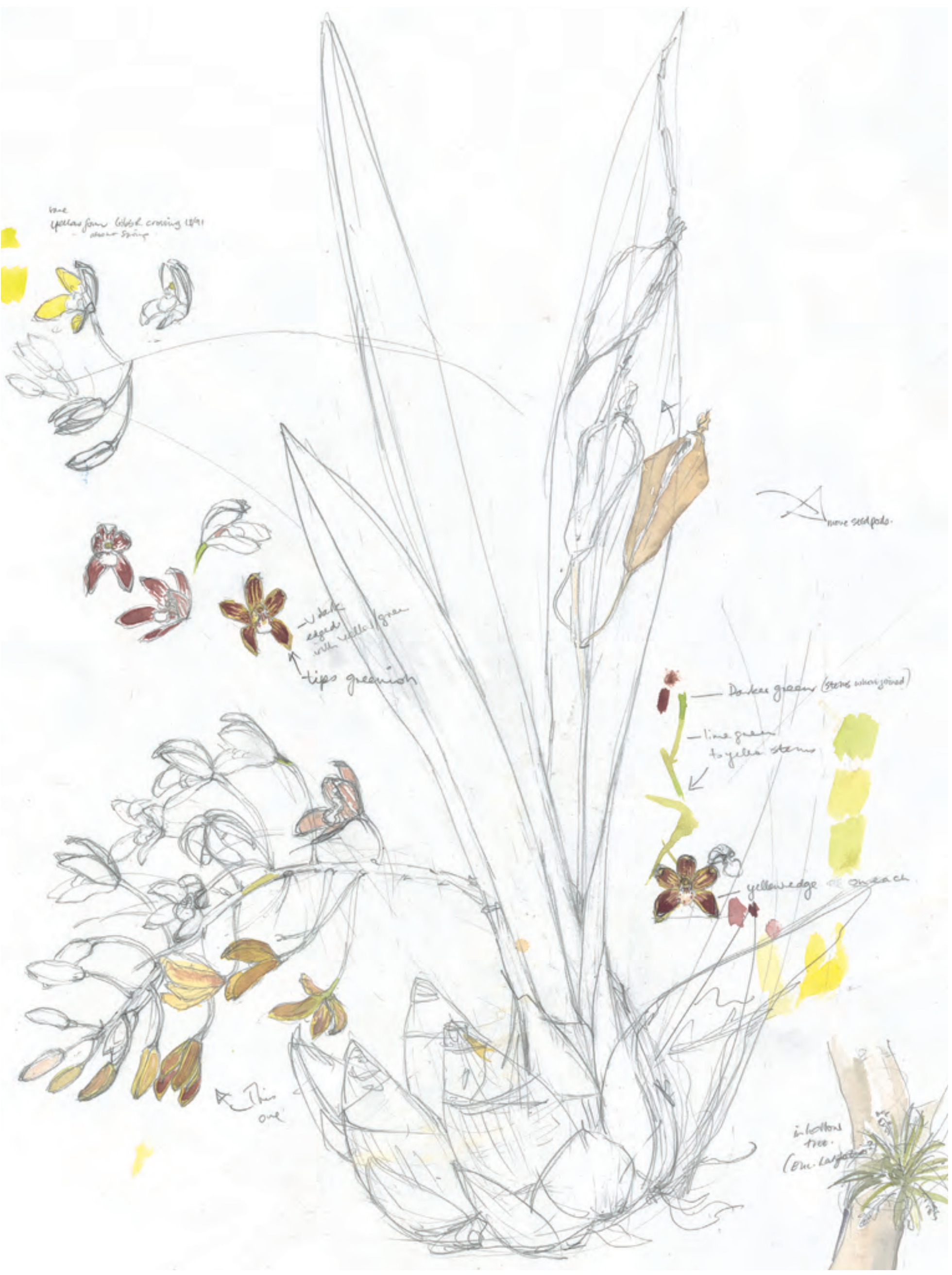
For a botanical artist, it is important to be able to work at a desk with good light and a fresh plant. Very little artwork contained in the book was done in the field, as is it best to spend that time looking for plants. However, some field drawings were occasionally made and notes were made about colours, number of flowers and height. It is helpful to see as many variants as possible and to see how and where they grow. An *in situ* painting at the beginning of each genus endeavours to show the habitat typical for the majority of species. It is essential to observe the plant closely, particularly in the case of orchids where many of the diagnostic features are minute. Even so, several of the plants illustrated in this book may look similar to one another, and you will need to carefully read the accompanying text to ascertain the differences.

All but a few orchids were painted from fresh material. In some cases, it was necessary to rely on herbarium specimens and photos, especially for those rare orchids which have not been seen for many years. While the beginning of the season heralded a handful of orchid species to paint, by spring it was a race against time to collect and paint the many species that flowered concurrently.

An outline of the orchid was drawn in pencil, then coloured using watercolour. When there were many specimens, the flower was painted first (as it was shorter-lived) and leaves and stems painted later. A technique to make flowers last longer was to place them in plastic bags and keep them in the fridge, although care had to be taken not to freeze flowers.

The paintings were done within an A3 format but reduced to A4 for this book. The paper used for the species paintings was Arches aquarelle 100% rag and for the genera was Saunders smooth 100% rag.

Pat Dundas



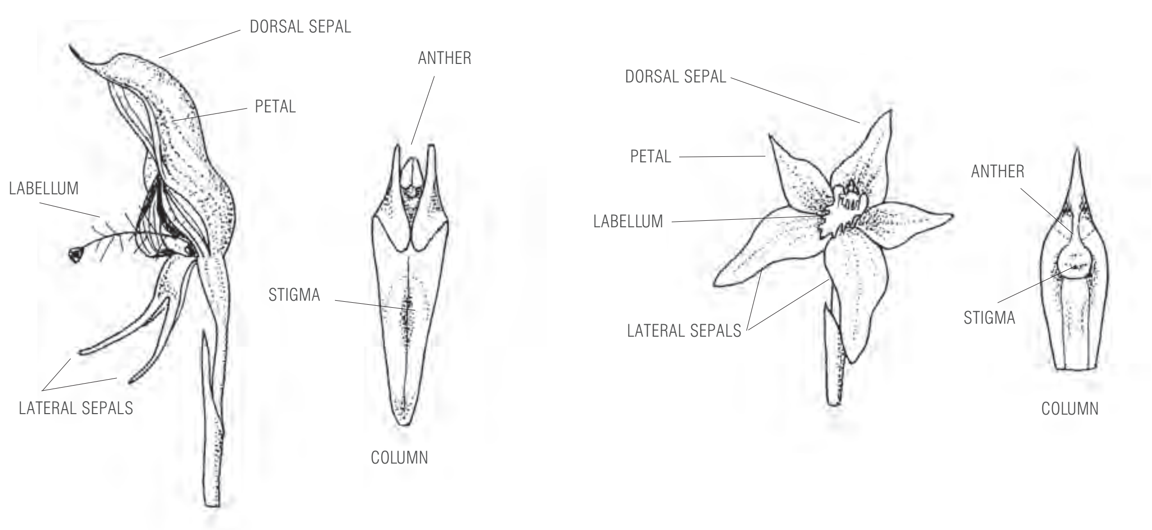

Field drawing of *Cymbidium canaliculatum.*

# INTRODUCTION TO THE ORCHIDACEAE

Originally defined by Haller in the eighteenth century from the well-known northern hemisphere genus *Orchis*, the Orchidaceae family comprises over 800 genera and 25,000 species and equates to about 10 per cent of the world's flowering plants. About 800 new species are described each year and many more await discovery in areas where botanists have yet to explore. In addition to naturally occurring species, over 100,000 hybrids and cultivars have been produced by horticulturists since the cultivation of tropical species began in the nineteenth century. Australia is currently known to have 192 genera and 1,700 species of orchids, many of which are yet to be formally named, with 95 per cent of species endemic.

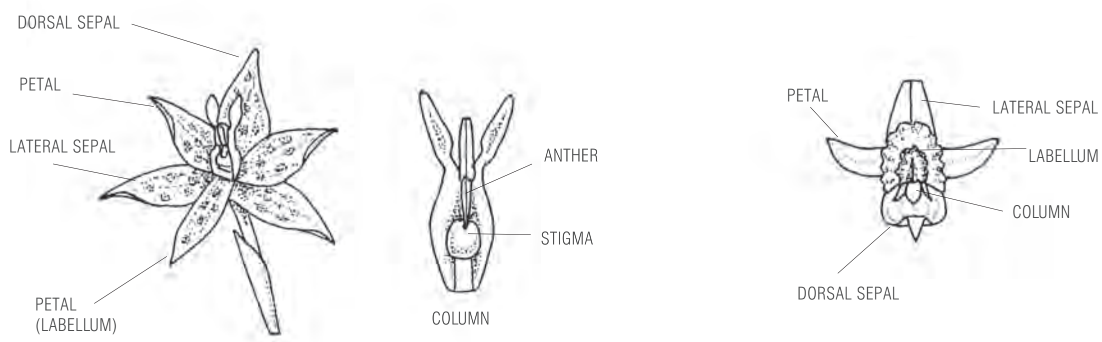
Although most prolific in the tropics, orchids are found throughout most of the world's landmasses, from Alaska in the Arctic to Macquarie Island in the Subantarctic. Orchids occupy rainforests, cloud forests, mangroves, woodlands, heathlands, forests, grasslands, alpine meadows, wetlands and scrublands. The only places that orchids are not found are in very dry and very cold areas. In Australia, orchids are most abundant near the coast but also extend inland to the edges of the deserts in lower numbers. Just three orchid species are found in the desert regions of Australia. Habitats vary enormously from tropical rainforest to temperate forest, woodland and shrubland.

Orchids belong to the group of plants known as monocots, which have a single cotyledon (embryonic leaf) and usually have parallel-veined leaves, and flower parts arranged in groups of three or in multiples of three. Common examples are grasses, bamboos, palms, lilies, irises and orchids. Monocots comprise some 75,000 species in ninety-seven families, over a quarter of all flowering plants. Orchids differ from other members of this group in that most have a highly modified third petal that forms a structure known as a labellum or lip, the exception being the genus *Thelymitra* where all petals are roughly the same size and shape. In orchids the stamens and style are also highly modified and are fused together into a column. This organ is situated centrally on the flower and is often quite conspicuous. A further distinctive feature is found in the pollen of orchids, which is aggregated into packets known as pollinia, each of which can contain thousands of pollen grains. These packets are usually removed as a unit during pollination but in self-pollinating orchids often lack coherence and readily break into fragments. In most orchids the pedicel, which is below the ovary, twists through 180 degrees during development. This results in the labellum appearing below the column, effectively making orchid flowers upside down. In a few Australian genera, such as *Prasophyllum* and *Paracaleana*, the labellum is above the column. The function of the labellum in most orchids is to attract insects and provide a landing stage for them.




Although they at first appear unalike, the flowers of *Pterostylis barbata* (left) and *Caladenia flava* (right) are typical of most orchids in having three sepals, three petals (two normal and one highly modified) and a column which comprises the male anther and the female stigma.

There are several distinct groups within the Orchidaceae, the most common worldwide being the epiphytes (73 per cent of species) that are generally evergreen and mainly found in the tropics. In these areas rainfall is abundant and the majority of orchids grow on trees where they are able to receive more sunlight than is found on the dark rainforest floor. In Australia, epiphytic species are found only in tropical eastern and northern Australia. The second largest group of orchids is the geophytes. These grow in the ground and it is this group that is best represented in the Mediterranean regions of southern Australia. Most geophytes are deciduous, having a dormant phase where they survive the long dry period (winter in the north and summer in the south), by dying back to fleshy underground storage organs called tubers or rhizomes. In Australia, the majority of species fall into this category. The third and smallest group is the lithophytes. These grow on rocks and in Australia are found mainly along the east coast.

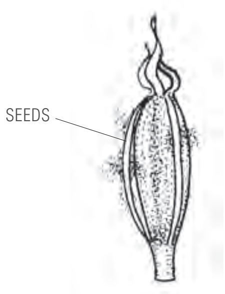



Right: In a few Australian genera, such as *Prasophyllum fimbria*, the labellum is above the column.

Left: The genus *Thelymitra* is unusual in that all petals are roughly the same size and shape.

Orchids are one of the most specialised groups of plants and in order to achieve pollination the orchid flower has undergone a number of major evolutionary adaptations. The methods they use to attract pollinators provide a fascinating subject for study and have attracted the attention of many, including Charles Darwin who devoted a book to the subject of orchid pollination, as did some of his contemporaries. Most Australian orchids are pollinated by insects or, in rare cases, self-pollinate or produce seed through apomixis. Once pollen has been deposited on the stigma of an orchid flower, hundreds or thousands (millions in some species) of pollen grains produce pollen tubes that grow down through the style and fertilise the ovules. As the seeds develop the seed capsule increases in size and the perianth and column wither. Once dry, the seed capsule splits and the seeds are released. For most orchid genera, each flower, depending upon the species, produces some hundreds if not thousands (millions in some species) of fine dust-like seeds that are dispersed by wind.

In natural conditions, few orchid seeds germinate from a seeding event. This may be due to natural waste and attrition as the dust-like seeds would be lodged in a variety of places not suitable for germination and growth of the seedling, but may also be a result of the specialised requirements for the germination of orchid seed. The minute seed of most orchids only germinate with the aid of a specialised mycorrhizal fungus with the resulting plant maturing over several years to a point where it is large enough to produce a flower. This can take up to three or more years depending upon the growing conditions and the orchid involved. The mycorrhizal fungi come from a range of taxa including *Ceratobasidium* (Rhizoctonia), *Sebacina*, *Tulasnella* and *Russula* species. Some orchids are associated with saprotrophic, or pathogenic fungi, while other orchids are associated with ectomycorrhizal fungi. These latter associations are often called tripartite or epiparasitic associations as they involve the orchid, the ectomycorrhizal fungus and the ectomycorrhizal host plant (as proven for the Western Australian underground orchid). This symbiotic relationship with fungi, whose hyphae are digested and provide nutrients including carbohydrate for the plant, exists with most orchids and may persist throughout the life cycle of the orchid.




Once dry the seed capsule splits and the seeds are released.

Once they reach maturity orchids are capable of living for many years as long as conditions are favourable. Each year, orchid plants will produce one or more new pseudobulbs, rhizome segments or tubers and in some cases will over time produce large clumps or colonies via this method.

## THE NAMING OF ORCHIDS

The scientific method of naming plants is related to the study of taxonomy. Taxonomy is the identification and classification of plants which are grouped into divisions, classes, orders, families, genera, species, subspecies, varieties and forms. Naming of plants is governed by an *International Code of Botanical Nomenclature*, a rule book agreed to and updated by taxonomists every six years at an International Botanical Congress.

As with other plants, orchids are classified by taxonomists using the binomial (two words) or trinomial (three words) system of nomenclature. The generic name when combined with a species name makes up the binomial name. *Caladenia* is a generic name and can be used by itself to indicate a member of the *Caladenia* genus or can be used in combination with a species name such as *longicauda* to indicate the particular species within that genus. When using the trinomial system of classification an additional name is added, for example *Caladenia longicauda* subsp. *eminens*.

The binomial system we use today was brought into wide use by the Swedish botanist Carolus Linnaeus over 200 years ago. Because there has been a standard method of naming plants and rules for the creation and application of new names, we can read taxonomic works from Linnaeus's day to the present day and easily understand which species the authors are referring to.

The name of a genus (plural – genera) is written in italics and the first letter is capitalised. The name of a species (plural – species) is usually an adjective that modifies the genus. Like the generic name the species name is always written in italics but, unlike the name of a genus, the species name never starts with a capital. Generic names and species names may come from any source. Often they are Latin words but they may also come from ancient Greek. They can be derived from a feature of the plant, a place where it grows, from a habitat in which it grows in, from a person's name (perhaps its discoverer) or from a variety of other sources.

Often, a species exhibits some variation, such as different flower colour, flower size and shape, or height. If this variation is insufficient to warrant naming the plant as new species, but is nevertheless distinctive, a subspecies, variety, or form may be named. When one of these ranks is recognized, its name is formed by using the species name followed by subsp., var., and more rarely forma, as an additional epithet followed by the name of the author. Which of these three ranks is used depends upon the type and magnitude of the differences between it and the other members of the species, on geographical and ecological considerations, or patterns of variation across the geographical range of the species.

The term subspecies is usually used to designate a group of populations with their own geographical range or distinctive ecological habitat that are approaching species status. Subspecies often show zones of transition into each other where their geographical ranges or habitats are adjacent. Given time, it is expected that a subspecies might evolve into a species, although this idea today is giving way to mounting evidence that new species arise in small isolated populations that may or may not be subspecies. A subspecies is usually geographically distinct and has other characteristics that distinguish it from the species. However, the degree of separation is insufficient to call it a species. This is admittedly subjective and is one of the reasons why taxonomists change the names of plants. An alternative view held by some taxonomists is that subspecies is a rank between species and variety. In other words, subspecies are groups of varieties. An example of a subspecies is *Caladenia flava* R.Br. subsp. *maculata* Hopper & A.P.Br.

The term variety has traditionally been used in the same manner as subspecies, to distinguish taxa that are approaching, but have not yet reached, species status. Variety is also used to distinguish groups of populations with ecological differences. Variety and subspecies are often used interchangeably. In recent times the use of the term variety has been largely replaced with subspecies.

Forma is usually used to designate a minor variation within a species or subspecies. For instance, albino forms of species are often designated as forma *alba*.

Occasionally, a species, subspecies or variety is placed in a different genus or provided a different rank. When this happens, the original author's name is placed in parentheses. This is followed by the author of the current binomial. For example, *Caladenia caesarea* (Domin) M.A.Clem & Hopper indicates that the botanist Karel Domin first named the orchid as a variety of *Caladenia filamentosa*. Its original name was *Caladenia filamentosa* R.Br. var. *caesarea*

Domin. Later, this variety was elevated to species level by Mark Clements and Stephen Hopper. An example of a species being moved to a different genus is *Cyanicula amplexans* (A.S. George) Hopper and A.P.Br. The orchid was originally named as a species of *Caladenia* by Alex George and was later placed in the new genus *Cyanicula* by Stephen Hopper and Andrew Brown.

Plant classification systems rely on assessing the differences and similarities between one group of plants and another group. Studies in orchids have traditionally been heavily biased towards floral morphology but recent studies have revealed the importance of vegetative features in the roots, stems and leaves, and even different flowering seasons.

Name changes are the inevitable result of continuing taxonomic studies. Such studies can be frustrating to enthusiasts who often have difficulty in keeping abreast of the latest names but are inevitable as new scientific information comes to hand.

Recently, detailed molecular studies have become a powerful method for revealing hidden aspects of the genetic make-up of orchids and casting light on ancestral relationships that are not easily determined by morphological techniques. These laboratory techniques are a relatively modern innovation but they are being taken up rapidly by botanical students in many countries, resulting in name changes worldwide.

# WESTERN AUSTRALIAN ORCHIDS

Just over two hundred years ago, Archibald Menzies collected three orchid species from King George Sound, the location of present-day Albany. Since then, some 39 genera and 411 species have been found in two well separated regions of Western Australia – the Kimberley Region with twelve genera and seventeen species and the South-west Region with 28 genera and 394 species. Just two species, *Pterostylis* sp. 'hairy' and *Thelymitra petrophila* ms, have been found outside these two regions, surviving as small populations in the arid interior by inhabiting moist run-off areas on the sides of rocky hills.

## HABITAT

Habitat occupied by Western Australian orchids varies enormously: the Kimberley Region species growing in small pockets of tropical rainforest, swamps, savannah and seasonally wet sandstone pavements; the South-west Region species in heaths, swamps, shallow soils on granite outcrops, salt lake margins, woodlands and forests, and even swales in coastal dunes. Orchid species occupy all but the most arid and saline areas within these two Regions.

## ABUNDANCE

Some Western Australian orchids are common and widespread while others are rare and restricted. *Caladenia flava* grows in a variety of habitats over a very large area between Augusta and Menzies, and often blooms in large numbers as a result of its clonal behaviour. The species grows equally well in coastal heath, woodlands and forests, swamp margins and shallow soils on inland granite outcrops. *Eulophia bicallosa* is abundant and widespread between the Gibb River Road and Kalumburu, growing near springs in seasonally wet savannah woodland or in open grassy swamplands. Other species are much rarer or are restricted to specific habitats. *Caladenia williamsiae* is known from a single nature reserve near Brookton where it grows on the tops of lateritic breakaways, and *Zeuxine oblonga* is known from a single location east of Kununurra, where it grows in closed canopy forest in boggy soil near a freshwater spring.

## FLOWERING

Western Australian orchids flower throughout the year, with the concentration of the Kimberley Region species in summer and the South-west Region species in late winter and spring. In the South-west Region, *Praecoxanthus aphyllus* flowers can be found as early as March while *Thelymitra fuscolutea* begins flowering in November and continues well into February. The first Kimberley Region species to flower is *Eulophia bicallosa* which can begin as early as August while the last is *Didymoplexis pallens* which starts in February and continues into March. A few Kimberley Region species, such as *Dendrobium dicuphum* are not summer flowering and instead flower during the winter months.

*Praecoxanthus aphyllus* (left) is one of the first south-west species to flower while *Thelymitra fuscolutea* (above) is one of the last.

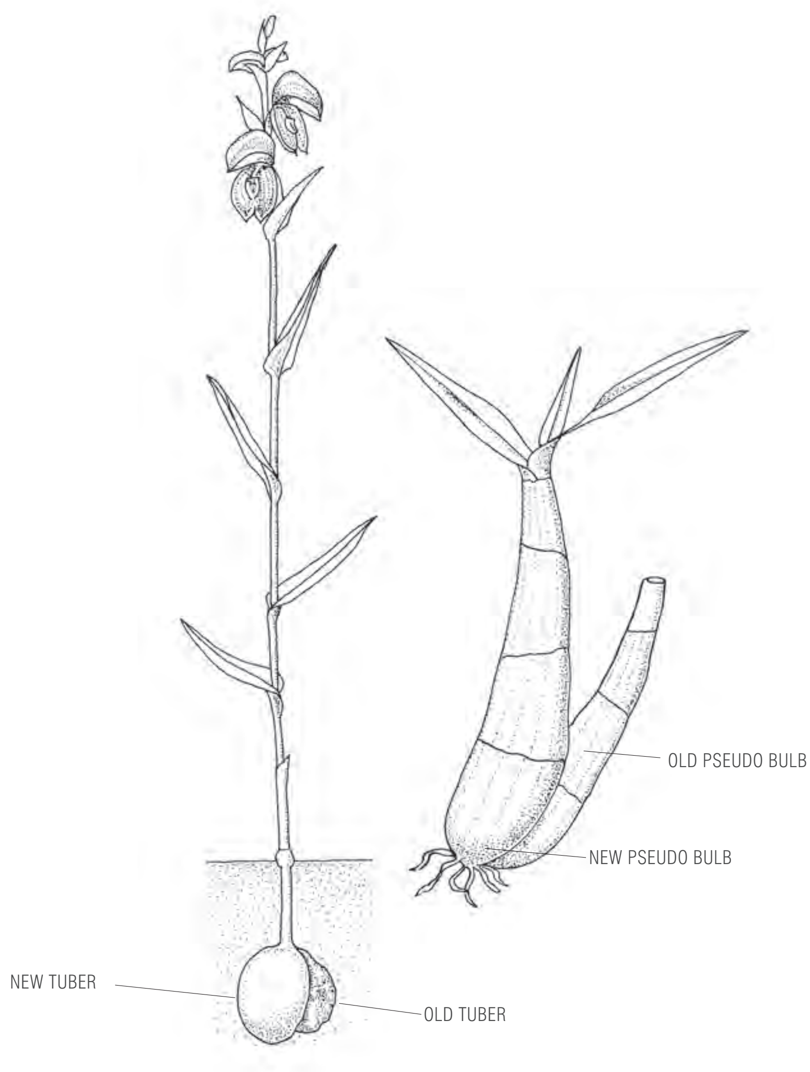
*Caladenia bryceana* is one of the smallest flowered spider orchids.

## SIZE

The height and flower size of Western Australian orchids is remarkably diverse. The diminutive *Corybas recurvus* grows to just 1.5 cm high while the tallest of all the Western Australian orchids, *Prasophyllum regium*, grows to well over 2 m high. The largest flowered Western Australian orchid is *Caladenia excelsa* which has flowers to 25 cm in length and 15 cm across, while the smallest is *Microtis atrata* which has flowers a mere 2 mm across. Even within genera flower size varies enormously. *Caladenia* for instance contains species with flowers ranging in size from the previously mentioned *C. excelsa* to the diminutive *C. bryceana* with flowers just 2 cm across. The variation in floral shape between species is enormous. Many are extremely attractive, but some of the Western Australian orchids such as *Pterostylis* and *Drakaea* have flowers that are so bizarre that it is hard to imagine that they really are orchids.

## EPIPHYTES AND GEOPHYTES

The majority of Western Australian orchids are geophytic (just one true epiphytic species is found in the Kimberley Region) with most species being deciduous. This means they have a dormant phase where they survive the long dry period (winter in the Kimberley Region and summer in the South-west Region) by dying back to fleshy underground storage organs called tubers or rhizomes. Kimberley Region geophytic species resprout in the late winter or spring and South-west Region species resprout in autumn. During the active growing period of these plants a new storage organ is formed and the old one withers. Just one South-west Region species, *Cryptostylis ovata*, which has fleshy roots, retains above ground leaves all year round. For the handful of Kimberley Region evergreen species, plants produce one or more pseudobulbs or canes each year and retain those developed the previous year to serve as food and water reserves.




*Pterostylis vittata* (left) is a deciduous South-West Region species that dies back annually to an underground tuber, while *Dendrobium dicuphum* (right) is an evergreen Kimberley Region species that is visible all year round.

## SEASONAL CYCLE

Most geophytes have the same seasonal growing cycle regardless of their flowering time. Species that flower early in the season often have no leaves or their leaves are immature, meaning that the leaf or leaves either appear or continue to develop after flowering. At this time the new tuber or rhizome has not yet begun to form. Midseason flowering species flower whilst the new tuber or rhizome is still immature but usually have fully formed leaves. Late flowering species have fully formed leaves and a fully formed new tuber or rhizome. By this time the old tuber or rhizome has begun to wither. Some very late flowering species have leaves, and an old tuber or rhizome that is completely withered during flowering. Thus, although different species flower during different times of the year the seasonal development of leaves, tubers and rhizomes is the same for all geophytic species.

## POLLINATION AND REPRODUCTION

While some Western Australian orchid species such as *Pterostylis rogersii* are able to multiply vegetatively (asexually) by producing two or more tubers each year or, like *Cymbidium canaliculatum*, are able to multiply by producing two or more pseudobulbs each year, most are like *Eriochilus dilatatus* and rarely multiply this way. They must instead rely upon seed dispersal as a means to increase their numbers and this dependence requires the flowers to be actively pollinated by insects or, in rare cases, by self-pollination or apomixis.

Western Australian orchids use a variety of contrivances in order to attract pollinating insects. Some are no different from most other flowering plants in offering food to potential pollinators. However, many provide neither nectar nor pollen. Instead, they engage in pretence and deception. There are flowers that resemble fungi, some that smell like rotten meat, others that have structures like pollen-laden anthers of lilies, and some flowers simply mimic other flowers to trick the unwary bee. The masters of deception, however, are those orchids that deceive male wasps or flying ants by successfully emulating females of the insect species. This is done by emitting pheromones and also, occasionally, by visually resembling the female. This is an evolutionary theme that reaches its most diverse and sophisticated development in south-west Western Australia.

Some of the first observations of pollination were made in the 1870s by Robert Fitzgerald, well-known for his perceptive studies on the pollination of species of *Thelymitra*. Using jars to cover flowers, Fitzgerald demonstrated that, unlike most other Australian orchids, some *Thelymitra* species were capable of pollination without insects. In the 1900s Oswald Sargent unwittingly observed the pseudo-copulatory pollination of *Caladenia barbarossa* by a black wasp. This was followed by Edith Coleman's discovery in the 1930s of pseudocopulation in *Cryptostylis*, thus putting Australia firmly on the map as a place where unusual pollination systems occur. Richard Rogers, also in the 1930s, described the pollination of *Pheladenia deformis* by a bee (*Halictus subinclinans*) and in 1946 Fred Fordham gave an interesting description of the pollination of *Calochilus campestris* by a male scoliid wasp. In recent years this research has enjoyed a resurgence of interest by workers such as Robert Bates, David Beardsell, Peter Bernhardt, Colin Bower, D.M. Calder, Mark Clements, Amots Dafni, M.A. Hutchinson, David Jones, Rod Peakall, Warren Stoutamire, Florian Schiestl, Norris Williams and others, resulting in a new understanding of the biology of sexual deceptive systems.

A diverse group of insects pollinate orchid flowers; these include beetles, fungus gnats, midges, mosquitoes, flies, bees, termites, wasps and flying ants. Although it would appear that bees are the most common pollen vector used by orchids, it is with wasps and flying ants that some of the closest ties between orchid and pollinator occur.

### NECTAR

There are several groups of orchids in the south-west that offer nectar and attract a range of insects as pollinators. The two largest groups are *Prasophyllum* and *Microtis*, both of which advertise their nectar by producing sweet floral fragrances and, in some species, colourful flowers.

Many *Prasophyllum* species flower prolifically following summer fires and appear as erect black or green stems amongst the blackened remains of associated burnt shrubs. A typical example of *Prasophyllum* is the beautiful *P. fimbria*. It advertises the droplets of nectar found near the


The flowers of *Cyrtostylis robusta* (top) and *Habenaria triplonema* (bottom) produce small quantities of nectar to entice pollinators.

base of its brightly coloured labellum by its sweet floral scent. The flowers of both this and other *Prasophyllum* species attract many nectar-feeding insects, including flies, beetles, bees and wasps, many of which will pollinate the flowers.

Although smaller flowered, *Microtis* species are similar to *Prasophyllum*. Favouring winter-wet habitats such as ephemeral swamps or moss swards on granite outcrops, they often occur in large colonies, sometimes amounting to thousands of plants. The minute flowers of *Microtis* species produce small quantities of nectar that attract tiny insects such as midges, ants and tiny bees. Interestingly, most species of *Microtis* will self-pollinate if insects have not been active.

Also using nectar as an attractant are species of *Cyrtostylis*. These occur in cool, damp habitats and provide nectar for the small pollinating fungus gnats that are abundant where the orchids grow.

Other orchids that use nectar as an attractant are species of *Eriochilus*, *Habenaria*, *Leptoceras*, *Pyrorchis* and some of the dainty *Caladenia* species. Many of these are bee specialists.

## COLOUR

Bees respond to certain fragrances and colours and usually seek pollen and nectar from flowers. A diverse array of Western Australian orchids have flowers specially modified to attract bees as their major pollinators. Some fairy caladenias exemplify this specialisation. The lip and column combine to form an open-mouthed tube that can be forced apart only by bees of the required size, shape and strength.

Many insects, including beetles and bees, are attracted to bright colours, a feature shown in several south-west orchids. The intense yellow of the common *Caladenia flava* and the bright pink of *C. latifolia, C. reptans* and *C. nana* are familiar sights in the spring. These orchids often produce massed displays, particularly following summer fire. Obviously the insect pollinators are attracted to several of these species as hybrids are often seen, producing flowers with a beautiful range of colours. *Thelymitra* is another genus that contains species with bright-coloured flowers. Although it has been shown that some species are actually mimicking other flowers, the rich blues, yellows and pinks of most *Thelymitra* species are known to attract insect pollinators.

## MIMICRY

There is a close similarity in shape between the flowers of *Diuris purdiei* (right) and those of co-blooming *Lobelia* species (left).

Other orchid flowers resort to what is referred to as 'floral mimcry' to attract pollinators because they appear to mimic the shape and/or colour of another flower. On first inspection, the intricate and delicate flowers of *Diuris* species make little sense in terms of pollination as they are not sweetly scented and do not offer a food reward. When seen in the wild, however, it will be noticed that there is a close similarity in shape between the central parts of *Diuris* flowers (dorsal sepal and labellum) and those of co-blooming peas such as *Daviesia*, *Pultenaea* and *Isotropis*. Studies have shown that bees regularly visiting pea flowers for their rich source of nectar occasionally explore the *Diuris* flower in the same way. One such visit is usually enough to remove pollinia and one more mistake in visiting a second *Diuris* flower ensures pollination. It is known that other *Diuris* species mimic different co-occurring flowers. For example *Diuris purdiei* is known to mimic the floral shape of species of *Lobelia*.

The flowers of *Thelymitra speciosa* ms (left) mimic the flowers of *Calectasia grandiflora* (right) in order to entice a similar range of pollinators.

As William Dampier first observed at Shark Bay in 1699, Western Australia has an unusually high number of blue-flowered herbs and shrubs, most of which we now know attract bees as pollinators. These flowers are mimicked superbly by some species of *Thelymitra*. The nectarless *Thelymitra macrophylla*, for instance, has a prominent yellow apex to the column that bees appear to mistake for the bright yellow pollen-bearing anthers of native lilies. Bees are known to collect pollen from these lilies by a special action called buzz-pollination, achieved by audibly vibrating their wings to release pollen from the flower's anthers. Occasionally these bees mistake a *Thelymitra* species for an associated lily and, in an attempt to buzz the false anther, inadvertently pollinate the flower. Other *Thelymitra* species that mimic associated native flowers include the spectacular *Thelymitra apiculata* which has flowers that resemble those of the genus *Calectasia*, and *Thelymitra crinita* which is a close match to the blue morning iris *Orthrosanthus laxus*.

A further orchid genus that has evolved species with elaborate structures that resemble anthers is *Elythranthera*. Found only in Western Australia, *Elythranthera* species have brightly coloured, glistening flowers that contain enlarged structures at the base of their much-reduced labellum. As with *Thelymitra* species, these attract native bees and appear to be mimicking similar looking buzz-pollinated flowers found in species of *Thysanotus*, *Solanum* and other plant genera.

The inconspicuous *Corybas* species that make their home on the dank floor of south-west Australia's forests or the sodden margins of swamps, appear to attract fungus gnats, probably due to their fungus-like odour and dull purple and brown colouration. This combination may well deceive the gnat into perceiving the orchid flower as a fungal fruiting body and on visiting the flower they achieve pollination. An amazing transformation then takes place. Once the tiny ground-hugging flowers are pollinated they are rapidly pushed skywards for up to 30 or more centimetres by the elongating stem. When the seed capsule ripens the elongated stem most likely assists in more effective dispersal of the seed.

Once the flowers of *Corybas recurvus* are pollinated they are pushed skywards for up to 30 or more centimetres.

**PSEUDOPOLLEN**

Pollen is used by many plants as a food reward to attract insects; however, none of the orchids found in the south-west are known to provide pollen as a legitimate food. Some instead produce a mealy substance known as pseudopollen. *Prasophyllum* species for instance, offer nectar but also have labella that contain false pollen on which insects can often be seen feeding. Interestingly, these orchids may also be mimicking the erect flower spikes of *Xanthorrhoea*. Species of *Xanthorrhoea* are like *Prasophyllum* in that they flower prolifically in the season following fire. A similar range of nectar-seeking insects visit both genera and this would appear to be the case of a plant offering nectar, but also indulging in deception and mimicry.

During the early summer the inconspicuous bell-shaped flowers of *Gastrodia sesamoides* can be seen in the higher rainfall forest areas of the lower south-west. On the lip of each flower is produced a fine granular pseudopollen which bees, having entered the flower, proceed to scratch. They are known to place this on their hind legs together with real pollen gathered from other plant species and in doing so, inadvertently remove pollinia from the anther and/or deposit it on the stigma.

**ODOURS**

Many *Caladenia* species offer neither nectar nor pollen, nor do they contain false anthers, pseudopollen or mimic other flowers. However, they do attract a large range of insect pollinators such as flies, beetles, hoverflies, bees and wasps. This group of orchids, which have elongated wispy floral segments covered in glandular hairs, is known to emit various scents ranging from sweet and fragrant to obnoxious, the latter often like rotting meat. It would appear that insects are attracted by these odours.

**SEXUAL DECEPTION**

Several south-west orchid groups share characteristics with female insects to attract their male counterparts under sexually false pretences, a process often termed pseudocopulation. They are usually coloured dull shades of green, yellow and maroon, and are often odourless to humans. However, all produce pheromones that are irresistible to pollinating male insects. These pheromones appear to be especially active on warm days, particularly from midmorning to early afternoon. Orchids of these groups are often small and easily overlooked, as they blend remarkably well into the dull background. Many also have a flexible labellum that is attached to the flower by a narrow claw and resembles a small insect in shape and colour.

Female flower wasps are flightless and live underground for most of their lives. When ready to mate they emerge from the soil, climb up nearby vegetation, and advertise to males by releasing a pheromone that blows downwind. The winged males (belonging to the family Tiphiidae, subfamily Thynninae) rapidly respond by flying upwind in ever decreasing zig-zag motions towards the odour source. They then clutch the females from above and mating takes place in flight. The mated couple then fly to flowers, where the male feeds on nectar and either regurgitates some for the female, or backs around so she can feed herself. After several such mating events, the female burrows underground in search of beetle larvae, which she subsequently paralyses. She then lays her eggs beside this food source which the juvenile wasps feed on once hatched.

*Caladenia barbarossa* has an insect-like labellum that closely matches the size, shape and texture of a female flower wasp.

*Caladenia barbarossa* is a superb example of an orchid that mimics female wasps with its insect-like labellum closely matching the size, shape and texture of a female flower wasp. The males of these non-social wasps attempt to pick up the orchid decoy and, during their frustrated lift-off, are thrown against the column by the hinged lip.

*Drakaea thynniphila* attracts a male flower wasp which attempts to fly off with the flowers insect-like labellum and in doing so is flung over and upside down against the column.

Like *Caladenia barbarossa*, *Drakaea* species are masters of sexual deception. There are ten species found in the south-west and their inconspicuous, odourless flowers are living examples of extreme specialisation. These flowers are invariably solitary on top of a thin wiry stem, and are reduced to mere remnants of their colourful counterparts seen in genera such as *Caladenia*. The biggest and most conspicuous part of a *Drakaea* flower is its lip, which resembles to a remarkable degree a female flower wasp (thynnid species). Pollination is achieved by sexual deception of the male wasp, which is flung over and upside down against the column when it attempts to fly off with the female decoy. Each species of *Drakaea* is thought to be pollinated by a different species of wasp and illustrates one of the most specialised relationships between pollinator and plant known to occur in Australia, and indeed the world.

In several *Caladenia* species the calli along the centre of the labellum have become aggregated and modified to the point where they resemble a female mimic (at least to a wasp). *Caladenia crebra*, for instance, is known to attract a large yellow-banded flower wasp that attempts to mate with the dark band of glandular calli found along the centre of its labellum. However, some species are much less modified but still manage to achieve this deception. Most *Caladenia* species that use sexual deception have clubbed tips to the petals or sepals (osmophores) which appear to be the source of the sexually attractive pheromone. *Caladenia pectinata* is an example of an orchid that uses this method. Attraction can be demonstrated by removing the clubs then exposing them to a wasp population separately from the remainder of the flower. When this is done, wasps will visit the clubs in preference to the remainder of the flower.

The clubbed sepals of *Caladenia pectinata* emit a sexually attractive pheromone to entice pollinators.

Yet another group of orchids that use sexual deception are species of *Paracaleana*. These have a sensitive labellum that acts in a similar way to the column of triggerplants (*Stylidium*) in being capable of movement on mechanical contact. The female decoy is formed by the labellum of the orchid and is attached to the inverted winged column by an elongated springy claw. On contact with the female decoy, both the male wasp and labellum are swung down into the pouch formed by the column wings. It takes considerable exertion by the wasp to back-pedal out of the trap and in doing so it removes or deposits pollinia. The flower resets itself to its original position over a period of several minutes.

The tiny elbow orchid, *Spiculaea ciliata* is bizarre even by orchid standards. Although emerging in autumn it does not begin to flower until the moss swards, where it grows, dry out prior to the long hot summer. Under these rather harsh conditions the orchid dies at its base but is able to support the flowers and developing seed capsules with water and nutrients stored in its thickened fleshy stem. Each plant has up to seven flowers with hinged insect-like labella and curiously shaped column wings. When small male flower wasps, attracted to the female decoy, attempt to fly away with it, they are momentarily trapped by the column wings, thus depositing or removing pollen.

Pollination by ants is an extremely rare occurrence anywhere in the world. A few species of *Microtis* are known to be pollinated by ants, but pollination by sexual deceit of male flying ants is unique to the genus *Leporella*. The single species of this genus – *L. fimbriata* – is unusual in that it flowers in autumn. However, this makes sense when you consider that it is this time of year when most flying ants swarm. These primitive ants – *Myrmecia urens* – are in search of a queen with which to mate and start a new colony. On nearing the flower of a *Leporella* they act in a similar way to male flower wasps on other species of orchid by being initially attracted by a pheromone. However, unlike the male flower wasps, they first land on the plant's stem rather than the flower, then climb upwards, align themselves sideways across the lip for a few minutes, and squirm their way out, picking up pollinia as they do.

When male flower wasps are attracted to the insect-like labellum of *Spiculaea ciliata* and attempt to fly away with it, they are momentarily trapped by the column wings.

The large, colourful scoliid wasps (*Campsomeris*) appear to be attracted to the wonderfully ornamented labellum of *Calochilus* species. It is believed that they are lured by pheromones emitted by the flower and, in their attempt to mate, inadvertently pollinate the orchid. Interestingly, these orchids are also capable of self-pollination should the insects not be active.

Perhaps the most well-documented case of an orchid using pseudocopulation as a method of achieving pollination is in the species of *Cryptostylis*. So convincing is their attraction to male ichneumon wasps (*Lissopimpla excelsa*) that copulation is attempted and sperm packets are ejaculated into the orchid. The labellum of the orchid is highly modified and held upside down so that male wasps alight upside down and, in their attempt to copulate, pollinia are picked up or deposited.

Species in other genera such as *Pterostylis*, *Genoplesium* and *Thelymitra* have evolved their own methods of successful pollination by sexual deceit. *Pterostylis* is a large genus of Australian geophytic orchids. All species have their petals and dorsal sepal fused into a hood which encloses the winged column. As with species of *Paracaleana,* the often-protruding labellum found in most *Pterostylis* species is sensitive to the touch, springing upwards to trap inside the flower any insect that alights on it. The most common visitors to the flowers are tiny midges or mosquitoes that, for reasons currently unknown, are attracted to the flower. They can escape only by crawling upwards, first past the stigma on which they deposit any pollen that has already adhered to them, then past the anther from which they remove a new load of pollen. They finally emerge from the flower by passing out though the cavity at the top of the bloom or when the labellum resets.

### SELF-POLLINATION AND APOMIXIS

Some Western Australian orchids have foregone the use of insects to transfer pollen and instead achieve self-pollination, also known as autogamy, by a process involving the anther collapsing onto the stigma. Some self-pollinating orchids such as *Thelymitra vulgaris* rarely open. However, most species that self-pollinate are also visited by insects and only resort to self-pollination when insects are not active. Self-pollination is especially common in *Calochilus* and *Thelymitra*, but also occurs in many other genera. Some orchids are able to produce seed without any sexual union taking place. This is known as apomixis and several species of *Microtis*, such as *M. orbicularis*, use this method. Plants resulting from apomixis are genetically identical to the parent and are often quite abundant, as they produce large amounts of seed. They are thought to use this method because cross-pollination is likely to fail in the absence of appropriate insects or because of severe or unstable environmental conditions. Although a short-term advantage in that large numbers of plants are produced that are well adapted to local conditions, the long-term disadvantage is the lack of genetic variation leaving the population susceptible to extinction in the event of changed environmental conditions.

### VEGETATIVE REPRODUCTION

Some orchid species, where more than one new tuber or pseudobulb develops each year, are capable of vegetative (asexual) reproduction whereas those that produce only one new tuber each year multiply entirely through sexual production and growth of seeds. Many Western Australian orchids are capable of vegetative reproduction and include *Leptoceras menziesii*, *Prasophyllum drummondii*, *Pyrorchis nigricans*, and many *Diuris, Microtis* and *Pterostylis* species. When this happens these orchids are able to form very large colonies with all plants in the colony, a clone of the original seedling.

### THE MYSTERIOUS *RHIZANTHELLA GARDNERI*

*Rhizanthella gardneri* is one of Western Australia's botanical marvels, as it germinates, grows, flowers and fruits entirely underground. Although, recent studies have shed new understanding about this remarkable plant, its pollination remains largely a mystery. When flowering, the plant forms a crack in the soil surface and a range of insects including minute flies and termites have been seen leaving and attending the tulip-like head with pollinia attached.

## HYBRIDISATION

Hybrids are found in most Western Australian orchid genera and are particularly common in *Caladenia* (132 known hybrids) and *Thelymitra* (30 known hybrids), but in some genera hybrids are much less abundant. In *Pterostylis, Drakaea* and *Paracaleana*, for instance, hybrids are rarely encountered. For more information on Western Australian orchid hybrids turn to 'Hybrids' on page 335.

*Caladenia* × *ornata* is a common hybrid between *C. barbarossa* and *C. longicauda.*

## FIRE

Fire is an integral part of the ecology of the Australian bush with much of the character of bushland influenced by its effects. The effect of fire on geophytes, including all terrestrial orchids, varies however. For most, fire during their dormant period – late November to March for the south-west species and April to August for the Kimberley species – has no adverse affect on their biology. In fact, many species respond favourably to fire during their dormant period by flowering only, or in greater abundance, following such an event. This is believed to occur in response to the ripening gas ethylene which is produced during the passage of a fire. Some thirty-two Western Australian species rarely flower unless there has been a summer fire, appearing as leaves in intervening years. Orchids that fit into this category include species of *Pyrorchis*; many species of *Cyanicula*, *Eriochilus* and *Microtis*; and a range of *Caladenia*, *Diuris* and *Prasophyllum* species. Fire at other times of the year, particularly during growth, flowering and seeding stages can be potentially detrimental and may be responsible for the decline in orchids in some bushland.

### Western Australian orchids that flower prolifically in the season following summer fire

*Caladenia busselliana*
*Caladenia evanescens*
*Caladenia marginata*
*Caladenia nana*
*Caladenia reptans*
*Caladenia* sp. 'Boranup'
*Caladenia starteorum*
*Caladenia uliginosa*
*Caladenia ultima*
*Caladenia viridescens*
*Cyanicula ashbyae*
*Cyanicula gemmata*
*Cyanicula gertrudiae*
*Cyanicula ixioides*
*Cyanicula sericea*
*Cyanicula* sp. 'Dale'
*Cyanicula* sp. 'Esperance'
*Diuris concinna*
*Diuris drummondii*
*Diuris emarginata*
*Diuris filifolia*
*Diuris laevis*
*Diuris pauciflora*
*Diuris purdiei*
*Diuris setacea*
*Diuris* sp. 'Augusta'
*Eriochilus dilatatus*
*Eriochilus scaber*
*Eriochilus tenuis*
*Eriochilus valens*
*Eulophia bicallosa*
*Leptoceras menziesii*
*Microtis alba*
*Microtis brownii*
*Microtis familiaris*
*Microtis globula*
*Microtis pulchella*
*Microtis* sp. 'green'
*Prasophyllum cucullatum*
*Prasophyllum elatum*
*Prasophyllum fimbria*
*Prasophyllum gibbosum*
*Prasophyllum giganteum*
*Prasophyllum regium*
*Prasophyllum sargentii*
*Prasophyllum* sp. 'crowded'
*Prasophyllum* sp. 'southern'
*Prasophyllum* sp. 'striped'

*Pyrorchis nigricans* rarely flowers unless there has been a summer fire.

Fire can severely damage tree-dwelling orchids if its intensity is sufficiently high to reach into the canopy. *Dendrobium dicuphum* is highly fire-sensitive and rarely survives burning, as its pseudobulbs have limited capacity to resprout after fire. A study of a riparian rainforest patch containing a large creek plum (*Pouteria sericea*) hosting scores of mature *Dendrobium dicuphum* showed that, over a ten-year period, high frequency burning of the rainforest had reduced the protective edge of the rainforest, exposing the *Pouteria* host to fire and a loss of all *D. dicuphum* plants.

High frequency burning, particularly in the wet season when orchids are in active growth, can be particularly damaging to both Kimberley Region and South-West Region orchids. The superficially buried pseudobulbs of Kimberley species such as *Liparis habenarina* and *Geodorum* *densiflorum* are particularly susceptible to fire with the latter being killed if the protective litter layer where the plants grow is burnt. For the majority of south-west species a fire when the new underground tuber or rhizome is developing is thought to kill or damage the plant. In many forest areas where orchids were once abundant, prescribed fires undertaken in the autumn, winter and early spring have resulted in a dramatic decrease in both orchid composition and abundance, with only a few hardy species surviving in any numbers.

Managing fire with appropriate regimes that protect biodiversity values is a complex issue that requires a multi-disciplinary approach if the aim is to protect sensitive natural elements such as orchids.

## THREATENING PROCESSES

Unfortunately, many of the most orchid-rich plant communities in Western Australia coincide with areas of greatest urban and agricultural development. The wheatbelt, for instance, stretching from north of Geraldton to near Esperance, has had about 15 million hectares (around 80 per cent) cleared for agriculture. Many coastal areas between Geraldton, Augusta and Albany have also been extensively cleared for urban and agricultural development. Much of the remaining bushland in these areas is fragmented and often degraded, and is surrounded by highly grazed areas, cleared pasture and housing. The orchids that survive in these remnants are becoming increasingly rare. *Caladenia huegelii*, for instance, is likely to have once been abundant in *Banksia*-jarrah woodland between Wanneroo and Capel, but now occupies a few mostly small bush remnants, the majority of which are now wedged between large housing estates or areas of cleared farmland. Areas of remnant bushland are continuing to be cleared and many orchids that were considered common just a few years ago are now less so, and may soon become rare if clearing continues.

The clearing of bushland also removes habitat required for pollinators to feed, mate and reproduce. This reduction of pollinator habitat results in an increasing number of native orchids being inadequately pollinated or not pollinated at all. Although unlikely to be a short-term threat, as orchid plants are capable of living many years, removal of pollinator habitat and therefore by default the pollinators themselves, has the potential to have disastrous long-term consequences.

In pastoral zones, grazing by stock (cattle and sheep) and feral animals (goats, pigs and donkeys) has destroyed habitat occupied by orchids. These animals remove covering vegetation, trample orchid plants and introduce weeds through soil disturbance and depositing weed seed in their dung. This habitat destruction has resulted in inland species such as *Cyanicula fragrans* and *Caladenia incrassata* becoming rare in many places where they were once abundant.

The ruggedness and size of the Kimberley Region is contrasted by the extreme fragility of its ecology and ecosystems to human impact. The introduction of cattle and regular burning to the region has resulted in extensive alteration to much of the landscape, particularly seasonally wet to moist sites such as river and spring-fed habitats. Unlike native animals, cattle congregate near water during the dry season, denuding the vegetation and leading to erosion and often quite radical habitat alteration. For example, *Liparis habenarina, Geodorum terrestre* and *Eulophia bicallosa* favour sites containing deep leaf and bark litter near springs and seasonally wet sites – areas that can be heavily impacted by cattle.

In the wheatbelt the rising saline water table attributed to excessive clearing of land for agriculture is destroying the low-lying habitat favoured by many orchid species. *Caladenia drakeoides* is one of several orchid species now known from a handful of locations, precariously surviving on small rises above highly saline lakes and flats.

Dieback (*Phytophthora* spp.) is not thought to directly kill native orchids but does permanently change habitat composition through the death of susceptible associated plant species that are replaced by a predominance of low-growing, dieback-resistant native plants. These plants take up habitat previously occupied by orchids and, in many areas where the disease is prevalent, previously common orchid species are now rare. Other orchid species require cool, moist shaded areas and these too are being affected by dieback through the removal of tall cover.

As at February 2008, thirty-six orchids were listed as threatened in Western Australia and it is likely that many more will be added in the future if threatening processes are not abated.

*Cyanicula fragrans* is becoming rare in its natural habitat due to the damaging effects of feral animals.

The habitat of *Caladenia drakeoides* is becoming increasingly degraded due to a rising saline water table.