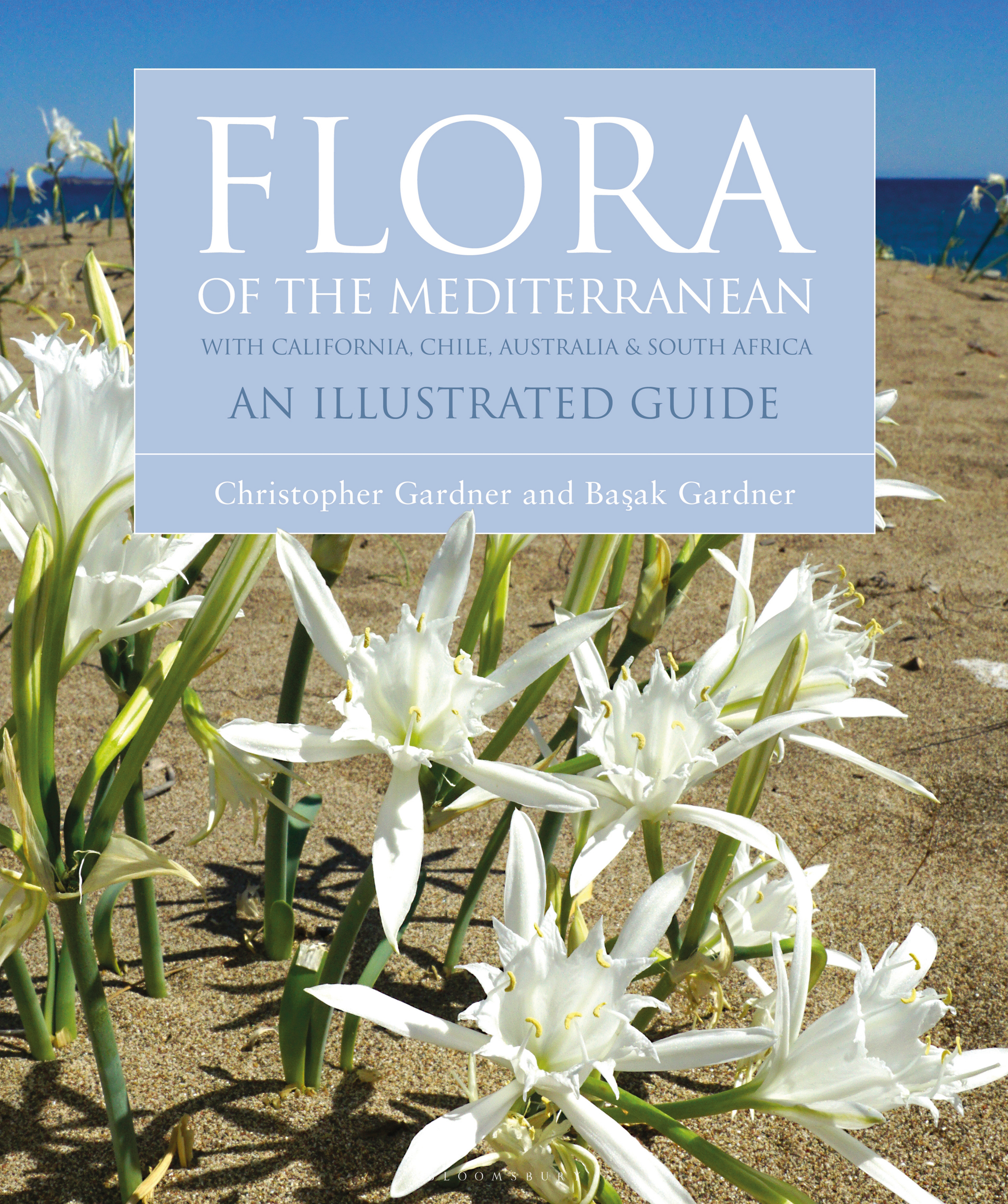

# FLORA OF THE MEDITERRANEAN

## WITH CALIFORNIA, CHILE, AUSTRALIA & SOUTH AFRICA

## AN ILLUSTRATED GUIDE

Christopher Gardner and Başak Gardner

BLOOMSBURY

# Flora of The Mediterranean

## with California, Chile, Australia & South Africa

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Christopher Martin Gardner
Başak Güner Gardner

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For our sons, Merlin and Aren

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# Foreword

I first became aware of Christopher and Başak Gardner when I purchased a copy of *Flora of the Silk Road*. Since I was born, and have lived almost all my life in the steppes of western America, I've gradually become aware of the tremendous parallels our semi-arid continental climate shares with central Asia. This has become a focus of research and interest for public horticulturists throughout the intermountain west (and a centerpiece of Denver Botanic Gardens). Over the last few decades, half a dozen of us have taken trips throughout the 'stans' and Mongolia to study this flora and conduct plant exploration. We had begun to feel we'd learned a lot until suddenly the *Flora of the Silk Road* revealed a whole world of plants new to us and proffered so many fresh insights. It was so successful that it quickly sold out, but a new edition will be in print to accompany this new exciting volume. Chris and Başak have explored so many places few tourists, or even botanists visit that turning the pages of their books is akin to the famous Zen slap, which fortunately lands us in botanical Nirvana!

Having spent many summers in Greece growing up, I have also been aware of the overlap of many genera and even some species between the Mediterranean climate biome proper, California, and their steppe sisters at higher elevations. Although the climates would appear to be so different – austere, cold winters on the steppes and green, growing winters in Mediterranean climate regions, so many genera in key families are shared – it is apparent these two regions share a common botanical ancestry. This book underscores this, and extends the parallels to the southern hemisphere!

These themes and more are woven throughout this monumental book: I know of no other synoptic view of the principal Mediterranean climate floras. Once again, the Gardners have captured the most astonishing light and angles on every plant – each picture is a work of art. The depth of scholarship (not to mention energy and perspicacity and serendipity) necessary to find so many taxa at the perfect time of blossoming and to gather them into another ambitious tome is nothing short of magic.

The steppes are vast and rich, but though much smaller, the Mediterranean climate regions are incomparably richer in species than any biome, excepting perhaps equatorial rain forests. They boast an astonishing biological diversity. This is all the more remarkable, since most of these regions have nurtured humankind for millennia – we have been impacting, and even helping evolve these floras in a sort of slow dance, adopting so many plants as food crops. The flora constitutes the very basis of most of our herbs and many medicines. The dance steps, alas, are rapidly changing tempo and rhythm.

Over the course of half a century of travel throughout the Mediterranean itself, and its sister climates in California, Chile and South Africa, I have witnessed the elimination of vast areas of wildflowers. Where charming villages once grew a diversity of crops, agronomic reform has replaced them with monocultures of olives or grapes, which expand for countless miles. Herbicide is applied universally in these modern factory fields, eliminating the tapestry of plants that once grew underneath them.

Non-stop acres of bungalows and condominiums crowd the beach fronts in many parts of all these biomes, further decimating plants. And let's not even think about the colossal spread of cities and industry in each region.

I hope that this book shall be more than a testament and tombstone to what we are daily sacrificing for convenience, and 'progress'. I believe the Gardners' book shall serve as an aesthetic battle cry to inspire each of us to learn more, to act decisively, to fight! We must do everything in our power to preserve the Mediterranean's astounding wild beauty.

Panayoti Kelaidis, Senior Curator and Director of Outreach, Denver Botanic Gardens

# Preface

Four years ago, we published a book titled 'Flora of the Silk Road'. It showcased the finest flora from the countries along that ancient trade route. The area encompassed a vast number of temperate plants, around 40,000 species, all bound by the common and evocative theme of the Silk Road. To our delight the book was a success and motivated us to plan a second title. With that first book, it was the discovery of so much that was new that drove us on. So, any second project had to fire our imagination to the same degree, to justify the outsize effort required to complete it. Once again, we were aware we already had a big resource of photographs from various places that had strong appeal (to us) such as Chile, Turkey or Greece. But, we needed a hook and a commonality, something unique and enticing. It was while staying with friends during a family holiday to California that I noticed a wonderful volume on their bookshelf, 'Plant Life in the World's Mediterranean Climates' by (the late) Peter R. Dallman. It was a fascinating (scientific) introduction to the subject. But we quickly became aware that there was currently nothing that showcased the flora in the way it deserved. Here was our common theme and an amazing flora. The opportunity to even attempt to distil this richness into a single volume was irresistible and a decision was instantly made.

As before there was considerable ground to cover, but the adrenaline was already flowing. Başak and I took a flower packed trip to south-west Australia. In Cape Town, a friend, Callan Cohen of Birding Africa tours, very-generously covered the costs of repeated trips to the Western Cape and facilitated what would have been impossible for me on my own, gaining access to remarkable locations and some very special plants. Further trips to California, Chile, Crete, Cyprus, Italy, Spain and Australia have followed. And what an outstanding flora it is, a spectacular assemblage of 50,000 species, so many of which are beautiful and so many of which are poorly known. As with *Flora of the Silk Road*, the further we looked the more beguiling and addictive it became. By now we had our second son, Aren, and this meant Başak was extra busy and unable to add as many of her beautifully crafted, keenly observed photographs as before, though they are still sprinkled throughout the book. Once again though, it is her skill and accuracy in producing the book that has been crucial in bringing this project to life.

The book is our personal collection of 600 beautiful Mediterranean climate bulbs, herbs, trees and shrubs. Given the enormity of the flora it is not comprehensive. Ideally, we would have made more trips and to more places to find more special plants. However, we feel it is still representative of the wealth of plants to be found. To have seen them all would take a lifetime or more. My profession as a specialist botanical tour guide has taken me to many remarkable and special places. The Mediterranean climate lands are certainly special and we once again invite the reader to enjoy our flowers.

Christopher Gardner
March 2019

*Thelymitra speciosa,* near Albany, south west Australia

# What and where is the Mediterranean climate?

First thoughts of Mediterranean lands drift perhaps to pine-scented lands with idyllic sandy beaches set beneath a perfect, unblemished azure sky. A place to holiday, relax and unwind. Yet attractive though this image is the blue skies are neither endless, nor constant, and this perception is based on just one facet of the Mediterranean climate, albeit a crucial and defining one and one that has shaped the flora in many ways. In its simplest terms a Mediterranean climate applies to temperate areas that experience relatively mild wet winters (with an average above 0˚C and below 18˚C) and summer drought. How much rainfall and how long a summer drought varies within any Mediterranean climate region, but both conditions are experienced to some degree. Because of this (at times considerable) variation, more than one Mediterranean-type climate can be argued to exist, but we will be treat it loosely as one climate. The development of the Mediterranean climate is a recent phenomenon in Earth's history. It began around three million years ago, when a succession of glacial periods lasting 100,000 years was separated by warmer and progressively drier inter-glacial periods. We currently live in such a warmer period.

According to the climate classification devised by climatologist and plant geographer Vladimir Koppen in 1918, there are five places in the world that have this climate: the Mediterranean Basin incorporating southern Europe, North Africa and Asia Minor (and technically a wide strip into western Iran); California (including parts of southern Oregon and northern Baja in Mexico); central Chile; south-western and southern Australia; and the Western Cape of South Africa. All lie between approximately 30 and 40 degrees of latitude, on the western side of continental landmasses. The drier warmer ends of each region are bounded by deserts or steppe; the cooler, wetter ends (where possible) are bounded by tall forests and, in the case of Chile and California there are additional significant mountain barriers. Not only are all of the regions isolated within their respective continents, but they are separated from one another by thousands of kilometres and furthermore exhibit great variation in geology, geological history and topography.

In order for plants to survive in these regions they need strategies to cope with the period of drought, which is invariably accompanied by high temperatures. Many also need additional strategies to deal with the natural wild fires that can sweep through following these long dry periods. This has strongly influenced the flora, favouring the most resilient or pre-adapted precursor plants, which have gone on to speciate and establish themselves. This is coupled with the development of pollinator relationships from whatever pollinators also survived the shift towards a Mediterranean climate.

Elevation has a profound effect on vegetation - one finds different plants appearing that are adapted to lower temperatures. But the cooler highland areas within the five regions identified still experience a Mediterranean-type climate, with winter precipitation (some as snow), followed by a summer drought with arguably even higher levels of insolation than the lowlands. Such foothill and montane areas have a great many species that are closely related (floral) elements to lowland species and it can all be regarded as Mediterranean-type vegetation (sitting within their respective floristic regions). They also directly share many species from lowland areas. Furthermore, boundaries between the Mediterranean floristic regions and neighbouring floristic regions are invariably soft, with additional crossover commonplace along transition zones. We have included many beautiful species from highland and boundary areas, to create a more complete picture of the flora of each region from coast to mountain.

All of these factors, along with a wide range of habitats and microclimates, have precipitated intense speciation and despite only occupying 2% of the Earth's surface, these regions contain over 12% of the worlds' flora, around 50,000 species. If we include species from neighbouring higher areas, then there are thousands more. A significant percentage of these are endemic and invariably quite distinct from their equivalents in other regions. Nonetheless, sharing a climate has created fascinating similarities between the regions and common traits are clear, albeit alongside stunning differences. The overall result is the most beguiling and varied array of temperate plants on Earth, growing beneath what is quite possibly its most appealing sky.

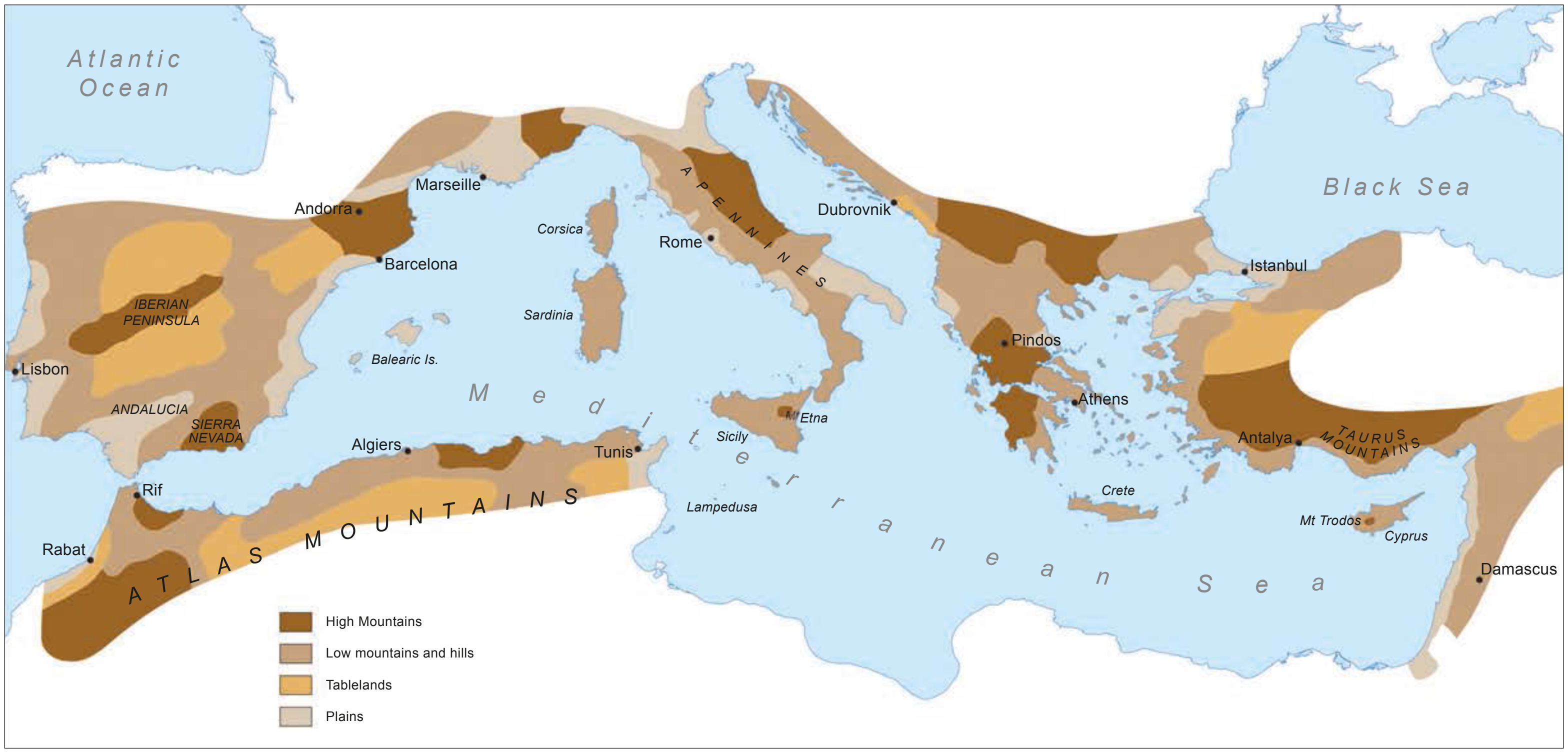
The many aspects touched on here will be dealt with in greater detail within the following overviews of different aspects of the Mediterranean climate flora and in each of the regional chapters, which also include a selection of the most notable and beautiful species found in each Mediterranean climate region.

The floras found within the five Mediterranean climate regions are:

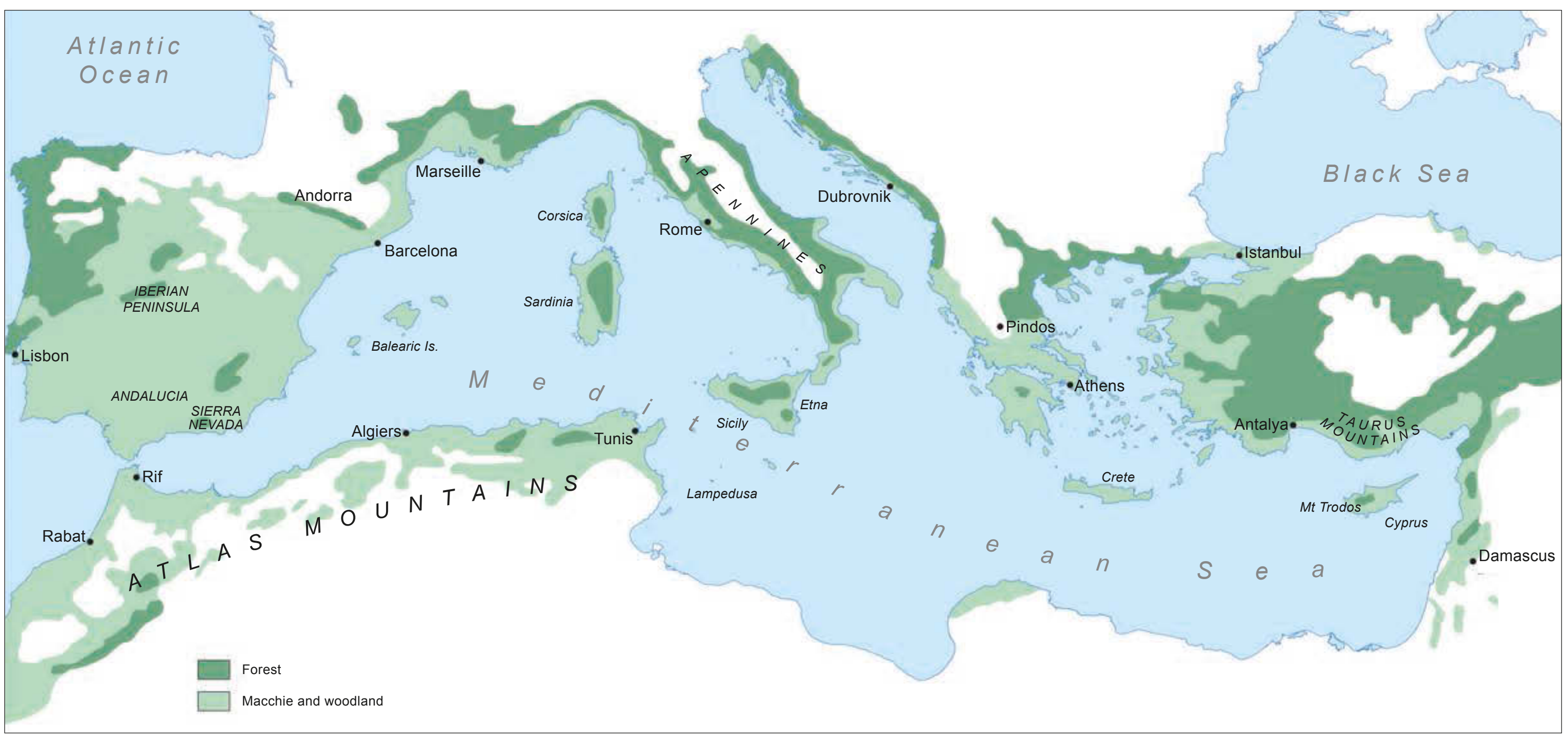
Mediterranean Basin = Mediterranean floristic region
(Inland mountain areas = Sub-Mediterranean floristic province)
California = Californian floristic region
Chile = Chilean floristic region
Australia = Southwest Australian floristic region
South Africa = Cape floristic region

# The Five Mediterrenean Climate Regions

## Mediterranean Basin




Mediterranean climate area

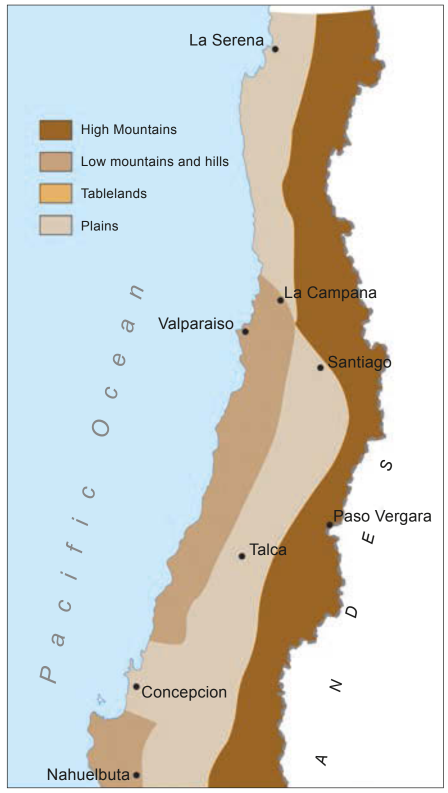



Mediterranean-type vegetation

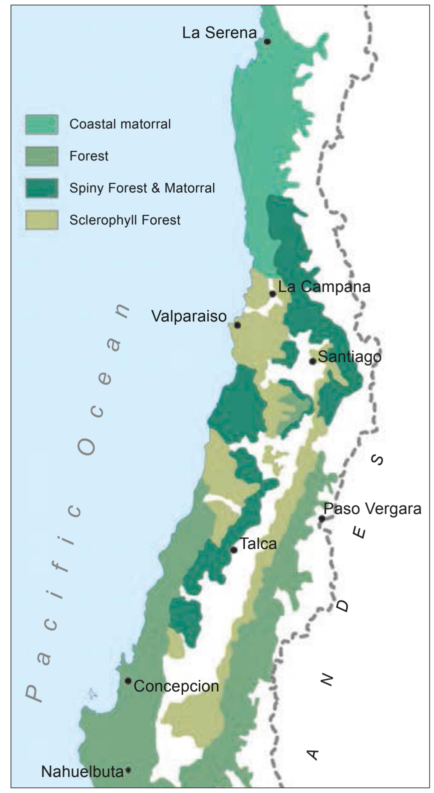
# California


California climate area

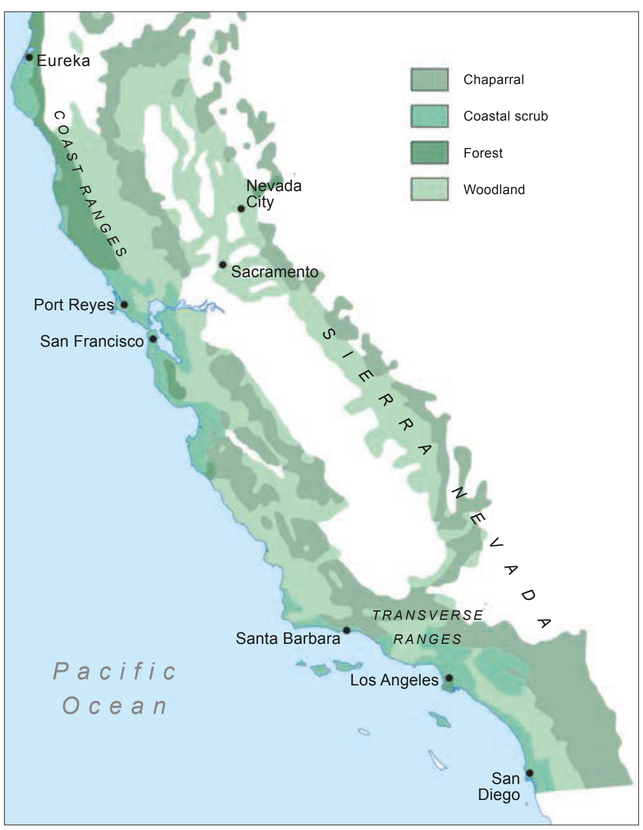
# Central Chile




Chile climate area




Mediterranean-type vegetation of Chile



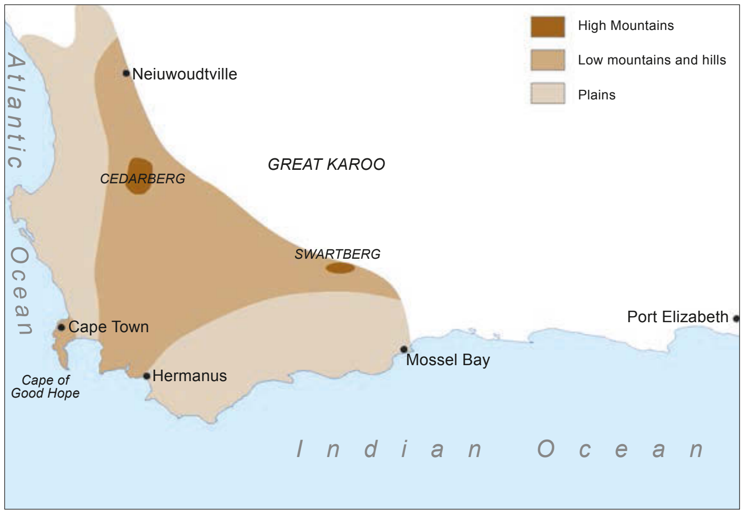

Mediterranean-type vegetation of California

The five Mediterranean climate regions vary greatly in size. The Mediterranean Basin is by far the largest, comprising 60% of the total area. Its west-east orientation is unique, and has encouraged a number of pan-Mediterranean plants. However its climate is far from uniform with significant variations in rainfall and even seasonality. Typically, most rainfall is in the winter, but in eastern Spain, Italy and the Adriatic states it falls heaviest in the autumn. The wettest areas are the Atlantic facing parts of Spain and Portugal, Italy, the Dalmatian coast, south-west Turkey and Lebanon – parts of which receive in excess of one metre of rain per year. The length and intensity of summer drought also varies. In general, the drought period is greatest in the south, with much of North Africa, south-east Spain, Sicily, eastern Greece, Crete, southern Turkey, Israel and Cyprus enduring five or more rainless months. Conversely, parts of north-west Greece, much of Italy, the Adriatic states and France have much shorter dry periods. The Apennines of Italy and inland areas of the Adriatic states are far too wet to qualify as Mediterranean climate and have different vegetation. The vegetation map also shows how Mediterranean-type flora extends beyond the climate boundaries, indicating the adaptability of much of the flora that allows it to thrive in neighbouring climates.

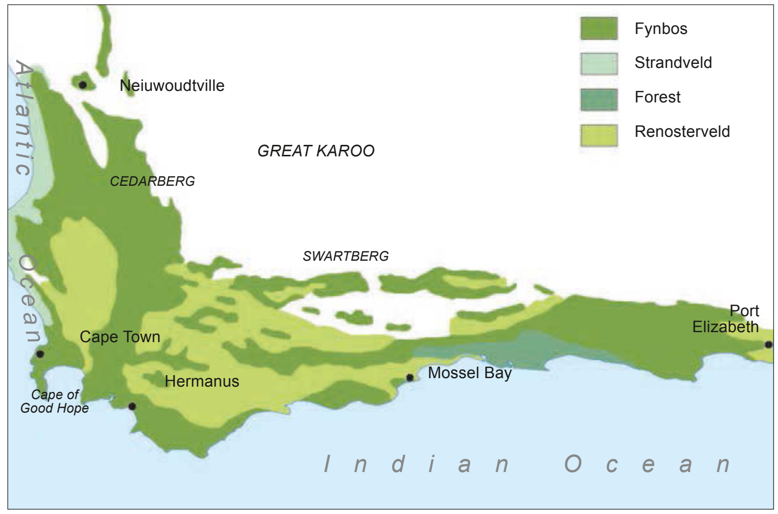
Significantly, the Mediterranean Basin lacks the cooling influence of a major ocean and coastal summer temperatures are higher than the other regions. This is certainly not the case in California and Chile where coastal fogs shroud the coast in summer. Chile and California both have a north-south orientation and rather mirror each other. In both regions the temperature increases inland from the coast. In California the wettest and coolest areas are in the north, which has just four dry months, compared to San Diego in the warmer south, which endures eight months. While, in Chile the wettest coolest areas are to the south, becoming progressively drier to the north with La Serena very much the climate equivalent of San Diego. Higher areas of both regions receive significant snowfall in winter.

California occupies around 10% and Chile 5% of the total world Mediterranean climate area. Large parts of the central valleys of both are bereft of natural vegetation today.

## South Africa

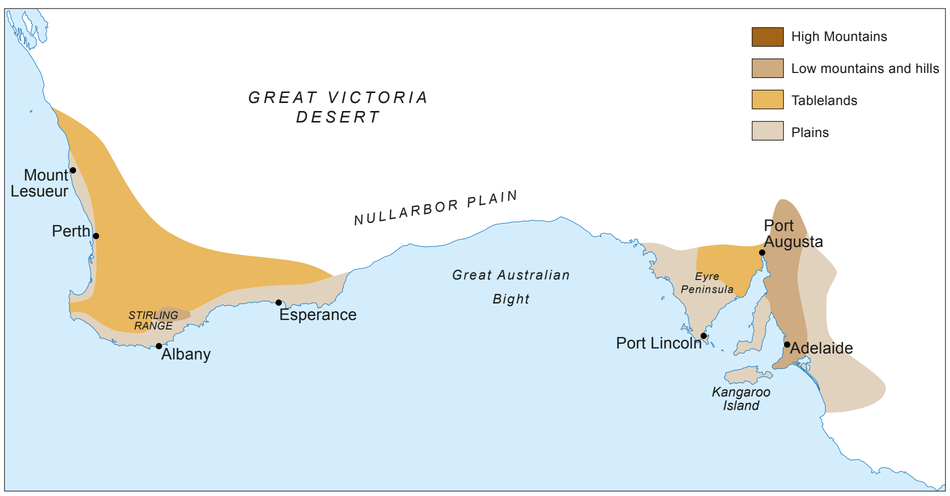



South Africa climate area




Mediterranean-type vegetation of South Africa

## Australia




Australia climate area


Mediterranean-type vegetation of Australia

All maps adapted from *Plant Life in the World's Mediterranean Climates* by Peter R. Dallman 1998.

Australia's Mediterranean climate areas are divided into two areas separated by desert, and they represent around 22% of the total world Mediterranean climate area. South-west Australia becomes drier to the east and north and is wettest in the south-west corner, where rainfall continues into summer and nurtures tall forests. Elsewhere, rainfall is typically in the winter. Summer temperatures in this region can be high when dry winds from the north-east desert blow. South Australia is wettest in the southern coastal areas.

The Western Cape is relatively tiny, occupying only 3% of the total world Mediterranean climate area. However, it has a complex climate as it is influenced by two oceans. Rainfall is highest along the southern coast and the inland north-south oriented Cape Fold mountains. This falls mainly in the winter. However, Table Mountain and similar areas are swathed in mists during the three dry summer months and this adds a significant 50 centimetres of moisture per year. Summer rainfall increases beyond Mossel Bay.

Inner valleys become progressively drier and warmer to the north and east as the land transitions to semi-arid karoid shrubland. Despite its small size the Western Cape contains one of the greatest diversity of plants in the world.

# Shared Plants

The notion of pre-adaptability is strengthened further when we consider plants that are shared between the separate Mediterranean climate regions. Many families and genera existed well before the development of the Mediterranean climate, which began a mere three million years ago. As such a good number had already spread across the globe. When the climate did change their shared pre-adaptive traits allowed them to persist and thrive in the new climate. It is not at all unusual for families to be shared since they are often large and globally widespread. What is more interesting, are examples of shared genera and these are surprisingly common and give a fascinating insight into global plant distribution.

*Clematis* (Ranunculaceae) is a remarkable shared genus of mainly tough climbers, with a near cosmopolitan distribution. For example in the Mediterranean Basin there is *C. flammula* and winter-flowering *C. cirrhosa*, in California *C. lasiantha* and *C. ligusticifolia*, in Australia *C. pubescens* tumbles over coastal vegetation in the southwest, while Chile has *C. denticulata* and South Africa sees the widespread *C. brachiata* extend into its Mediterranean climate region from the east.

Other examples include *Quercus* (oaks) and *Pinus* (pines), which are abundant trees in both California and the Mediterranean Basin. *Quercus* are supremely well adapted to dry periods with deep taproots and vast lateral root systems. They dominate the landscape in California (especially the south) and are still prominent in parts of the Mediterranean Basin despite extensive historical clearance. Pines are equally robust and are still abundant throughout the Mediterranean Basin. Beneath the oaks and pines in both of these regions also grow *Cercis*, *Arbutus*, *Paeonia*, *Iris*, *Lilium* and *Fritillaria*. The latter two have diversified in both regions, demonstrating strong pre-adaptability. Other examples exist between California and Chile, such as *Clarkia*, *Mimulus*, *Sisyrinchium* and *Phacelia*. South Africa shares *Erica*, *Gladiolus*, *Drimia* and *Moraea* with the Mediterranean Basin, but has many more species of all of these.The situation is reversed for *Salvia*, *Geranium* and *Anemone*. South Africa also shares Proteaceae and Myrtaceae with Australia and Chile, and although none of the former ever made it to the northern hemisphere, Myrtaceae did and *Myrtus communis* is a common small, aromatic-leaved shrub in the Mediterranean Basin.

The large Fabaceae genera *Astragalus* and *Lathyrus*, as well as the peculiar trumpets of *Aristolochia* are also shared between three regions; the Mediterranean Basin, Chile and California. Whilst, *Anemone*, *Stachys*, *Polygala*, *Senecio*, *Viola* and *Eryngium* occur in a remarkable four regions each. The latter is absent from South Africa, and the other four are absent (at least naturally) from Australia. What is perhaps more surprising is that there are any genera shared with Australia, given the island continent's long isolation.

There are other examples, but these few offer an insight into the shared flora between regions and how their pre-adaptive traits have allowed them to succeed in a Mediterranean climate wherever it has arisen. It goes some way to explaining why the various regions have similarities in general appearance and when, for example, travelling through parts of southern California there is a striking similarity to the cork oak woodland of Spain, the macchie of Corsica or the matorral of Chile. However, there are even more delightful differences.

*Clematis cirrhosa*, Gythio, Greece

*Clematis pubescens*, Denmark, Australia

*Clematis lasiantha*, near Chico, California

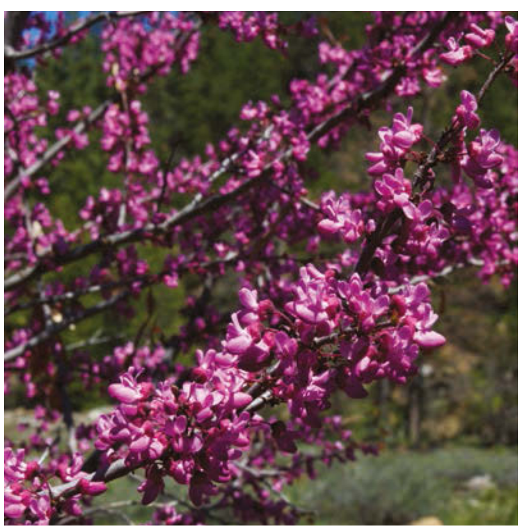
# Floral Communities & Adaptations

Various distinctive floral communities and types of plants have evolved in Mediterranean climate regions. Within these communities are many plants that can be considered as pre-adapted to the climate. As the Mediterranean climate developed these pre-adapted plants came to the fore and those less capable of surviving the drought declined and died out. Since then, the survivors have diversified and expanded their ranges. Many of them are also quite capable of surviving in moister and/or colder climates, they just excel in a Mediterranean climate. Examples include many of Europe's orchids and *Arbutus unedo*, which will grow in rain-soaked western Ireland as well as the Mediterranean Basin.

Forests and more open woodlands are present in all regions, though much reduced in South Africa. They are at their most extensive in the wetter cooler end of each region and decline towards the warmer drier end. Mediterranean woodlands vary from immense redwoods to oak savannah in California; palms, southern beech and monkey puzzles in Chile; towering eucalypts and mallee in Australia; and extensive pine, oak and cedar forests in the Mediterranean Basin. Such forests and woods always have an accompanying understorey of geophytes, herbs and importantly, shrubs.

It is the various species-rich shrub communities that are such a feature of Mediterranean climate regions. These naturally cover large areas of coastal land and foothills, often where tall forests cannot establish. Others, such as those in Californian sagebrush communities are deciduous and survive the (excessive) summer heat in a dormant state. Each region has its own term for this habitat; macchie in the Mediterranean Basin, chaparral (and sagebrush) in California, matorral in Chile, kwongan in south-west Australia and fynbos (and renosterveld) in South Africa. In all, a dense stand of woody shrubs and small trees develops. Many of these species are also very good at recovering from fire, either re-shooting from the base or seeding prolifically (often with fire triggering the release of seeds from hard seed pods). A second type of modified shrub-dominated vegetation is coastal scrub, which consists of smaller, lower-growing species, not only drought resistant but also tolerant of salt spray and wind. There are versions of this community in all regions. In the Mediterranean Basin, this is known as garrigue (or phrygana), in Chile as coastal matorral, in South Africa as strandveld (or fynbos-mosaic). Finally, there are some fascinating littoral plants that survive in the dunes and sands that line the coast and the beaches that lure so many to all these regions. The plants found in all of these habitats are drought resistant with thick (sclerophyll) leaves, covered in wax, indumentum or hairs to prevent water loss. Within the leaves the stomata may be narrow, sunken, surrounded with hair, mainly on the underside of leaves, or a combination thereof, all to conserve moisture. Leaves are also often held upright to reduce their exposure to the sun.

Another adaptation that assists drought survival is the dual root systems. Many species have both an extensive network of finer lateral roots that spread out near the soil surface as well as deep penetrating taproots. Examples include *Eucalyptus*, which can send roots down to 40 metres, or Californian oaks that extend 20 metres. Both also have vast lateral root systems. Even smaller shrubs will show similar development, though since their deep roots do not reach as deep they back it up with lateral roots many times the size of their canopies. Indeed, more than half of their mass will be roots. Roots also obtain



*Cercis occidentalis,* Scott Mountains, California

*Retzia capensis*, Kogelberg, Western Cape

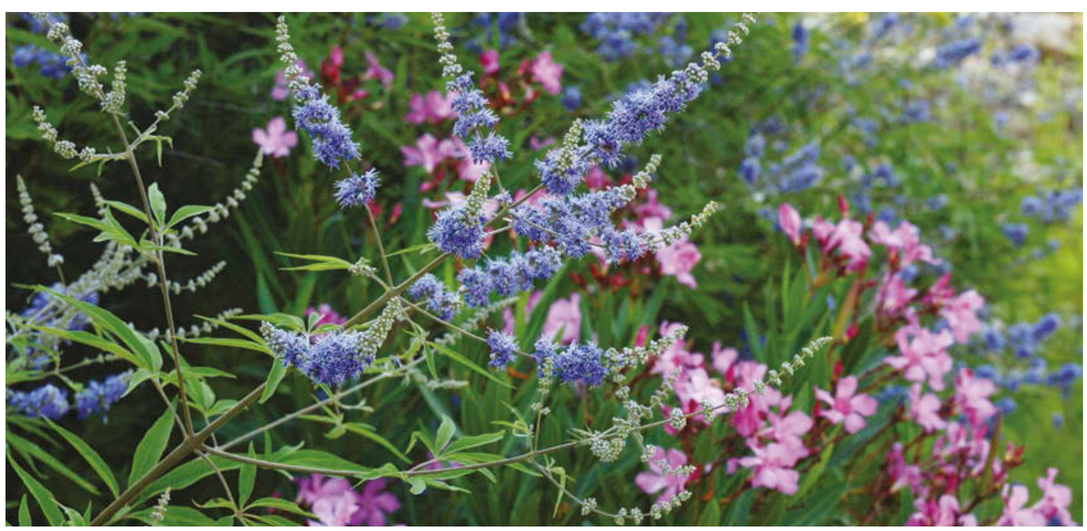
*Hybanthus calycinus*, Perth, Australia

nutrients for the plants and it is interesting that the highest diversity of woody plants always occurs in the lowest nutrient areas such as fynbos or kwongan, with intense competition for finite resources and many narrow niches. The many Proteaceae found here have specially adapted proteoid roots whereby fine masses of rootlets develop from lateral sub-surface roots to capture nutrients. Mycorrhizal fungal associations are also common (in all regions) utilising fungi to capture scarce nutrients, then passing sugars and water back in return. Other smaller plants in poor nutrient areas have become carnivorous - e.g. *Drosera* - using insects for their nitrogen needs. Yet others are parasitic. Geophytes, i.e. bulbs, corms, orchids and other plants that have below ground storage organs, are also prevalent within these communities, as are annuals (see p. 9 for both).

Since important adaptations are essential to plants thriving in the Mediterranean climate there are floral elements regarded as typical of Mediterranean type vegetation and these can be used to define its extent. For example, in the Mediterranean Basin the olive, *Olea europaea* is used to define the extent of the Mediterranean climate, whilst holm oak *Quercus ilex*, is commonly used to determine the extent of Mediterranean type flora, particularly if it combines with other widespread species such as *Cistus salvifolius, Arbutus unedo, Erica arborea* and *Lavandula stoechas*. Each region has its own version of these typical floral communities. Coastal mountains and nearby highlands have modified Mediterranean type vegetation that includes both: many shared plants that span a wide altitude range and closely related floral elements with similar adaptations to climate extremes, both hot and cold.

Yet, despite so much adaptation and pre-adaptation, it is notable that many species of moisture-dependent plants, that do not have effective drought strategies, still persist, or indeed thrive within Mediterranean climates. For a start, a huge variety of microclimates exists augmented by variations in temperature, moisture and altitude. Some are relict plants, legacies from cooler moister times e.g. *Rhododendron ponticum* in south-west Spain, which has now retreated to the Black Sea mountains of north-east Turkey. Or they find refuge during ice ages, providing a vital reservoir to recolonise after the ice sheets have retreated, and they persist in these locations e.g. the Vikos Gorge area of northwest Greece. Others have evolved in these niches and are not found elsewhere e.g. the remarkable *Cephalotus follicularis* (p. 335) in seep-fed wet ground in south-west Australia, a product of the rain forest lineage from that continent's wetter past. Or the flamboyant *Disa uniflora* (p. 358) on Table Mountain in South Africa, where it grows on seeps and beside pools among rocky fynbos. Such localised permanent water sources are exploited by a fantastic array of flowers in Mediterranean climate regions. Anyone exploring Greece in the heat of summer will quickly become aware of the cooling shade of plane trees, *Platanus orientalis*. These wonderful trees with marbled bark and at times vast crowns can always be found where underground moisture is available along watercourses and seasonal channels. They are able to exploit this resource through their huge root system; and they provide further niches in the deep leaf-mould that develops beneath them, for other plants such as *Galanthus*, *Cyclamen* and *Paeonia mascula*. In Chile springs are swathed in *Mimulus luteus* and the huge leaves of *Gunnera tinctoria* (p. 289). These specialised moisture-dependent plants add yet another intriguing layer to an already burgeoning flora.

*Balbisia pedunculata*, La Serena, Chile



*Vitex agnus-castus*, a widespread Mediterranean Basin plant, here with *Nerium oleander* near Beycik, south-west Turkey

*Crocus wattiorum*, near Antalya, Turkey

# Geophytes

In terms of being pre-adapted to the Mediterranean climate, few plants are better suited than geophytes. A geophyte is any plant with an underground storage organ, be it a bulb, corm, tuber or rhizome. This adaptation allows a plant to survive a part of its life cycle dormant below ground. It is an excellent strategy for coping with drought (and cold). Safely ensconced below the scorched earth above, it can reappear when rain arrives and continue its life cycle. Therefore, it is not surprising that geophytes are common and diverse in Mediterranean climate regions. Their level of abundance varies depending on soils and habitat, but they are almost ever present. Their diversity also differs between regions and each regional chapter deals with this in more detail.

The various storage organs used by geophytes adopt different approaches (see glossary, p. 416) to the problem of conserving moisture and nutrients during inclement conditions. The majority of geophytes are monocotyledons and key families are Iridaceae, Liliaceae, Amaryllidaceae, Colchicaceae, Araceae, Asparagaceae and Xanthorrhoeaceae. Orchidaceae is also very strongly represented, and this family perhaps above all others demonstrates the wealth of Mediterranean climate geophytes, with a dazzling variety of different forms. Indeed, each regional orchid flora is totally distinct from all others. Examples of widespread dicotyledon geophytes are *Cyclamen* (Primulaceae), *Anemone* (Ranunculaceae) and *Aristolochia* (Aristolochiaceae). Many herbaceous plants also withdraw to rootstocks but these are not modified to the same degree.

# Annuals

A successful alternative strategy is demonstrated by annuals. These choose to pack their life cycle into one brief season, germinating with the rains, growing, flowering, setting seed and withering in a few short weeks before the drought ensues. The seeds then survive through to the next season. Plants such as these can readily and rapidly take advantage of erratic rain events such as those experienced in the drier, warmer ends of Mediterranean climate regions, lying dormant for years if necessary. Indeed, they are most numerous in these areas and the Mediterranean climate regions have more species of annuals than anywhere else. They can occur in huge numbers, colouring great swathes of land in good years. They can also take advantage of disturbed ground such as roadsides, field margins and waste ground. Some are very specialised such as those that occur around vernal pools in California, taking advantage of a seasonal abundance of water (see p. 175).

Fire also favours annuals and there can be spectacular displays following fire. Removal of vegetation by fire creates a sudden increase in light and this combined with an influx of nutrients from the ash creates the perfect environment for them once the rains arrive. They will reappear for a few seasons, slowly diminishing as the burnt areas regenerate and woody plants reassert their dominance. During this time, a large seed reservoir is built up ready to germinate after the next burn.

Asteraceae is an important annual family along with Lamiaceae, Fabaceae, Apiaceae and Plantaginaceae.

*Bartholina etheliae*, Ceres, South Africa.

*Herbetia lahue*, Angol, Chile.

*Clarkia gracilis*, Bear Valley, California

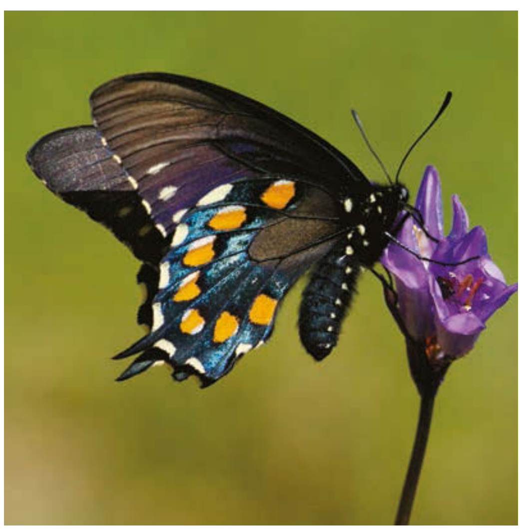
# Pollination

The Mediterranean climate regions have exceptional diversity and various factors combine to achieve this. One of the main drivers of speciation anywhere is pollination and how to get ahead of the rest. There are differences between the five regions as to pollinator availability. And this has had a significant impact on the design and diversity of flowers. The arrival of the Mediterranean climate eliminated many species, not able to withstand drought, but allowed others to diversify and fill niches. Most of the dominant trees in Mediterranean climate regions are wind-pollinated - for example *Quercus*, *Pinus*, *Cedrus* and *Nothofagus*, merely holding spikes or dangling catkins in the air for wind currents to carry the male pollen to an available female flower. The exception is *Eucalyptus* in Australia, which uses birds instead. The most common physical pollinators are insects, everything from bees to beetles, flies or butterflies can achieve pollination.

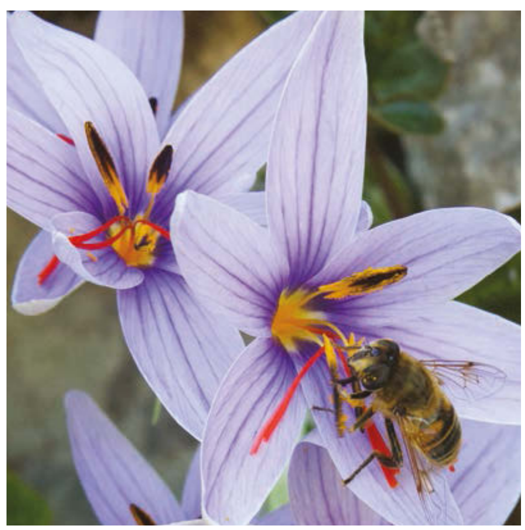
Some flowers aim for particular types of insect, others are more general. Flowers such as the various daisies (Asteraceae) are bright and obvious, and seem to offer themselves to any passing pollinator just by being so. Yet closer examination of the flowers (including under ultra-violet light) reveals hidden patterns to direct insects into the flower. Some of the loveliest in this respect are the *Gazania* of South Africa (p. 384). Bees attend everything from foxgloves to crocuses and countless legumes. Yet even this most familiar of pollinators has surprising adaptations. For example, solitary bees attend the flowers at Californian vernal pools. They live most of their lives underground, appearing above ground for just a month when their particular flower is in bloom. Each species specialises in a particular flower. Flies are very diverse, and specialised long-proboscised species pollinate many of the Western Cape's *Erica*, Iridaceae and *Pelargonium*, as well as Chile's *Tropaeolum*. Some flamboyant lilies (e.g. *Lilium chalcedonicum* p. 143) use butterflies. Their anthers are held clear of the nectaries in such a way that they rub against butterfly wings and smear them with bright orange pollen. Others use lines or modified grooves as guides in the flower itself to draw pollinators to the promise of nectar. However, flowers can also restrict who can reach their nectar, as is the case with tubular flowers of particular widths or those having long spurs designed for tongues of the right length. Others such as *Salpiglossis sinuata* (p. 270) from Chile, or *Serapias orientalis* (p. 45) from the Mediterranean Basin, offer shelter to roosting bees. They emerge the next morning with pollen attached and can immediately get on with business.

Scent is used, sometimes powerful and readily detectable, either during the day or at night for moths. Some of it is undetectable by humans - for example from the swollen sepal-tips of *Chloraea* or *Caladenia* orchids. Indeed, orchids are among the most specialised of plants sometimes targeting very specific species with highly adapted flowers. Bees and wasps are a favourite, pollinating many species from the *Ophrys* of Europe to the remarkable hammer orchids of southwest Australia. Both offer insect-mimicking designs to lure their pollinator. Many orchids do not even offer nectar as a reward e.g. *Chloraea* in Chile or (most) *Anacamptis* and *Himantoglossum* in Europe - but rely on scent or subterfuge. Indeed, it is thought that some 30-40% of all orchids (and there are more than 25,000 species) offer no nectar reward. The designs can be breathtaking in their intricacy with (very) insect-like appendages to their labellums

*Lapageria rosea*, the national flower of Chile, is pollinated by hummingbirds. Near Temuco, central Chile.



*Battus philenor* (pipevine swallowtail) taking nectar and pollinating *Dichelostemma capitatum*, California.



*Crocus wattiorum* undergoing pollination by a drone fly (*Eristalis sp.*), south-west Turkey.

e.g. *Caladenia barbarossa* (p. 301). Or, more subtly with the need to be viewed at the insects' level as in *Chloraea apinnula* (p. 263). It has been found that orchids have a different set of genes for their labellums than for their other perianth segments, something that has allowed them to evolve so many amazing designs.

One of the chief differences between the Mediterranean Basin and the other Mediterranean regions is bird pollination. Migratory nectar feeders do not occur and there exist only two species of nectar-feeding sunbirds in the warmer south. It is more prevalent in all other Mediterranean regions to varying degrees. For example, there are several species of hummingbirds in California and likewise Chile as well as (surprisingly) white-crested elaenias. The latter are small birds that typically hawk insects from the canopy, but on several occasions, I have witnessed them feeding on *Embothrium coccineum* (p. 287) flowers, their heads caked in red pollen as a result. Sugarbirds are in constant attendance around open *Protea* flowers in South Africa and honeyeaters and tiny parakeets buzz about eucalypts in Australia, carrying out pollination as they avidly drink the, often copious, quantities of nectar these flowers provide. It is a sound strategy, since birds can fly a long way, improving the chances of effective cross-pollination. It is frequently stated that birds are drawn to bright hot colours such as reds and oranges, and indeed there are many such flowers in regions where bird pollination is common. However, they are far from tied to this and will feed from any colour flower that has suitable nectar. For example, *Puya bertroniana* (p. 249) from Chile is blue and I have seen at least six different species of bird attending these spectacular, very specialised inflorescences, which have even developed specific perches to make it easier for the birds. I have also watched Anna's hummingbirds eagerly feeding on white *Arbutus menziesii* in California. There are also a few insects which favour red (most do not) including long-proboscis flies in Chile and the fast-flying butterfly *Aeropetes tulbaghia* (Pride of Table Mountain), which specialises in the late season reds in the Western Cape, including *Disa uniflora, Gladiolus cardinalis* and *Crassula coccinea*.

Yet another option exists, with cute nocturnal honey possums pollinating Proteaceae and Myrtaceae in Australia and rock mice pollinating some low-growing *Protea* in South Africa. For flowers to develop specialist strategies takes time and it is no coincidence that the highest incidence of these is in Australia and South Africa. Both areas have enjoyed exceptionally long, stable climate periods and geological stability to allow such relationships to develop. Examples where increased speciation is (at least partly) in response to a broader range of pollinators, includes two genera that are shared between the Mediterranean Basin and the Western Cape: *Erica* and *Gladiolus*. In both there are many times more species and a far wider variety of forms and colours in the Western Cape. In the Mediterranean Basin both genera are of limited scope in terms of colour, form and habitat choice. Another instance is the limited range of colours of Chilean orchids. The isolation (and instability) of that region has restricted the diversity of pollinators, and orchids here are only white, green or yellow, and (mainly) the same general form i.e. stout spikes. In the Western Cape and south-west Australia a much wider range exists, including reds and (near) blues along with a staggering diversity of flower design, plant form and also habitat choice. The more one delves into the often, undiscovered world of pollination the more fascinating (and addictive) it becomes.

*Banksia coccinea*, a plant pollinated by a mammal, the honey possum (*Tarsipes rostratus*). Fitzgerald River National Park.

Crab spider capturing the pollinating wasp of *Disa bivalvata*, South-western Cape, South Africa. © Callan Cohen

Purple-crowned lorikeet taking nectar and pollinating *Eucalyptus caesia*, south-west Australia.

# Importance of Fire

Devastating fires sweeping through forests in California or Australia make dramatic news stories. And indeed, the human cost can be tragic. But from the perspective of Mediterranean climate plant communities it is an important and necessary natural process that despite appearing destructive at first impression, is actually also a giver of life. Many plant species have their life cycles closely linked to fire. For example, the seed pods of many *Protea* in South Africa and *Banksia* in Australia will only open once triggered by such high temperatures; likewise, some pines such as *Pinus attenuata* in California. Fire clears the ground of competition, allows in light and provides a flush of nutrients. Smoke and temperature also trigger the germination of certain dormant seeds, whilst some orchids and bulbs are wholly dependent on fire and appear only the year (or two) after one. However, more frequently, plants are stimulated to come into flower after fire, rather than being dependent on it, and will flower at other times too. Many woody plants are well-adapted to regenerate after fire, whether by seed (e.g. *Ceanothus* in California) or by re-sprouting (e.g. *Protea cynaroides* in the Western Cape) and their subsequent regeneration forces geophytes, annuals and herbs to decline or become dormant. There can be several or many years between fires, the natural cause of which is lightning. In both Chile and the Mediterranean Basin lightning strikes are rare in summer and both have few if any truly fire-dependent plants. The subject of fire will be dealt with more fully in each regional section, as its impact, frequency, and the flora it affects vary. It is also at odds with human designs on Mediterranean climate regions, where the vast increase in residential properties has put their owners in direct conflict with a natural process.

# Impact of Man

The Mediterranean climate is very appealing to people. It is also a good climate for agriculture as it is not too hot or too cold. As such, the pressures on the five regions are intense. From the lure of the sun and its associated mass-tourism development along large stretches of coastlines, to intensive agriculture, many ecosystems have suffered as a result. The history of settlement in the Mediterranean Basin is long, from at least half a million years ago. During this time, the landscape has been greatly modified and settled, forests have been felled on a large scale and livestock have grazed for centuries, forever altering the native flora. That said areas of intact habitat remain, and certainly mountainous areas still harbour a great wealth of species. In fact, some species will have benefited and are arguably more numerous as a result. For example, those requiring disturbed ground or bare slopes thrive on road cuttings, fields and waste ground. Geophytes enjoy the reduced competition brought about by grazing and certain unpalatable species come to dominate e.g. *Asphodelus aestivus* in the Mediterranean Basin. Also, manipulation of fire regimes be it (over-long) prevention or increased frequency through arson, affects the balance of plant communities. There will be continued and increased pressure and the need for effective conservation of some habitats is paramount. Besieged coastal areas, wetlands, vernal pools, old growth forests, bulb-rich renosterveld and kwongan heaths, are all under threat. Added to this is pressure from horticulture and the collection of wild plants, especially geophytes, for trade, which puts undue pressure on some species.

Incinerated chaparral in southern California (left). The fire, in Los Padres national forest, near Santa Barbara, consumed a vast area in just a few days. However, with the arrival of spring the first signs of recovery are already visible with resprouting trees and shrubs. Setting controlled burns, such as here near Perth, Western Australia (right), reduces the fuel load and prevents intense fires. but this can change the mix of plants within an area over time.

# Invasive Species

Global travel over the centuries has led to both the accidental and intentional introduction of many species between continents and certainly between Mediterranean climate regions. Today it is possible to see, in fact impossible to avoid seeing, numerous non-native plants thriving far from their native lands. This can have serious consequences for the native flora. Invaders tend to be aggressive and dominant, forcing out the original flora. They both fill available niches and out-compete existing ones. In the mountains of the Western Cape, various *Pinus* species can be seen colonising the slopes, slowly but inexorably establishing (fire-prone) forests, sometimes in lands that never had forests before. This is in no small part because their seeds survive fires unlike the native afro-montane species. Elsewhere, ugly species of *Hakea* from western Australia are invading native fynbos and forcing out rare Proteaceae and orchids. In Chile, vast swathes of hillside are coloured yellow with *Cytisus scoparius* from Europe, the scent heavy in the air. This plant relishes the volcanic cinder found in many areas. Another more attractive weed here is *Eschscholzia californica*, which now gilds roadsides and open sunny places throughout the south. In California, most of the native bunch grassland has been replaced by non-native grasses that compete more effectively and true Californian grasslands can only be found in a few places. Other examples include many herbaceous fabaceae such as *Lathyrus tingitanus* from the western Mediterranean Basin. Australia has been besieged by South African bulbous plants, such as *Gladiolus caryophyllaceus, Freesia alba x leichtlinii* and *Zantedeschia aethiopica* (p. 393), as well as hundreds of other trees and herbs from around the world. One of the most notorious is *Echium plantagineum* from the Mediterranean Basin, now a widespread pest in South Australia. Australia has the highest number of invasive species in any Mediterranean climate region. In the Mediterranean Basin there are problem *Acacia*, *Eucalyptus* (though much is planted for timber), whilst the daisy *Cryptostemma calendula* and the fleshy-leaved spreaders *Carpobrotus edulis* and c. *acinaciformis* all from South Africa, appear along sandy coasts. The cactus *Opuntia ficus-indica* and trailing *Oxalis pes-caprae* have also naturalised in many areas. However, in my personal experience of living in Turkey virtually nothing escapes from gardens and establishes in the native macchie despite massed plantings of many exotics. Quite why much of the Mediterranean Basin is so resistant may be in part due to its extremes. A large percentage of Australian and South African species are not frost hardy and hard frosts certainly occur (even at modest elevations) in the Mediterranean Basin and snow settles at sea level every few years. In summer, the temperatures frequently exceed 40 degrees Celsius for many days in a row with a long and withering summer drought. Also, the flora here has long been subjected to botanical influences from Asia, Africa and northern Europe. On top of this, many species have already been moved around the region (and naturalised) during the thousands of years of human settlement there. Examples of this include *Nerium oleander* (p. 16) and the olive, both native to the east (and south) of the region, but commonly seen throughout. This has created a robust flora with established vigour. Furthermore, there is the availability and/or lack of suitable pollinators, few (natural) fires and possibly also the predominance of limestone, which is comparatively lacking in all of the other regions.

Lovely but unwanted! *Eschscholzia californica* from California is widespread in sunny places in Chile, though, admittedly here, it combines well with native *Alstroemeria pulchra* (centre). Other examples are the South African duo of *Gladiolus caryophyllaceus* (left) in south-west Australia and colourful coastal swathes of *Carpobrotus acinaciformis* (right) swamping native Mediterranean Basin flora. Corsica in April.

# PHOTOGRAPHING FLOWERS IN THE WILD

All the photographs in this book have been taken by us on location (except for a very few but crucial contributions from other photographers). The majority were taken with limited time available, often during a botanical tour and in less than ideal weather and lighting conditions. In part, this book seeks to show what is possible when operating within such parameters. Certainly, a reasonable amount of time has been devoted to some subjects, but rarely hours, more typically ten or fifteen minutes, even half an hour sometimes. (An exception is the two hours I spent capturing *Disa uniflora* in the rain, see p. 360-1) How to succeed? Be organised, know your camera and its functions, have a well-rehearsed method and have all your equipment well arranged in your camera bag to be ready to take advantage of opportunities. Learning the fundamental technical aspects of depth of field and exposure is necessary, although there is greater latitude in the latter with digital photography, but this requires more time in front of the computer. Composition is critical, as this cannot realistically be changed with photo editing software. However, digital photography now allows anyone to learn this quickly because it is possible to review images instantly and then make the necessary adjustments. For any subject always check the flower first: What is its condition? Is it damaged, are the anthers and styles fresh? Does it represent the species well? Where is the light coming from? Do you want shade, backlight or full sun? How is the background? Try to have a concept of what you're aiming to convey and then work with that particular flower to get the best out of it, exploring different angles, backgrounds and lighting. White cloud, or overcast even light, are ideal for much of the time. Harsh, highly contrasting midday sun is least desirable. But it is necessary to learn how to use what there is. Careful diffuse shading does produce good results in terms of detail and colour, but to apply this approach to all subjects can be too clinical. At times an extra dimension is needed and a bit of sparkle by using the light more can give alternative and interesting results. For example, flowers often look interesting backlit whilst reflectors or soft-fill flash help to add a tweak of light to balance shadows in high-contrast situations – so there are options other than always shading subjects. Be creative. For my image of *Thelymitra pulcherrima* (p. 296) I used a reflector to fill in a strongly backlit subject to give a 'glowing' image. And of course, photographing plants in their wider environment precludes the use of diffusers, whilst again a reflector can boost the subject and solve unwanted shadows. Ultimately, however, much depends on the subject itself, its colour, texture and the time of day (and thus the quality of light) as to what brings the best results. Tidying a subject is

The author photographing *Disa maculata*, near Cape Town. Photo: © Callan Cohen

a bone of contention and is subjective. Clumsy and excessive 'gardening' looks exactly that; but no gardening at all, and the flower will not stand out. We garden carefully, as we want to show the flower at its best; it is a thing of beauty and deserves to be seen as such. Attention should be paid to distracting background items – always review images to check this. Do not cut away protecting shrubs; instead bend them back and then return them to the position afterwards as these branches, though unwanted by you, might be the plant's only defence against grazing animals. Personally, we find untidy, 'as-you-found–it' shots do an injustice to the subject. Lastly, bring yourself down to the level of the flower for better use of depth of field and general appreciation of its structure. This can be tough on the knees, back and the hips, so tough clothes, kneeling mats or a tolerance of thorns and scratches are needed. Patience is also an essential of photography, provided the weather (and your back and knees) holds out. For the moving photographer wanting great landscape images, serendipity undoubtedly has a large part to play and it is important to have a camera ready for that moment of perfection because it seldom lasts for long. Having one of the modern, high-quality compacts helps you to be always ready. It is often difficult to achieve the best lighting during botanical tours as they invariably start too late and finish too early in the day for the best landscape lighting. Early morning and late afternoon are best and some of our favourite landscape images were taken at these times or in mist, which always evokes wonderful depth and an intriguing ambience. However, it is a case of opposites, since sunlight gives depth and life to the landscape and overcast skies render it flat and lifeless - the antithesis of what is often desired for flower photography.

There is no real difference between the major camera brands in terms of picture quality, and more megapixels does not necessarily mean better photos. But good quality lenses are invaluable. DSLRs offer the greatest flexibility, and a good camera bag to protect kit from dust, rain and heat, as well as to organise the equipment, is essential. Finally, the most important piece of equipment after the camera itself is the tripod, considered by many as a weighty cumbersome piece of baggage. But for others – including myself – it is a sleek, practical and essential tool. Of the images shown here 90% have used a tripod. Tripods are invaluable for composition, providing great stability when working close-up, and vital stillness when capturing shots that require a greater depth of field (and thus a slower shutter speed). Give yourself the best chance of succeeding.

Most of all: enjoy your photography and the places it takes you!

*Nerium oleander,* growing wild near Petra, Jordan

# The Five Mediterranean Climate Regions

*Pancratium maritimum*

# MEDITERRANEAN BASIN

Far and away the largest area with a Mediterranean climate is the Mediterranean Basin itself. It occupies around 60% of the total area and contains around 25,000 species of plant. It is not only larger, but more densely populated, more modified and more varied in its' topography. The Mediterranean Sea, which unifies the region, was formed through a colossal waterfall when the Atlantic breached the Straits of Gibraltar and filled the basin 5.3 million years ago. The geography is complex with the large Iberian Peninsula nearly touching Morocco's Rif Mountains at the western end, whilst to the south the taller Atlas Mountains climb to 4,167 metres and cross into Algeria and Tunisia, blocking the drying Sahara Desert beyond. Mountains and their foothills are a feature of many parts of the region, hugging the coastal strip in many places and adding to the floral richness. The collision of the African and Arabian tectonic plates caused tremendous uplift and mountain building. Almacen, in Spain's Sierra Nevada, reaches 3,481 metres, but passing the edge of the Pyrenees the land lowers, moving east past southern France to the junction of the Maritime Alps and the Apennines. The latter run through the centre of the striking profile of Italy, with Sicily at its tip almost in contact with Tunisia. Sicily has the huge Mount Etna volcano at its heart, with Stromboli and Vesuvius farther north to make a fiery centre to the region. Italy is separated from the Balkans by the Adriatic Sea, before one reaches the biodiversity hotspot of Greece and south-west Turkey, the most botanically rich part of the region. Greece has a complex of highlands formed by the Pindos and Taygetos, as well as hundreds of islands strung across the Aegean Sea, including flowery Crete. Southern Turkey is dominated by the Taurus Mountains, which reach 3,756 metres and stretch the length of the south coast, joining the Jabal-al-Nusaira of western Syria. Then, on south into Lebanon, Jordan and Israel, where the Mediterranean climate zone ends on the edge of the Arabian Desert. It also continues into western Iran, along the southern flank of the Zagros Mountains, which is technically an extension of the same Mediterranean climate region, but we have confined ourselves in this book to the countries surrounding the Mediterranean Sea. The large island of Cyprus lies off the Turkish coast. Other notable islands include Sardinia, Corsica and the Balearics, the latter two with a number of endemics.

There are large areas of non-calcareous rocks (e.g. Apennines, Atlas and Iberian Mountains), as well as granite (e.g. Corsica) and volcanic rocks (e.g. Sicily and Morocco). However, unlike all other Mediterranean climate regions, limestone is widespread and dominates many areas, especially in the eastern Mediterranean Basin. It has more species associated with it than any other rock type and is immensely variable, weathering to produce rich *terra rossa* soils. (When the calcium carbonate of the limestone dissolves the various impurities such as clay are left behind as soil.) Serpentine often appears among areas of limestone (and other rocks). It is a tough rock, which many plants cannot tolerate but a good number of specialised plants have evolved, e.g. *Fritillaria epirotica* (p. 117) and *Pinguicula crystallina* (p. 120). There are also many species tied to serpentine in California e.g. *Darlingtonia californica* (p. 189).

Aspect, altitude and rainfall also influence the flora. Given the complex geography it is not surprising that there is great variation in rainfall across the Mediterranean Basin. At its simplest it is wetter in the north than the south. The wettest parts of the region are the Apennines of Italy, the Balkans down to the Peloponnese of Greece, and a large part of south-west Turkey and western Syria. These areas all receive over 1 metre of precipitation per annum. However, much of eastern part of this area also swelters in strong summer heat and has between four and six dry months. The Mediterranean climate is at its most extreme in these places. My experience of living in southwest Turkey is very much this: intense winter storms and prolonged summer heat with zero rainfall.

The range of olive (*Olea europaea*) cultivation, is normally used to define the Mediterranean climate area, as it closely mirrors the boundary of the Mediterranean floristic region. There are other typical indicator species too, such as *Quercus ilex*, *Q. cocciferus*, *Cistus salvifolius* and *Arbutus unedo*, all very widespread species. However, none is a perfect fit as to the actual extent of Mediterranean-type vegetation. The notion of pre-adaptability means a plant has the ability to survive summer drought, but it does not preclude it from being able to grow elsewhere, including in colder or wetter areas.

This certainly applies to sub-alpine/alpine flora from higher on the many coastal mountains, as this also endures a Mediterranean-type climate. In fact it can be especially harsh in drier areas such as the Sierra Nevada and Atlas Mountains, where a plant community known as the 'hedgehog' zone exists and is characterised by very tough spiny shrubs such as *Erinacea anthyllis* (p. 61) able to withstand cold, heat and drying winds. These and the other upland areas fall within, or are immediately adjacent to, the Mediterranean floristic region and have Mediterranean-type vegetation with many similar floristic elements, e.g. *Verbascum*, *Salvia*, *Genista*, *Asphodeline*, *Fritillaria*, *Daphne*, *Astragalus* and *Paeonia*. They also often share plants with the lowlands. For example, on Tahtalı Dag, a coastal peak in southwest Turkey, *Euphorbia rigida* flowers in January at sea level but in June at 1,800 metres among cedar forests that bake for rainless weeks in summer. *Orchis anatolica*, *Vicia cracca*, *Phlomis grandiflorus* and others do

*Nigella damascena*

much the same. In Croatia another coastal peak - the 1,762-metre Mount Biokovo - is just a very few kilometres from the Mediterranean Sea, and snow remains for several months a year. The cooler conditions here permit plants from the neighbouring Sub-Mediterranean floristic province to grow, such as *Erythronium dens-canis* (p. 114). Thus, determining where two floral areas meet and when one becomes the other is not straightforward. The same applies to all Mediterranean climate regions where climates meet, be it desert or mountain, with transitions rather than sharp delineations. Common species exist in all. There are further factors behind the development of the very rich flora in the region. It has been, and continues to be, influenced botanically from different directions and is the least isolated of any of the five regions. Boreal Europe lies to the north, Africa to the south and Asia to the east. It is no coincidence that where these continental boundaries meet diversity is highest. One of the richest areas is the Iberian Peninsula, influenced by African species from northern Morocco. Then there is the nexus of the southern Balkans, Greece and south-west Turkey. Here, as in the Western Cape, a complex geography with many isolated peaks and twists and turns in the coastline has driven high levels of speciation with many localised endemics.

Forests and woodlands were formerly much more widespread than they are today. Humankind has been in the region in some way for hundreds of thousands of years. Extensive and intensive modification of the natural vegetation has taken place. In their natural state, tall forests of mainly oak and pine (with some cypress, juniper and cedar) would have clothed many areas. There are still some fine tracts, especially in the mountains, but much has been managed and manipulated with some tree species moved about the region, blurring their true distributions. There are interesting parallels with California, where pines and oaks are also very significant and form another example of the pre-adaptability of certain genera. One difference with Mediterranean Basin pines is that no species are dependent on fire to open their cones (hot weather is enough). What is seen today in the region are large areas of pine plantation and scrub oak, where grazing and cutting have lowered the canopy and created a stunted landscape. Some species such as cork oak, *Quercus suber,* have been exploited sustainably and still cover some large areas (though they are in decline as wine producers move away from using cork to stopper their bottles).

The sclerophyll scrub of the Mediterranean Basin is macchie. As in all regions this type of scrub habitat is species-rich. Typical plants include *Quercus*, *Arbutus*, *Spartium*, *Cistus*, *Phlomis*, *Lavandula*, *Pistacia*, *Genista* and *Erica*. Some of these genera are found in other regions with *Arbutus* in California and *Erica* in the Western Cape (where it has undergone explosive speciation). Many other species are involved in macchie depending on the location, but some or all of those mentioned will be present. Structurally, macchie is less dense than chaparral perhaps because of grazing or the lack of fires, which create a broader age structure. Garrigue is a lower growing community that allows many more geophytes, herbs and annuals to thrive among it. Wandering through macchie or garrigue is always a journey of discovery, with many delights tucked away in gaps among the shrubs. There is also a mixture of deciduous and evergreen species, since soils are much more fertile and nutrients are available for either strategy to succeed. Many of the species are also spiny and/or pungently aromatic to deter grazing animals, though we enjoy the herb flavours ourselves in cooking. Millennia of grazing have greatly influenced the floral composition with some graze-resistant species dominating the landscape e.g. *Phlomis*, *Genista*, *Styrax* and *Euphorbia*. This grazing-induced selection is equally striking among geophytes, e.g. *Asphodelus aestivus* (p. 107), which can dominate intensively grazed landscapes. In places such as northern Greece, there is also species-rich sub-alpine grassland that forms superb plant areas between late spring and early summer, along with the many rocky summits, high cliffs and screes. Sub-alpine and alpine communities are rich and varied, especially in Spain, Greece and Turkey.

Given the size of the region there is a vast coastline with some fascinating littoral plant communities, with many highly specialised plants that can thrive in sand and salt spray. In early spring, they are colourful places before the hordes of summer tourists arrive, though finding good quality untrammelled littoral today is not easy.

Geophytes are superbly evident throughout, though there are differences in distribution of genera, partly a result of migration from western Asia and Africa. The western Mediterranean Basin has many *Narcissus* and *Scilla*, some fine *Iris* and *Crocus*. Another geophyte centre is the Balkans, Greece and Turkey, extending south to Jordan and Israel. Here we find an abundance of *Cyclamen*, *Fritillaria* (shared equally well with California), *Colchicum*, *Tulipa* and many more and varied *Crocus* and *Iris*. The latter have had a strong influence from western Asia. Irises occur in California too. Other key genera are *Allium*, *Ornithogalum*, and *Muscari*. There are also around 100 species of orchids, spread throughout, though the east tends to have more. Many are also found outside the Mediterranean Basin, but *Ophrys* and *Serapias* have essentially evolved here.

Annuals are very widespread throughout, especially in cultivated areas and along roadsides, where they create a blaze of colour in spring. Main families include Ranunculaceae, Papaveraceae, Asteraceae, Plantaginaceae and Apiaceae. A good number are now widespread pests in other Mediterranean climate regions , an example being *Echium plantagineum* in Australia.

Fire occurs in the region, but natural fires are not common and most that do occur today are through human activity. Some plants respond to the light and nutrients and flower prolifically after a burn. And most sclerophyll shrubs re-sprout, which may well have initially developed as an adaptation to grazing damage, though plants such as *Cistus* and *Rosamarinus officinalis* also germinate more strongly after fire. Other than unnatural fires the main issues confronting the region today are unrestrained tourist development that has seen massive infrastructure construction, huge demands on finite water supplies and degradation of fragile coastal ecosystems. The latter are especially vulnerable.

Despite much variation in the regional climate, there are number of species that are very widespread if not pan-Mediterranean. This is partly a product of a regional east-west axis, allowing plants to spread and establish both naturally and latterly with human help. It has made it difficult to categorise where to include them in the following chapters, so a degree of mixing between western and eastern species has been inevitable.

# WESTERN MEDITERRANEAN

On sandy banks and among the umbrella-like forms of stone pines little bushes of *Anagallis monellii* (Primulaceae) are smothered in deep-blue flowers in early spring. Showier than its abundant ruderal cousin *A. arvensis*, this charming plant is altogether more desirable. We saw this near Barbate in March, growing among lavender bushes with the bee orchids *Ophrys atlantica* and *O. tenthredinifera* (p. 94) as well as all-green *Gennaria diphylla* and the pretty white bulb *Leucojum triphyllum*. The pines continue west along the coast, stabilising vast dunes that stretch for many kilometres, smothered in wild rosemary, rockrose and lavender. The windswept nature of the Atlantic coast has spared the littoral the over-development that has devastated large parts of the Costa del Sol and many other coastal areas of the Mediterranean Basin. Along with Greece and western Turkey, the Iberian Peninsula is one of the richest areas in the Mediterranean Basin with many distinctive plants, some of which are shared with North Africa. The inland limestone of the sierras harbours everything from golden narcissus to irises, peonies and foxgloves, along with tracts of wonderful gnarled cork oaks whose bark is still harvested every decade (or so). Enjoying the cool shade of these trees are the soft mauve-blue flowers of *Vinca difformis* (Apocynaceae), which occurs from the Iberian Peninsula to Italy. Similar species occur across the region.

*Ophrys atlantica*

*Vinca difformis*

*Anagallis monellii* (left)

*Euphorbia officinarum*

*Euphorbia resinifera*

Heavily spined cactoid domes of *Euphorbia officinarum* (Euphorbiaceae) are dominant in areas of limestone in western Morocco, manifesting as botanical crown-of-thorns starfish intent on consuming all before them. Among them the slender parasite *Striga gesneroides* grows, as well as the succulent *Caralluma europaea* (p. 87). Photographed near Agadir in March. Farther east, hundreds of quadrangular stems comprise each sprawling enveloping mound of *E. resinifera* in another organic assault on the landscape. In reality neither presents a hazard except to grazing goats, and among their many impregnable stems they nurture and protect an array of plants that would otherwise be consumed. Photographed near Cascads d'Ouzud in March. Another slender-stemmed succulent, *Kleinia anteuphorbium*, also occurs in Morocco, but is unrelated, belonging instead to the daisy-family Asteraceae.

*Euphorbia myrsinites*

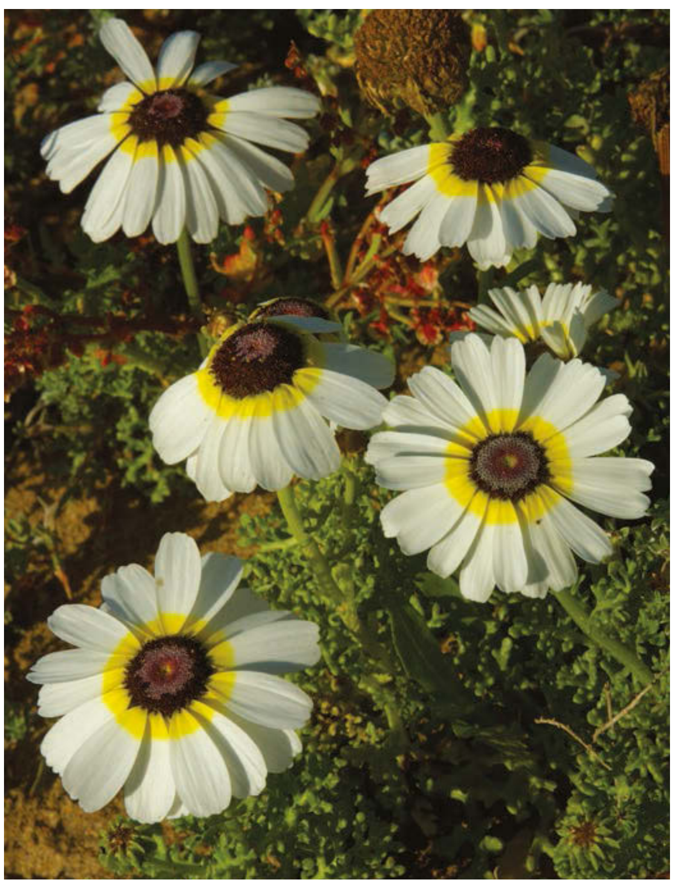
*Euphorbia anacampseros*

*Euphorbia dendroides*

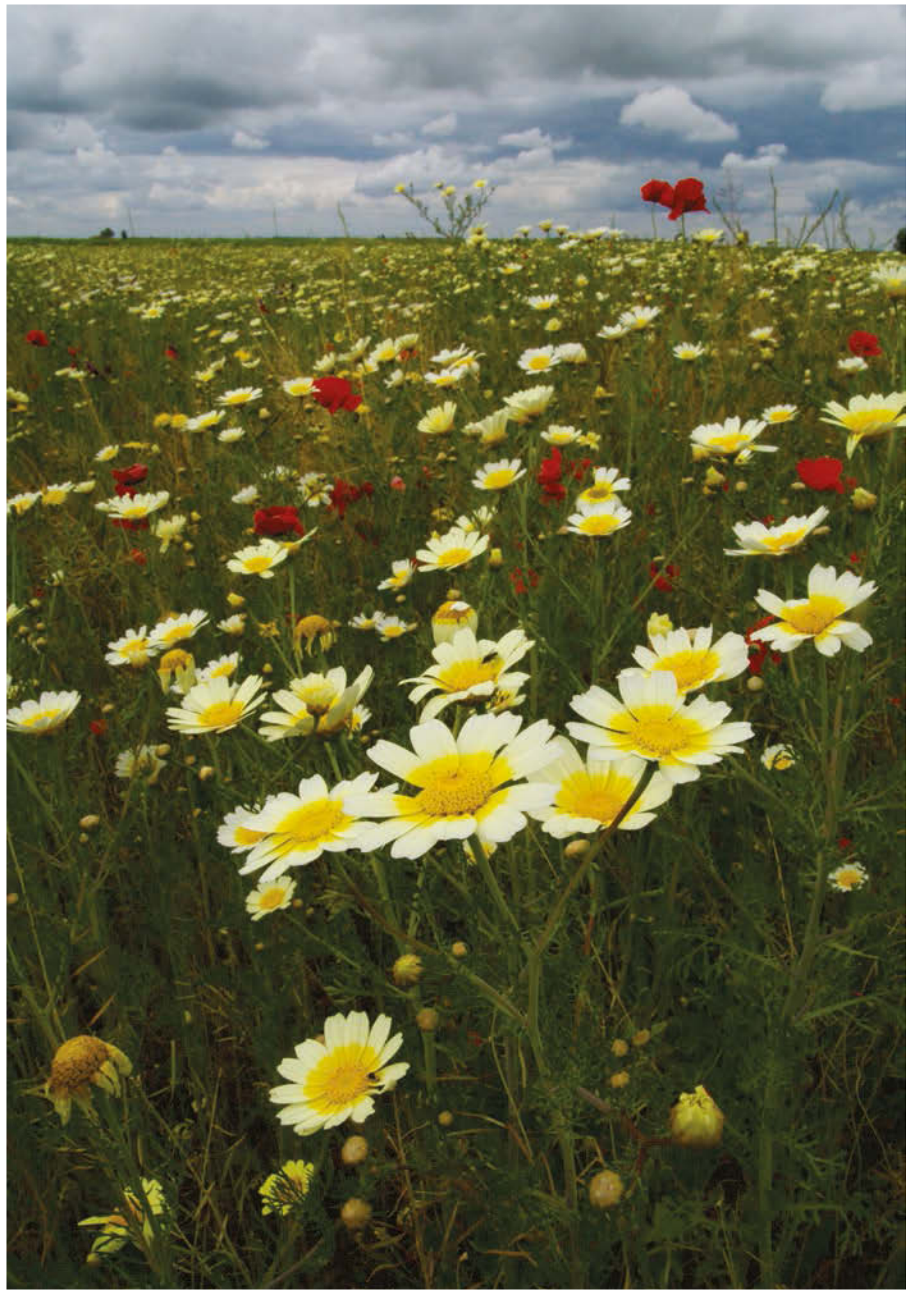
Whorl upon whorl of golden-green trumpets comprise the complex inflorescence of *Euphorbia characias* subsp. *wulfenii* (Euphorbiaceae). An architectural accent to the early spring macchie, they revel in sunny rocky places and the species is a familiar sight across the region. Photographed near Antalya in March, growing amidst lilac *Iris unguicularis* (p. 77) and the smaller, equally widespread *E. rigida*. Broad domes of *E. dendroides* are another structurally strong element, from Spain to Greece. Photographed, Corsica in April. Not all species are as imposing: the delicate purple-infused inflorescences of *E. anacampseros* are set on attractive glaucous-leaved stems that trail across rocky montane slopes in western Turkey. Species can be found in almost all habitats in the Mediterranean Basin, from macchie to forest, marshes or fields. Their toxic sap renders them graze-immune allowing them to dominate some areas. Perhaps this abundance means we rather overlook them, but closer examination reveals exquisitely designed flowers. These flowers are highly modified with showy bracts serving as petals, and each species has a unique arrangement of glands and male and female structures. *E. myrsinites* illustrates this remarkable design. Found from the Balearics and Corsica east to Turkey.

*Euphorbia characias* subsp. *wulfenii* (left)

*Cladanthus arabicus*



*Imelia carinata*



*Glebionis coronaria* var. *discolor*

Dazzling fields of annual flowers paint the landscape in northern Morocco. The composition of each meadow varies with different species dominant and always joined by many other colourful annuals that bloom until they drop before the heat of summer burns them away. Here the rich yellow of *Glebionis segetum* (Asteraceae) is matched by the intense red of the corn poppy *Papaver rhoeas* (Papaveraceae) and mingled among them is *Calendula arvensis* (which itself often forms pure carpets of orange) and the white spires of *Reseda alba* (Resedaceae). Closer examination would find another daisy *Reichardia tingitana* and the unusually branched golden-flowered *Cladanthus arabicus* (Asteraceae). Almost adjacent to this field was another, crowded with bi-coloured *Glebionis coronaria* var. *discolor* and of course more *Papaver rhoeas*, which can form great sweeps of red and formerly did so across much of Europe prior to agricultural intensification. Such displays are particularly noteworthy here in Morocco where less intensive methods are still employed, herbicides are applied less rigorously and flowers bloom spectacularly. The lovely tricolored discs of *Imelia carinata* are less ebullient and are confined to sandy places and dune slacks alongside some of the region's fascinating littoral flora. Photographed near Agadir in March.

*Papaver rhoeas* among *Glebionis segetum* and *Reseda alba* (left).

*Scilla peruviana*

*Scilla hyacinthoides*

*Scilla dimartinoi* © Oron Peri

*Scilla peruviana*

A dense cone of purplish buds slowly unwinds into a swirl of pink-tinged blue flowers. Without doubt the most impressive of all squills, and one of the finest bulbs in the western Mediterranean Basin, *Scilla peruviana* (Asparagaceae) also has one of the most perplexing names. Theories postulate that it was mislabelled among a collection from South America, or its remarkable appearance suggested an exotic origin when it arrived on the desk of a taxonomist. These hefty bulbs are actually native to southern Spain and northern Morocco east to Italy, sometimes rubbing shoulders with *Iris xiphium* (p. 54) and *Ophrys lutea* (p. 97). Photographed at Volubilis, Morocco and near Tarifa, Spain in mid-March. The ınflorescence of the lovely *S. dimartinoi* is similar, though the plant is smaller and this gem is confined to a small coastal area on the Italian island of Lampedusa.

Another striking species, *Scilla hyacinthoides*, is taller with paler flowers and is also found in the Iberian Peninsula, ranging east to Greece and south to Syria, where these were photographed close to the shattered and tragic city of Aleppo. Many other smaller species of *Scilla* (and related genera) occur in Spain and across the region to Iran.

*Erodium guttatum*

*Erinus thiabaudii*

Deep purple eyes stare back at the blue sky above, in their centre are ruby red styles and the whole ensemble is framed by crinkled lilac-pink. *Erodium guttatum* (Geraniaceae) is perhaps the loveliest species in the genus, and one of the prettiest in a family that is spread across the world. It occurs on stony banks and slopes with *Dipcadi serotinum* (p. 36). Early season in the Atlas Mountains of Morocco brings forth a diverse mixture of flowers from bulbs to shrubs and alpines. Highland macchie is populated with purple and yellow flowered *Polygala balansae*, abundant blue-green fans of the hardy palm *Chamaerops humilis* and turf peppered with various delightful *Narcissus*. Damp flushes and gulleys have the tall stems of *Linaria ventricosa* (Plantaginaceae) with fine-lined brownish flowers. Quite different in appearance and yet in the same family, the soft blue pom-poms of *Globularia alypum* colour cliffs and rocky macchie. It is widespread across most of the region and other western Mediterranean Basin species include *G. vulgaris* and spiny-leaved *G. spinosa*, all with similar flowers. Another rock-dweller in the same family is the charming localised endemic *Erinus thiabaudii*, which grows alongside saxifrages on limestone cliffs in the central Atlas near Afrourer. Also endemic is *Raffenaldia primuloides* (Brassicaceae), which colours turf among Atlantic cedar forests with flowery stemless rosettes alongside abundant *Romulea bulbocodium*. Equally short-stemmed are the dense flesh-pink flowered clumps of the bulb *Asphodelus acaulis* (Asphodelaceae) that pepper short turf in clearings among the cedars.