

A photograph of a lemur with white fur and a dark face, climbing a tree trunk. The background shows green foliage and a blue sky.

LIFE AMONGST THE THORNS

**Biodiversity & Conservation of
Madagascar's Spiny Forest**

Louise Jasper & Charlie Gardner
Foreword by Sir David Attenborough



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Front and back endpapers Stars wheel above a stunted and wrinkled baobab (*Adansonia rubrostipa*) known as the 'Grand-mère' in Tsimanampesotse National Park.

Page i Ring-tailed Lemurs (*Lemur catta*) climb to their nocturnal roost in Tsimanampesotse National Park.

Pages ii-iii A Chabert Vanga (*Leptopterus chabert*) nesting in the canopy of a *Pachypodium geayi*.

Pages iv-v A Verreaux's Sifaka (*Propithecus verreauxi*) feeding on the forest floor.

Pages vi-vii A variety of Spiny Forest plants and their spectacular flowers.

Pages viii-ix The Ihazoara River in the dry season. Spiny forest-thicket lines the cliffs, and is reflected in the river's many pools.

Opposite Standing's Day Geckos (*Phelsuma standingi*) bask in the afternoon sun on a twin-trunked baobab (*A. rubrostipa*).





Forest Cover and Major Features of the Spiny Forest Ecoregion



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Opposite Verreaux's Sifaka (*Propithecus verreauxi*) feed on the juicy leaves of the octopus tree (*Alfauaudia procera*), and amazingly are able to do so without injuring their hands or feet.

Foreword by Sir David Attenborough

The Spiny Forest of Madagascar is truly astonishing. Parts are dominated by swaying ten-metre tall vegetable pillars, studded with lines of tiny coin-shaped leaves alternating with others of ferocious thorns. They have an improbable, slightly crazy appearance to anyone unfamiliar with them, but the landscape they create becomes almost surreal when a pure-white furry animal that looks something like a monkey but is most emphatically not one, suddenly peers around one of these pillars to gaze at you with topaz eyes - and then leaps away, bouncing from pillar to pillar, its long white furry tail trailing behind it. Why it does not rip the soles of its feet and the palms of its hands to shreds, I still cannot understand.

Among the tangle of thorns there are, occasionally, huge trees. Some of these too seem to come from another world. They have immense bloated trunks within which they store water and each has its own very individual shape. This makes them valuable landmarks when you have got lost trying to find a way through the spiny tangled undergrowth.

The lemurs, for many, will be a major attraction of this amazing country and in addition to the white leapers there are several other species, some no bigger than rabbits, others as small as mice. As in most arid lands, there are numerous reptiles. Madagascar as a whole has more species of chameleon than anywhere else in the world and the spiny forest is particularly rich in these and other lizards. Spectacular tortoises, their shells handsomely patterned with yellow radiating stripes, plod across the red sandy ground. There are not many birds, the land is too hot and dry to support great numbers, but those you do spot are likely to include several species that are found nowhere else but in Madagascar.

Much of this strange forest has now been cut down and replaced by farmland, savannah and uniform rows of sisal plants, the leaves of which are used to produce industrial fibre. In some areas the uniform rows stretch in all directions as far as the eye can see. That makes the patches of spiny forest that have so far survived all the more precious. The authors of this book - one a photographer and the other a conservationist - have lived in and studied the Spiny Forest for nearly a decade and have come to know it intimately. The book they have produced will surely show to the world how extraordinary and unique this wonderland is and why it should be treasured.





Previous page Octopus trees (family *Didiereaceae*) dominate the Spiny Forest skyline.

Opposite Typical vegetation of the Spiny Forest ecoregion grows on the volcanic hills of Nord-Ifofaka Protected Area, not far from the rainforests of the Anosy Mountains.

Below The Ring-tailed Lemur (*Lemur catta*) is one of Madagascar's most famous and best-studied mammal species. It occurs throughout much of the Spiny Forest.

Madagascar – the Great Red Island – basks in the tropical sunshine of the Indian Ocean, some 450 km (278 miles) off the south-east coast of Africa. The fourth largest island in the world, it covers an area of 587,000 sq km (226,642 sq miles), roughly the size of France, and hosts the geological diversity of a small continent. A central high plateau runs the length of the country from north to south, with a steep escarpment fringing its eastern edge and gentler slopes to the west. This vast plateau strongly influences Madagascar's rainfall patterns: moist air currents coming off the Indian Ocean collide with the escarpment and release their moisture on the eastern slopes, giving rise to luxuriant rainforests. As the winds continue westwards, they release yet more moisture along the way, watering the central highlands. The air that finally reaches western Madagascar is largely drained of its humidity; it rustles the leaves of the dry, deciduous forests of the west and south, but provides little relief from the scorching sun. This rain shadow effect is most extreme along the south-west coast, which may receive less than 330 mm (13 in) of rain per year – ten times less than Toamasina in the east.¹

Madagascar's biodiversity is rich and unique: overall, an incredible 85 per cent of the island's species are found nowhere else. At the latest count, it is home to 11,031 native vascular plants, of which at least 82 per cent are endemic,² along with 170 species of non-flying mammal (100 per cent endemic), 300 amphibians (99 per cent), 405 reptiles (92 per cent) and 208 breeding birds (50 per cent).³ The total number of invertebrates is still unknown, but of the 5,800 species belonging to well-studied groups, such as beetles and butterflies, around 86 per cent are also endemic. Such figures are out of date almost as soon as they are calculated, as so many new species are being discovered and described every year. Indeed, between 1999 and 2010 an astonishing 615 new species were described, including 385 plants, 69 amphibians and 41 mammals.⁴ At the higher taxonomic levels of genus and family, the evolutionary uniqueness





Previous page Although it varies widely, the vegetation of the Spiny Forest is typified by the octopus trees (*Didierea* and *Alluaudia*) and coral-like *Euphorbia* trees. Ankodida Protected Area.

Opposite An array of Spiny Forest flowers, by row, top to bottom, left to right: *Oeceoclades decaryana*; *Colvillea racemosa*; *Cynanchum* sp.; *Adansonia rubrostipa*; *Alluaudiopsis marnieriana*; *Catharanthus* sp.; *Cordia mairei*; *Combretum grandidieri*; *Megistostegium microphyllum*; *Stereospermum nematocarpon*; *Didierea madagascariensis*; *Senna meridionalis*.

Below Coastal bushland along the Mikea coastline near Salaty, with stunted Silver Thicket (*Euphorbia stenoclada*) in the foreground.

For more than two centuries, botanists from around the globe have studied and catalogued Madagascar's diverse flora. As far back as 1890, Reverend Baron boldly claimed that 'the majority of the plants inhabiting the island are known to science', but his confidence was wildly misplaced. Just over 4,000 species of vascular plant were known at the time, but the count has since risen to an impressive 11,031 and the inventory is still far from complete. Estimates of the total plant richness are now in the region of 14,000 species.¹ The rate of species endemism is extremely high at 82 per cent, but the country's flora is also known for its unparalleled uniqueness at higher taxonomic levels: eight families and 310 genera are entirely endemic to Madagascar and the islands of the western Indian Ocean.²

The Spiny Forest's flora comprises at least 2,100 species, making it rather less diverse than the floras of the Humid Forest and Dry Forest ecoregions. However, an impressive 53 per cent of these plant species and eight full genera are restricted to the ecoregion,³ including the characteristic octopus trees (*Alluaudia* and *Didierea*) and the flamboyant coastal shrubs in the genus *Megistostegium*. This high rate of local endemism indicates that the vegetation of the Spiny Forest has been a distinct element of the island's flora for many millions of years, and there is evidence that suggests the spiny forest-thicket (the most extensive vegetation type in the ecoregion) may be the oldest surviving plant community in Madagascar.⁴

The Spiny Forest is widely recognized as a botanical wonderland, justly famous for its magnificent xerophytic (dry-adapted) plants, including the mighty baobabs (*Adansonia*), cactus-like octopus trees and a variety of succulent aloes (*Aloe*) and kalanchoes (*Kalanchoe*). These and many other groups form a range of visually distinctive habitats that inspire awe in even the most casual of visitors. As with the rest of Madagascar's native flora, the Spiny Forest harbours a mainly woody vegetation with relatively few herbaceous species; indeed, the





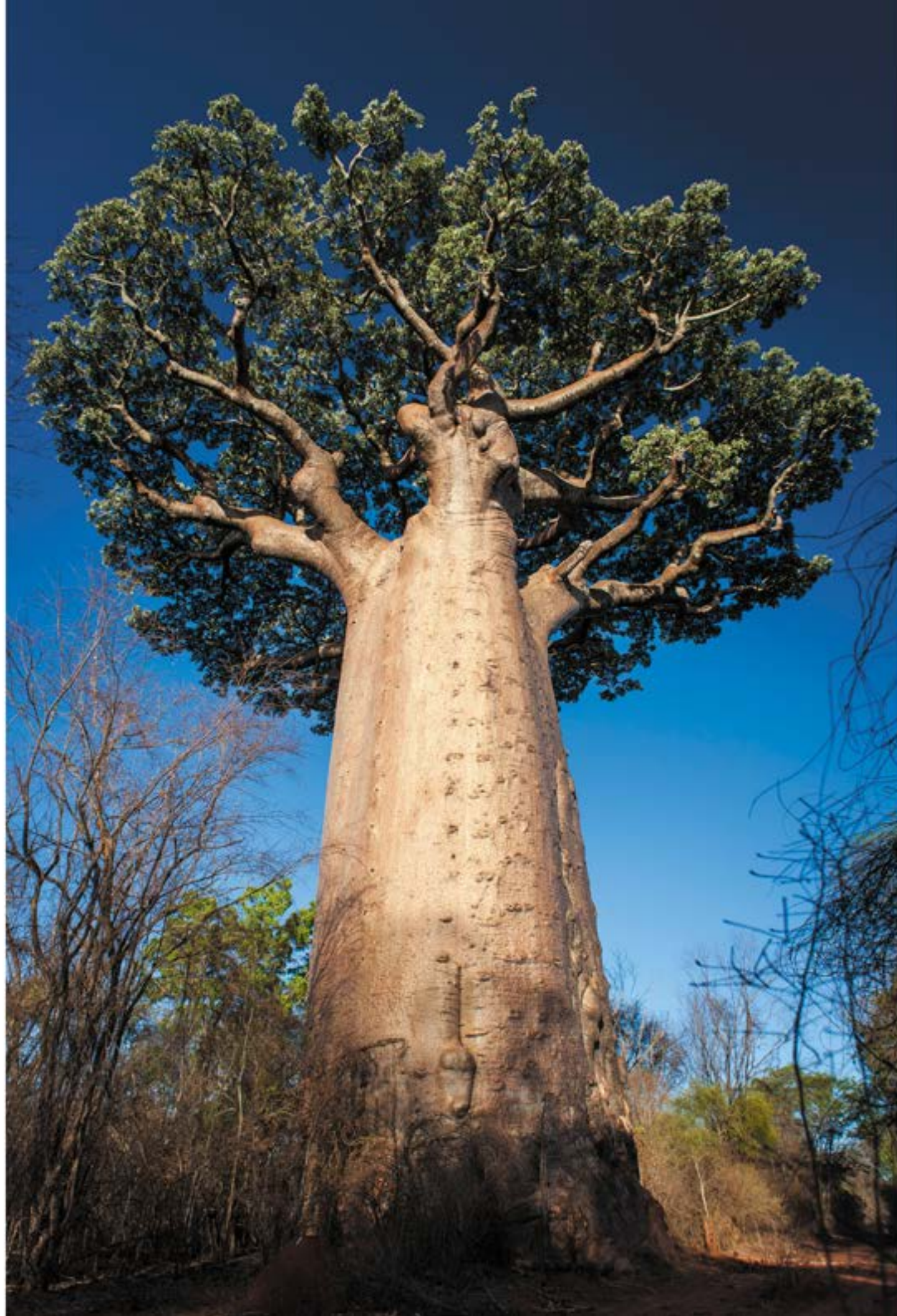


Above and opposite
 Granddier's Baobab
 (*Adansonia granddieri*)
 is Madagascar's tallest
 baobab species. In
 favourable conditions
 it grows straight and
 smooth, reaching up to
 30 m (98 ft) in height. In
 parts of the western Mikea
 Forest, where water is
 scarce and the limestone
 soils are thin, it rarely
 exceeds 6 m (20 ft) tall.

for example, grows tall, smooth and columnar in the wetter conditions north of Lake Ihotry. However, on the porous limestone pavements along the western edge of the Mikea Forest, just 35 km (22 miles) to the west, this same species rarely exceeds 6 m (20 ft) tall, and tends to have a stunted, gnarled and even grotesque growth form.¹⁵

Baobabs are unusual in that they store prodigious amounts of water in their over-sized trunks, yet appear to use very little of it during dry periods.¹⁶ In fact the water in baobab wood, in conjunction with the tree's thick, fibrous bark and huge girth, may help it to support its heavy crown of branches; if the tree were to draw too heavily from its water stores it might collapse under its own weight. At the very end of the dry season the baobab uses a tiny amount of stored water to produce new leaves so that it may take full advantage of the first significant rainfall.¹⁷ Other large bottle trees may also store water for structural support rather than for use during droughts, but more research is needed to confirm this.

Pachypodium (meaning 'thick foot') is an African genus of spiny and succulent trees, of which five of the island's 20 species occur in the Spiny Forest. *Pachypodium* contains a wide range of unusual growth forms, from small, ground-hugging, boulder-like plants to dwarf shrubs and tall, cigar-shaped trees. Four of the southern species belong in the latter category and have distinctive silver-white bark, of which the elegant *P. geayi* and *P. lamerii* are most widespread in the region.¹⁸



MAMMALS

Considering Madagascar's proximity to Africa, one might expect to see typical African mammals roaming its landscapes. However, the reality is quite different. Incredibly, all of Madagascar's 170 non-flying mammal species are unique to the island, and there are no giraffes, big cats or zebra to be seen. What's more, all these species belong to just four groups – tenrecs, lemurs, carnivorans and rodents – and each group colonized Madagascar just once. Successful mammal colonizations were evidently exceedingly rare over the course of the island's long isolation. Unhindered by competition from continental species, these few founders were free to proliferate into a wide variety of niches, giving rise to the astonishing diversity of mammals that populate Madagascar's forests today.







Above The Fossa
(*Cryptoprocta ferox*) has large teeth and powerful jaws, enabling it to feed on other mammals such as lemurs, Bush Pigs (*Potamochoerus larvatus*) and tenrecs.



Above Granddier's Vontsira (*Galidictis grandieri*) is endemic to the Spiny Forest, and is only known from the western edge of the Mahafaly Plateau.



Grandidier's Vontsira (*Galidictis grandidieri*) is endemic to Tsimanampesotse National Park, making it one of the most range-restricted carnivorans in the world. This species was only described in 1986, and until 1989 was only known from two museum specimens. Recent studies have shed some light on its habits and we now know that it is strictly nocturnal, mainly terrestrial, and enjoys a diet based on hissing cockroaches, grasshoppers and scorpions. Its powerful skull and large teeth, however, enable it to take larger prey on occasion, including tenrecs, rats, birds, snakes and iguanas.²² Local tales of this species hunting the flamingos that frequent the soda lake remain unverified.

Tenrecs Tenrecs (family Tenrecidae) are largely insectivorous mammals that lead secretive, usually nocturnal lives. Despite arriving in Madagascar long after the first lemur, tenrecs are descended from more ancient stock than the primates. Belonging to the Afrotheria (an early branch of the mammalian evolutionary tree that also produced elephants, sea cows and the Aardvark), tenrecs arose in Africa and spread to Madagascar between 42 and 25 million years ago.²³ Apart from the aquatic otter shrews (Potamogalinae), all African members of the Tenrecidae died out long ago, but Madagascar's thrived, diversifying in a spectacular adaptive radiation that resulted in 32 species. These are divided among three endemic subfamilies, the spiny tenrecs (Tenrecinae), the large-eared tenrecs (Geogalinae) and the furred tenrecs (Oryzorictinae).

Amongst these 32 species are some remarkable examples of convergent evolution. The Lesser Hedgehog Tenrec (*Echinops telfairi*) is covered in stiff spines and rolls up into a tight, prickly ball when threatened by predators, but is far more closely related to elephants than it is to hedgehogs. Spiny tenrecs and hedgehogs independently adopted the same effective anti-predator solution and evolved to resemble each other closely. There is an otter-like tenrec (*Limnogale mergulus*), which has evolved webbed feet and a keeled tail in order to hunt aquatic invertebrates, as well as several mole tenrecs adapted to a burrowing lifestyle, with short limbs, spade-like feet, and reduced eyes and ears.

The Spiny Forest is home to seven species of tenrec: the Common Tenrec (*Tenrec ecaudatus*), Greater (*Setifer setosus*) and Lesser Hedgehog Tenrecs, Large-eared Tenrec (*Geogale aurita*), Short-tailed Shrew Tenrec (*Microgale brevicaudata*) and the recently described Jenkins' (*M. jenkinsae*) and Grandidier's (*M. grandidieri*) Shrew Tenrecs. The Common Tenrec and Greater Hedgehog Tenrec are both widespread, occurring in a variety of habitats across the island, while the Short-tailed Shrew Tenrec is found from the Mikea forest in the south to rainforests of the north-east. The other four species are restricted to the country's dry regions, including the Spiny Forest.

The Lesser Hedgehog Tenrec is a medium-sized species, weighing about 140 g (5 oz); it forages for insects and fruits in dense vegetation both on the ground and in branches, where it is a surprisingly agile climber. When food is scarce, as it often is during the dry season, it will find a tree hole or other suitable nook in which to hibernate for up to five months. The Lesser Hedgehog Tenrec has a lower metabolic rate than one would expect for a mammal of its size, and is unusual among placental mammals in that it does not maintain a constant body temperature while active: like a reptile, its body warms up during the day as the air temperature rises and cools down again at night. These adaptations, along with the adoption of protective spines instead of insulating fur, may permit a slower, more energy-efficient lifestyle in the harsh and unpredictable Spiny Forest climate.²⁴

Opposite The Lesser Hedgehog Tenrec (*Echinops telfairi*) is a slow-moving creature that rolls into a tight, spiny ball when it feels threatened. It is, however, unrelated to the true hedgehogs of Africa and Eurasia.



tell, Madagascar has not suffered a recent mass extinction amongst the birds, and has lost just 20 species over the last 20,000 years and a further two (the Snail-eating Coua *Coua delalandei* and Alaotra Grebe *Tachybaptus rufolavatus*) in historical times. Thus, the island's impoverished bird fauna remains one of its biogeographical oddities.⁶

Species diversity within many of the island's endemic genera is surprisingly low, and the majority are monospecific, i.e. containing only one species each. Likewise, there is low species diversity within the more ancient endemic families, although the two younger ones – Vangidae and Bernieridae – represent the island's largest avian radiations.⁷ Of the two, the Vangidae is most diverse in terms of species (21 species spread widely across 15 genera), form, size and colouration, and forms a radiation even more impressive than that of the celebrated Hawaiian honeycreepers.⁸ The vangas possess a spectacular range of bill shapes, reflecting their varied diets and foraging strategies: several have sturdy, shrike-like bills with flesh-tearing hooks, but others have long, curved probes, hefty, laterally flattened bills like pliers, thin, warbler-like beaks and even a massive blue casque.⁹

With 127 breeding birds, the Spiny Forest harbours fewer bird species than the Humid and Dry ecoregions of Madagascar, but what really sets it apart are the ten Spiny Forest specialists, eight of which belong to endemic families or subfamilies. This high level of local endemism led to Birdlife International's classification of the ecoregion as an Endemic Bird Area (EBA). In fact the Mikea Forest has been described as the highest priority site in Africa (and one of the highest in the world) for bird conservation as it is home to two species – the Subdesert Mesite (*Monias benschi*) and Long-tailed Ground-roller (*Uratelornis chimaera*) – that not only have

Opposite These six species of vanga show the range of different bill-shapes present in the Spiny Forest. By row, top to bottom, left to right: Sickie-billed Vanga (*Falculea palliata*), Lafresnaye's Vanga (*Xenopirostris xenopirostris*), Red-tailed Vanga (*Callicolus madagascariensis*), Chabert Vanga (*Leptopterus chaberti*), Hook-billed Vanga (*Vanga curvirostris*), Archbold's Newtonia (*Newtonia archboldi*).

Below The colourful Running Coua (*Coua cursor*) is one of two coua species endemic to the Spiny Forest.







Opposite The Madagascar Buzzard (*Buteo brachypterus*) is relatively short-winged and small compared with other buzzards, enabling it to hunt in the forest canopy.

Above The Madagascar Harrier-hawk (*Polyboroides radiatus*) uses its long, double-jointed legs to extract prey from deep within tree holes and other crevices.



Above The Grey Heron (*Ardea cinerea*) feeds in shallow fresh- and salt-water wetlands, and frequents offshore islands such as Nosy Ve.

Opposite The Madagascar Plover (*Charadrius thoracicus*) is a rare endemic wader, restricted to the short, sparse vegetation around lakes and salt pans in the west and south of the island.

Wetland Birds

The climate of southern Madagascar has become increasingly arid over the last few thousand years, causing the disappearance of large freshwater wetlands and, consequently, many of the plants and animals that depended on them. Excavations at several subfossil deposits in the Spiny Forest have revealed the remains of numerous species of wetland bird that are now either extinct (such as an endemic lapwing *Vanellus madagascariensis*) or absent from the region (e.g. Meller's Duck *Anas melleri*).²⁵ Today the largest remaining lakes have a high mineral content and only three rivers usually flow throughout the year. Despite the relative scarcity of wetland habitats in the Spiny Forest, around three-quarters of the island's water bird species occur here, including five regularly occurring endemics: Humblot's Heron (*Ardea humbloti*), Madagascar Plover (*Charadrius thoracicus*), Bernier's Teal (*Anas bernieri*), Madagascar Jacana (*Actophilornis albinucha*) and Madagascar Grebe (*Tachybaptus pelzelni*). Of the five, only the two former species are often recorded south of Lake Ihotry.²⁶

The Spiny Forest is home to all 12 species of heron that occur on the island, of which the largest is Humblot's Heron. It has a massive bill, which it uses to feed on fish and crustaceans in a variety of shallow freshwater and coastal wetlands. Few breeding sites are known, and it may be suffering from the combined effects of habitat degradation, loss of nesting trees



Previous page Standing's Day Gecko (*Phelsuma standingi*) is regularly found on mature baobabs throughout the region. This striking juvenile is basking on a large *Adansonia* za.

Opposite The long limbs and toes of the Three-eyed Iguana (*Chalarodon madagascariensis*) are adaptations for running across the region's loose sands.

Below The Giant Hog-nosed Snake (*Leioheterodon madagascariensis*) is widely feared but, like all of Madagascar's snakes, poses no threat to people.

Madagascar's reptile fauna is exceptionally diverse, comprising more than 400 species (92 per cent endemic) from 13 families, and this total is continually growing as new species are discovered and described.¹ The origins of this diverse fauna are varied, and provide some insight into the history of Madagascar as an island continent. Broadly speaking, the terrestrial reptiles can be divided into three groups. First there are the recent colonizers, species that have been in Madagascar for only a short time in geological terms, and thus haven't evolved into endemic forms. These include the Nile Crocodile (*Crocodylus niloticus*), two species of freshwater turtle, the Snake-eyed Skink (*Cryptoblepharus boutonii*), and several species of house gecko that may have been introduced by man. Second is a suite of lineages of largely African origin, the ancestors of which arrived at various times over the last 70 million years and subsequently radiated into a rich assemblage of endemic groups, such as the tortoises, chameleons, plated lizards, and many of the skinks, snakes and geckos. The third group contains the Side-necked Turtle (*Erymnochelys madagascariensis*) and the Malagasy iguanas, whose existence on the island has long puzzled scientists because their closest living relatives occur in South America, rather than Africa or Asia. Research now suggests that these species are probably relicts from a time when Madagascar and South America were connected by Antarctica.²

All but two of the island's reptile families occur in the Spiny Forest, from which 88 species have been recorded (as well as a number of additional distinct forms that await formal description). Eighty-one of them are endemic to Madagascar, and almost a third (27 species) are entirely endemic to the ecoregion. They comprise three major lineages: the crocodiles with one species, the tortoises and turtles with four species, and the lizards and snakes (or squamates), which contain at least 83 species in 37 genera.





Opposite The Radiated Tortoise (*Astrochelys radiata*) once occurred across most of southern Madagascar but has now become extinct through much of its former range due to centuries of exploitation for food and, more recently, the pet trade.

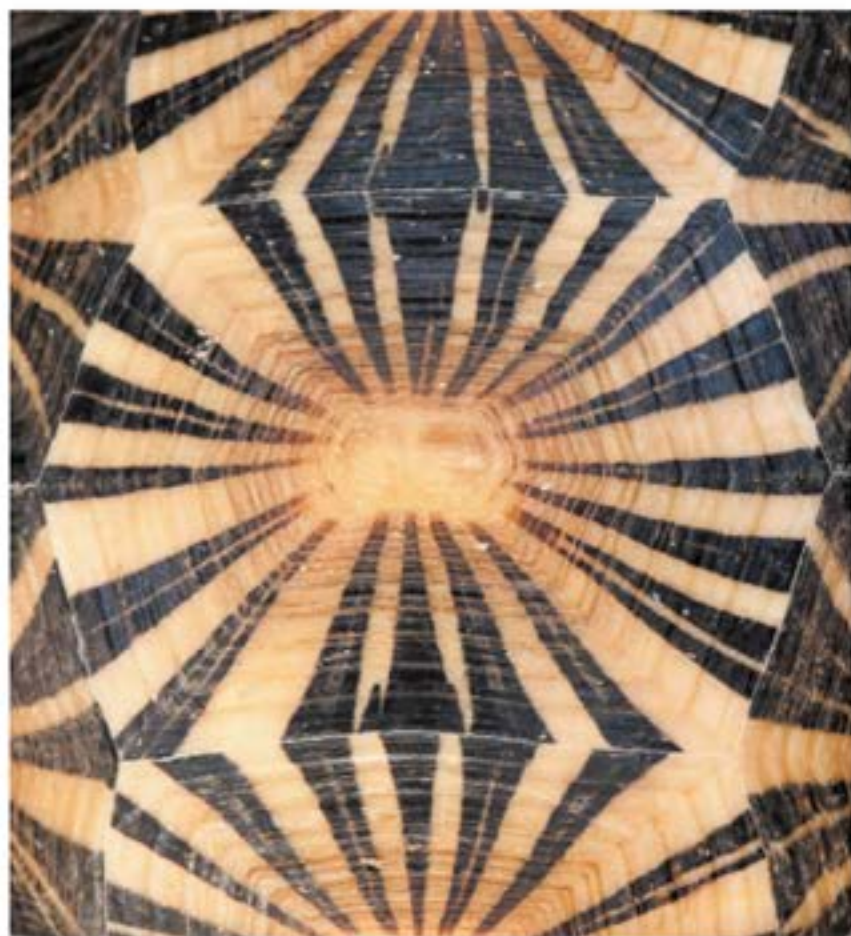
Below Named after its shell pattern, the Radiated Tortoise (*Astrochelys radiata*) is considered to be one of the world's most beautiful tortoise species.

and forelegs within its shell. Since the southernmost subspecies (*P. a. oblonga*) has the most flexible hinge and the northernmost (*P. a. bryggooi*) has a rigid plastron, this hinge flexibility may be an adaptation to help reduce water loss in the arid conditions of the south. The Spider Tortoise provides a fascinating example of evolutionary processes and appears to illustrate a case of speciation (the process whereby one species diverges into two) being thrown into reverse. The Fiherenana and Linta Rivers were previously believed to constitute dispersal barriers between the three subspecies' populations, forcing them to evolve in isolation. However, recent field surveys have revealed the existence of two populations of hybrids between the three subspecies. It is thought that, with increasingly arid conditions in the south-west, these rivers are dry for longer periods each year, so no longer function as effective barriers, thereby allowing re-establishment of gene flow between these previously separate tortoise populations.⁶

The Radiated Tortoise is much larger than the Spider Tortoise, weighing up to 13 kg (29 lb), and is one of the longest lived vertebrates known to man; one individual was taken from Madagascar and given to the Queen of Tonga by Captain Cook in 1777, and was thought to be at least 188 years old when it died. Although it primarily eats grass, the Radiated Tortoise is an opportunistic feeder and consumes a wide range of plant and animal matter. Items as diverse as snail shells, fish bones, dog and cattle faeces, and even the dried carcasses of goats and cats have all been recorded in their diet, and are probably ingested as a source

of protein, calcium and other nutrients. It is considered *faly* (taboo, *fady* in official Malagasy) by the Tandroy and Mahafaly people, who never eat it, but its large size makes it an important food item for people elsewhere. The tortoise is a delicacy for a growing number of urban dwellers who eat it during celebrations such as Christmas, Easter and Independence Day (see chapter 8, People and the Spiny Forest).⁷

The ecoregion also harbours two species of freshwater turtle, the African Helmeted Turtle (*Pelomedusa subrufa*) and Yellow-bellied Mud Turtle (*Pelusios castanoides*), which are both widespread through much of Africa, and have only colonized Madagascar relatively recently. These turtles avoid fast flowing waters and the deeper parts of lakes, preferring to inhabit a range of permanent and ephemeral wetlands, including rice paddies, where they forage along the muddy bottom. Both are dormant during the dry months, leaving the water to bury themselves in the leaf litter of the forest floor from June until the return of the rains seven or eight months later.⁸





Opposite The Carpet Chameleon (*Furcifer lateralis*) was long considered a single (though variable) species, but recent research has shown that it is actually composed of three distinct species. Populations in the Spiny Forest are now known as the Southern Carpet Chameleon (*Furcifer major*)

Only seven species of chameleon occur in the Spiny Forest, but they include the world's largest and rarest species, as well as one with a globally unique life cycle. They also include a single member of the dwarf or leaf chameleons (genus *Brookesia*), which do not closely resemble 'typical' chameleons, being adapted to life on the forest floor amongst the leaf litter. Although *Brookesia* is a very diverse genus in eastern and northern Madagascar, Brygoo's Leaf Chameleon (*B. brygooi*) is the only species found in the Spiny Forest, where it occurs in the gallery forests of the Manombo, Fiherenana and Onilahy valleys.¹⁵

Three of the six species of *Furcifer* chameleon present in the region are very widespread and occur across a range of habitats, while the remaining three species are extreme habitat specialists restricted to small areas. The Warty Chameleon (*F. verrucosus*) is a very adaptable species found across much of the region, being widespread in forests as well as other environments: it has been observed in reedbeds at Lake Ranobe and, like the Southern Carpet Chameleon (*F. major*), is common in the regional capital Toliara. The world's largest chameleon, Oustalet's Chameleon (*F. oustaleti*) seems to have a preference for gallery forests within southern Madagascar, and is rarely seen far from rivers.¹⁶

The Belalanda Chameleon (*F. belalandaensis*) is almost certainly the world's rarest chameleon species, with a population numbering just a few individuals restricted to three villages north of Toliara. It is thought to be a canopy-dwelling species, but the lower Fiherenana River valley from where it originates has been almost entirely deforested, leaving it clinging on for survival in the last few big trees in the area. The Antimena Chameleon (*F. antimena*) is also restricted to a very small range, occurring in the Mikea subregion between the Mangoky and Fiherenana Rivers.¹⁷

Below The annual life cycle of Labord's Chameleon (*Furcifer labordi*), which for eight months of the year exists only as eggs underground, is unique among four-legged animals.





AMPHIBIANS

With their permeable skin and moist, shell-less eggs, amphibians can only survive in damp areas and tend to be most diverse in tropical rainforests and wetlands. It is therefore no surprise that frog diversity is relatively low in the dry Spiny Forest, but even here they can be abundant during the rainy season. Several resilient species have found ways to survive the dryness and eke out an existence in this challenging environment; some stay close to reliable watercourses, others emerge only at night when temperatures are cool, and a hardy few bury themselves underground, where they lie dormant through the long dry season.



Opposite Elephant birds laid the largest eggs of any animal that has ever lived.

Below Many Spiny Forest plants, such as *Operculicarya hyphaenoides*, have zigzagging branches that would have resisted browsing by elephant birds (*Aepyornis* sp.).

responsible for their disappearance. The largest animals would have provided an attractive food source for the growing human population, and, lacking many natural predators, may have been quite easy to catch. Like other large-bodied animals alive today, the extinct species probably also reproduced slowly, making them particularly vulnerable to the impacts of over-exploitation. Climate change was also an important factor: in the south, the last few thousand years have seen a gradual drying of the climate, reducing the extent of wetlands and changing the composition of the vegetation. The combination of hunting, climate change, and the transformation of the landscape by fire and the grazing of cattle probably caused the gradual decline of all these species until, one by one, they disappeared.⁶ Several species, including a giant tortoise (*Aldabrachelys*) and the large koala-like lemur *Megaladapis edwardsi*, may have survived into the period of European colonization (16th century onwards), and it seems that the impenetrable Spiny Forest was the last refuge for many.⁷

What did the Spiny Forest look like during the time of the giants? We will never know for sure, but it was probably very different from the low, dense forest-thicket we see today. For one thing the climate was more humid, and the south-west coast would have been dotted with lakes and wetlands teeming with hippos and wetland birds.⁸ Large grazing and browsing animals were abundant, and must have exerted a heavy grazing pressure on the vegetation, thereby maintaining an open woodland habitat rather than the dense thickets that now characterize the region. The giant tortoises, in particular, probably occurred in vast numbers that would have kept the fuel load down and consequently helped to suppress fires.⁹ Many Spiny Forest plants have anachronistic defences against browsing by elephant birds or other large herbivores, such as zigzag-shaped twigs that extend when pulled but do not snap, or the spines that give the region its name.¹⁰ Other plants may have had symbiotic relationships with now-extinct species, relying on them for seed dispersal or pollination. For example, it is thought that the barbed fruits of *Uncarina* evolved to disperse by hooking the feet of elephant birds or large mammals as they trampled through the vegetation, while fruit-eating giant tortoises and lemurs would have helped to disperse and germinate the seeds of baobabs and other trees.¹¹

Although the complex drivers of Madagascar's past environmental changes are only now becoming apparent, what is clear is that human impacts in the last few decades have been particularly severe. Understanding the ways in which people interact with nature in today's world is essential if we are to ensure the conservation of the Spiny Forest, since the ecosystems of southern Madagascar are under ever increasing pressure.





PEOPLE AND THE SPINY FOREST

Although wild, even the most inaccessible parts of the Spiny Forest are not wilderness. Shaped by the hands of people for hundreds of years, the forests we see today form a lived-in landscape, as important to human communities as they are to the plants and animals that depend on them. Wild yams, for example, are an important source of food from the forest, and in some places provide the only supply of water through the long months of the dry season. They are almost never cultivated, but these tubers help people eke out a living in this harsh environment. Unfortunately, few forest uses are as benign as yam collection, and the Spiny Forest's habitats are now threatened as never before.







causing severe floods that destroy riverside villages and fields and wash the season's produce out to sea.³² The rise of rural banditry and cattle rustling makes herding a risky lifestyle,³³ while the degradation of the marine environment means that even fishing is no longer as productive as it was in recent times. Southern Madagascar's environment is less and less able to support its rapidly growing human population.³⁴ Furthermore, people are increasingly being pulled into the global cash economy, acquiring tastes for modern consumer goods whether or not they can afford them. Quite simply, the old ways of life are no longer sufficient in a rapidly changing world.

The traditional response to failing livelihoods is to leave home in search of new opportunities. Migrating to 'land where there is space' where one can settle, put down roots and provide for one's descendants is a strategy long adopted by people across the island, perhaps unsurprisingly since the first Malagasy were themselves, by definition, migrants.³⁵ While today many migrants head to the big city in search of work, it is the forest frontier that remains the most attractive destination; a place where land is free and seemingly limitless, where forests can be converted into golden maize, and maize sold to invest in real wealth – Zebu cattle.³⁶ In areas with good transport links, charcoal production is a growing sector that also presents new opportunities to transform trees into cash.

Opposite In southern Madagascar women have more than six children each on average, and overall the country has one of the highest population growth rates in the world. As essential natural resources continue to disappear, today's children face an uncertain future.

Below A changing climate means farmers struggle to predict when the rains will come, leaving them vulnerable to crop failures and increasing their reliance on the forest 'safety net'.











Opposite Rural communities can benefit from external support and training to help them effectively manage their natural resources. For example, the bird conservation NGO Asity helped the people of Andombiry to organize the tourist interest in their village's sacred baobab (*Adansonia grandidieri*).

Below Community-based management involves much discussion to reach agreement on shared objectives.

The second phase of the NEAP sought to solve this problem by granting rural communities the authority to manage the land they lived on. If rural people had legal authority to benefit from the forest, went the theory, then they would have an incentive to manage it sustainably and continue receiving those benefits in the future. Not only that, but they would have the power to stop outsiders from using their forests unsustainably, if they didn't want them to. Community-based natural-resource management, as this new type of conservation was known, had been increasingly practised in Africa since the 1980s and became a major focus of conservation efforts in Madagascar from 1996, when a law was passed allowing the transfer of management authority over communal lands from the State to an association of local-community members in the form of a time-bound, renewable contract.⁴¹ Hundreds of management transfers have now been established across the country, for the first time giving rural people some legal authority to manage their land and resources. They have not always been very successful, either in conserving forests or improving the economic situation of the communities involved, but there have been some notable triumphs that hint at the potential of the approach. In the Onilahy Valley, for example, local communities have been empowered by their management transfer to prevent migrant sapphire miners from destroying the sacred forest around Sept Lacs (see Case Study 1).⁴²







Above The global importance of Madagascar's biodiversity, like the iconic Ring-tailed Lemur (*Lemur catta*), spurred the government to massively expand its protected area system in 2003.

The 'Durban Vision'

By the dawn of the new millennium the protected area network had grown to 47 sites, covering a total of 1.7 million ha (4.2 million acres) – about 3 per cent of the country's land area. They were divided between the three types of protected area created during the colonial period (strict nature reserve, national park and special reserve),¹³ which differ slightly in their management objectives and approaches but are all 'strict' protected areas intended to conserve biodiversity first and foremost, with the secondary objectives of recreation (in national parks) and scientific research. Accordingly, national law forbade the extraction of natural resources (although there were some exemptions for local use in some sites), and neighbouring communities received little direct benefit from their existence.¹⁴

At this time, Spiny Forest habitats remained massively under-represented within the national protected area network. Only four areas of forest received any formal protection (Tsimanampesotse, Cap Sainte Marie, Beza Mahafaly and Andohahela), but they were too small and scattered to provide much of a buffer against ongoing deforestation, and many of the region's unique species remained completely unrepresented. The creation of new protected areas was seen as a critical priority if the Spiny Forest's biodiversity was to be effectively conserved, so WWF implemented a multi-disciplinary research programme to identify the most important sites and develop a plan for their protection.¹⁵ The opportunity to put this ambitious plan into action arose during a groundbreaking event in 2003.

Opposite Until 2003 only a tiny proportion of the Spiny Forest was officially protected, at just four sites: Tsimanampesotse National Park and three smaller patches at Cap Sainte Marie (top), Beza Mahafaly (centre) and Andohahela (bottom).





Above Members of the women's association of Marolinta dance to raise awareness and donations at the celebrations for World Environment Day.

In order to meet these ambitious goals, most of the new multiple-use sites permit subsistence activities such as livestock grazing, firewood collection and the harvesting of various forest products. These are managed according to a zoning plan, designed to ensure that local communities can meet their needs while minimizing any negative impacts their activities may have on biodiversity. However, even low levels of forest use can affect biodiversity so strategically placed conservation zones dot these landscapes, ensuring that the most important areas remain untouched by any extractive activity. Although largely initiated by conservation organizations, most new protected areas are governed by complex co-management structures that bring together local community associations, NGOs and regional authorities. In this way the interests of all parties can be advanced and protected landscapes that suit the needs of all stakeholders can be designed. Such consensus is essential if these protected areas are to endure in the long term.²²

The establishment of these new protected areas is ongoing, delayed by the political crisis that engulfed Madagascar in 2009. As we write, in 2014, the Durban Vision has been in operation for over a decade and has enjoyed some enormous successes. Dozens of new



protected areas have already been legally established, and nine of the existing national parks have also been significantly extended, bringing the total coverage to more than 7 million ha (17 million acres).²³ Within the Spiny Forest, coverage has increased from under 60,000 ha (148,263 acres) in 2003 to around 1.2 million ha (3 million acres) today.²⁴ This includes six new, multiple-use protected areas (Amoron'i Onilahy, Ankodida, Mangoky-Ihotry Complex, Nord-Ifotaka, Ranobe-PK32 and Tsinjoriake), one new National Park (Mikea) and significant extensions to three Madagascar National Parks sites: Beza Mahafaly, Cap Sainte Marie and Tsimanampesotse. Projects at several other sites are ongoing, and may lead to the creation of additional new protected areas in the future (see chapter 10, Protected Areas).

Managing the landscape

Since 2003 the extension of protected areas has been the main focus of conservationists in the Spiny Forest and throughout Madagascar. It has been an enormous, complex challenge, and will continue to be so for years to come. Managing these sites means much more than just drawing lines on a map, because a protected area that exists only on paper has no chance

Above Many forest areas feature prominently in local culture and have long, fascinating histories, as recounted by Manjovala, an ombiasa that lives by Nord-Ifotaka Protected Area. The objectives of Madagascar's new protected areas reflect this, and include the conservation of the country's rich cultural heritage.

Opposite top and bottom Jean-Claude, the former president of the local management association, at Sept Lacs. He and his community have helped protect this sacred site for decades.

Below The discovery of sapphires near Sept Lacs led to a huge influx of migrant miners, but the local community was able to keep them out of its sacred forest.

Case Study 1: Community Management at Sept Lacs

As it winds southwards through the hot, dry expanses of the Belomotse Plateau, a narrow stream of crystal-clear water spills over a series of cascades before joining with the Onilahy River. Known as Sept Lacs (seven lakes), this beautiful, tranquil spot was a popular tourist destination in colonial times but was cut off from the rest of the world when the road was washed away several years ago, and today receives few visitors. Harboring spirits deep within its waters and a mythical eel said to be larger than a man, it has long been sacred to the people of Ifanato and other nearby villages.

As part of a nationwide trend to decentralize management of natural resources, Ifanato was one of the first communities in the Spiny Forest to benefit from a management transfer when a community association called *Mahavita Azy* signed a contract in 2001. The villagers of Ifanato had few problems enforcing the rules of the contract – fear of the ancestors was

already an effective deterrent – but the community's resolve was tested in 2004 when sapphires were discovered and migrant miners started to arrive from all over the country. Within two years, the population had swelled from around 280 to as many as 18,000 people. Elsewhere, such rushes tend to bring anarchy in their wake, with local social norms overwhelmed by the sheer volume of newcomers, but Ifanato was different. Somehow the villagers were able to exert their authority, successfully keeping miners out of Sept Lacs and a sacred forest housing their ancestral tombs; they were even able to impose a rent system on the miners digging on their lands, a situation unheard of elsewhere. The experience of administering the Sept Lacs management transfer was pivotal in helping the villagers of Ifanato to organize themselves and impose their authority on the settlers, while the legal rights granted them by the contract gave them the confidence to do so.³³

Today the sapphire rush has subsided and only a few hundred miners remain, but shifting cultivation has devastated much of the forest on the Belomotse Plateau, leaving behind vast expanses of barren limestone. Amongst all this destruction Sept Lacs remains untouched, a wonderfully clear example of the power and potential of community-based conservation.





PROTECTED AREAS

Protected areas conserve many of the Spiny Forest's most beautiful and threatened wild places. From traditional National Parks to new community-managed sites, they form the foundation of conservation actions in the region and constitute a source of pride for Madagascar. They also provide a variety of attractions for visitors to the country's spectacular south.

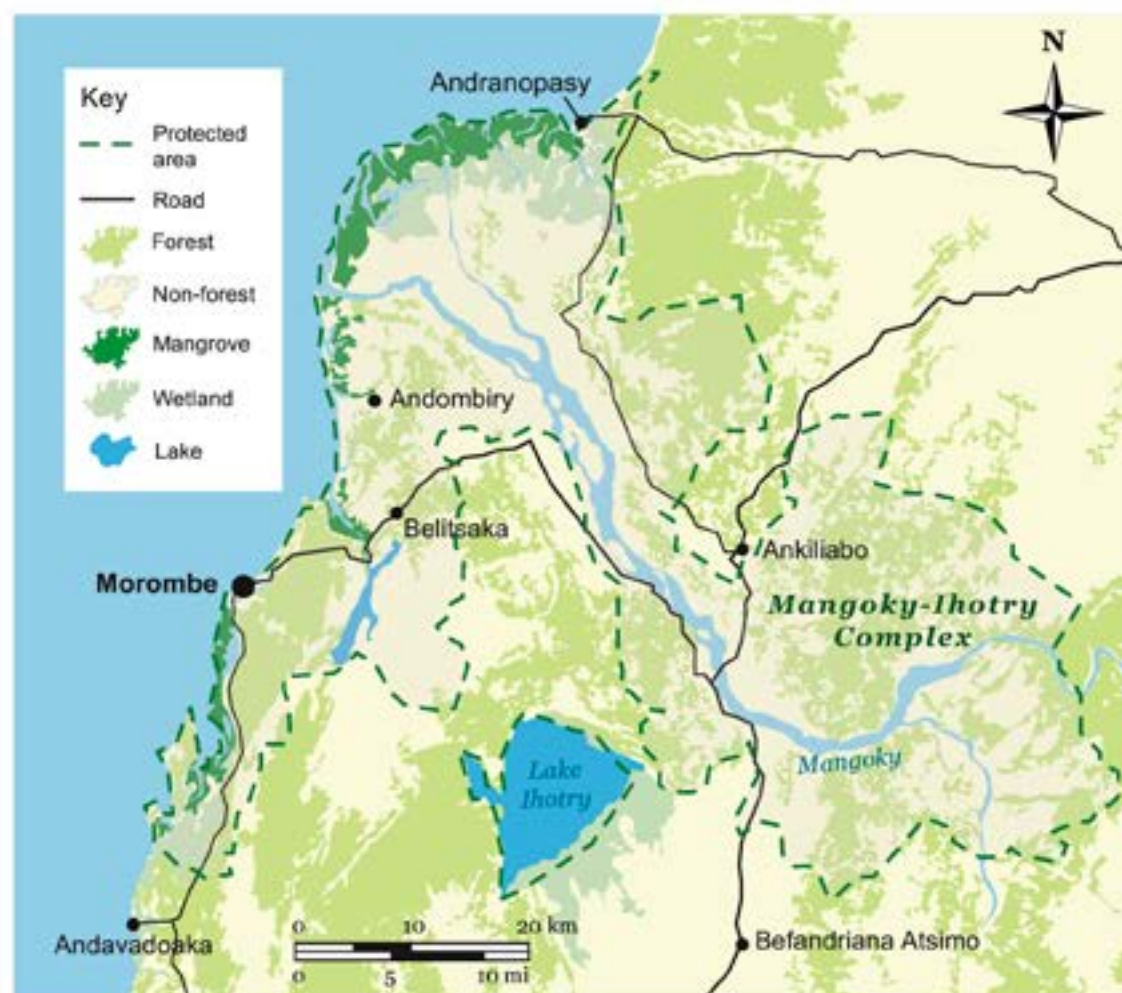




MANGOKY-IHOTRY

The great Mangoky River marks the boundary between the southern Spiny Forest and the western Dry Deciduous Forest ecoregions. Spanning this divide, the Mangoky-Ihotry Complex protects the river and surrounding wetlands, transitional forests and mangroves, as well as the island's third largest lake, Ihotry.





Mangoky-Ihotry at a glance

Size (ha): 408,539
(1,009,521 acres)

Date established:
awaiting definitive
protection

Governance type:
co-managed by
Asity and local
communities

Important habitats:
transitional spiny
forest-thicket, dry
deciduous forest,
gallery forest,
freshwater and
brackish wetlands,
mangroves

Tourist infrastructure:
under development

Key attractions:
birdwatching,
impressive baobabs,
boat tours at Lake
Ihotry/mangroves

Key species:
Granddier's
Baobab, Humblot's
Heron, Bernier's
Teal, Madagascar
Fish Eagle,
Madagascar Plover

Main threats:
unsustainable
fishing, shifting
cultivation, selective
logging, siltation

Covering more than 400,000 ha (1,000,000 acres), Mangoky-Ihotry Complex is the largest new protected area in southern Madagascar and straddles the divide between the Dry and Spiny ecoregions.²⁷ This ambitious project encompasses Lake Ihotry and a large portion of the Mangoky watershed, including the largest mangrove system in the region as well as the northern stretches of the Mikea Forest (comprising transitional spiny forest-thicket and western dry deciduous forest). The area supports a large human population, much of which is concentrated around the rice paddies of the lower Mangoky valley and southern Lake Ihotry, though many people also rely on harvesting local wetland resources such as fish, crab, shrimp and reeds.

Although it is a permanent lake, Ihotry is a highly dynamic ecosystem. Its extent varies dramatically from season to season, reaching up to 94 sq km (36 sq miles) after the rains, but often shrinking to a tenth of this size during the dry months. Climatic extremes have triggered even greater variation in water level in recent years: heavy rains in 2000 caused the lake to burst its banks, killing off areas of spiny forest-thicket, though it nearly dried up completely in 2012 following a severe drought. This caused large expanses of reedbed to die back and all but one fish species to disappear, but when cyclone Haruna hit in February 2013 the lake filled up again almost overnight. Reductions in the populations of the lake's various introduced fish species can have severe impacts on the fishing villages and aquatic birds that depend on them.

Opposite The Mangoky Delta is the largest mangrove system in southern Madagascar.

TSINJORIAKE

Meaning 'view of the sea', Tsinjoriake protects a dramatic coastal limestone plateau known for its dwarf vegetation, and as the site from which the Red-shouldered Vanga was described in 1997. It also boasts one of the most beautiful natural swimming pools in the whole region, the sea cave at Sarodrano.





Tsinjoriake at a glance

Size (ha): 5,855
(14,468 acres)

Date established:
awaiting definitive protection

Governance type:
co-managed
by Association
TAMIA and local
authorities (with
support from GIZ)

Important habitats:
limestone thicket,
coastal bushland,
mangroves

Tourist infrastructure:
several short circuits
are managed by
Association TAMIA

Key attractions:
natural swimming
pool at Sarodrano,
medicinal plant walk
at Andatabo and Barn
Hill, lemur watching,
birdwatching,
mangrove boat trip

Key species:
Red-shouldered
Vanga, Verreaux's
Coua, Ring-tailed
Lemur, *Oplurus
ferinensis*

Main threats:
selective logging, fire,
harvest of endemic
succulent plants

The distinctive flat-topped hill of Andatabo (also known as La Table) is the Spiny Forest's own miniature Table Mountain, greeting visitors to Toliara as they arrive by road or air. This hill marks the northern end of the dramatic Belomotse Plateau, which stretches south along the coast to the town of Saint Augustin at the mouth of the Onilahy River and forms the backbone of Tsinjoriake. The protected area also includes Sarodrano, a curved sand spit that harbours shifting dunes, a lush mangrove forest and a sizeable Vezo fishing village.

With its porous, infertile limestone soils and exposure to the strong, southerly winds, the plateau supports a stunted thicket rich in xerophytic plants – it rarely reaches 3 m (10 ft) in height, and in many places barely reaches as high as one's waist. The area is one of eight priority sites in Madagascar for the conservation of succulent plants:⁵¹ it hosts a locally endemic subspecies of aloe (*Aloe descoingsii* subsp. *augustina*) that shrivels up almost entirely during the dry season, and also encompasses much of the known global range of two dwarf bottle trees, *Delonix pumila* and *Operculicarya pachypus*.⁵² The protected area also includes several mangrove forests, sustained by freshwater upwellings that rise near the base of the plateau as it meets the sea.

Tsinjoriake is relatively rich in wildlife despite the lack of fresh water through much of its area. It shelters several troops of Ring-tailed Lemur that roost in caves on the plateau but often come down to the mangroves during the day: these are the only Ring-tailed Lemur troops known to use mangroves, though whether they feed there or just drink the freshwater seeping from the ground is not yet known. The Madagascar Flying Fox also visits the mangroves,

Opposite The Sarodrano sea-cave shelters an idyllic pool, fed by a subterranean freshwater stream and an inlet from the sea.





feeding on the night-blooming flowers of the mangrove apple, while the sea-caves around Sarodrano and St Augustin shelter as many as 11 species of small, insectivorous bat. With two further bat species roosting in nearby villages, Tsinjoriake is one of the most important areas for bat conservation in the Spiny Forest.⁵³

The 77 bird species recorded within the protected area include a number of coastal species such as Humblot's Heron and the Greater and Lesser Flamingos, which frequent the mouth of the Onilahy River and the mangroves of Sarodrano. Seven of the ecoregion's ten locally endemic species also occur, including Verreaux's Coua and the Red-shouldered Vanga, which was famously described from the area around Andatabo as recently as 1997.⁵⁴ Over 30 species of reptile have been recorded in the protected area, including both the region's tortoises and several rare, locally-endemic species such as *Oplurus fierinensis* and *Phelsuma breviceps*.⁵⁵

Tsinjoriake also includes a number of culturally important sites, such as the Christian shrine on the summit of Andatabo, and the sacred sea cave at Sarodrano that is a popular swimming spot for locals and tourists. The latter is an open-topped limestone cavern, which shelters a calm, turquoise pool of groundwater and seawater: these waters don't mix, creating a halocline where tropical reef fish swim alongside their freshwater counterparts. The protected area's proximity to Toliara gives it great potential for tourism, and a number of circuits have recently been established to enable visits to sites of cultural and biological interest, such as a medicinal plant walk on Andatabo, Ring-tailed Lemur watching at the animals' cave roosts, and boat trips through the mangroves. Established in 2008, the protected area is co-managed by the local community association TAMIA and regional authorities including the forest service and tourism office, and is supported by the PGM-E/GIZ project (*Programme Germano-Malagache pour l'Environnement de la Coopération Internationale Allemande GIZ*).⁵⁶

Above La Table (or Andatabo) is part of a ridge of forested, flat-topped hills that form the gateway to Toliara from the interior.

Opposite top Flocks of Greater Flamingos (*Phoenicopterus roseus*) grace the tidal mudflats of the Onilahy estuary.

Opposite bottom In the dry south, mangroves form oases of life supporting a wide variety of wetland birds, fish and crustaceans.

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While we do not intend *Life Amongst the Thorns* to be an exhaustive reference work, we have strived at all times to ensure that the book is accurate. Wherever possible we have sourced our information from the peer-reviewed literature, and we have provided references so that readers can delve deeper into any topics that interest them. We would not have been confident in the fruits of our research, however, without the help of the many conservationists, researchers and other experts who generously lent their insight and expertise to the task of peer-reviewing individual chapters. We offer particular thanks to Barry Ferguson and Steve Goodman, who both reviewed multiple chapters, as well as Manjakalaza Andrianarimanana, Franco Andreone, Daniel Austin, Brooke Crowley, Stefan Eichenberger, Roland Eve, Frank Glaw, Jim Hansen, Rick Hudson, Jeff Kaufmann, Martin Nicoll, Pete Phillipson, Domoina Rakotomalala, Jeanine Rasamimanana, Nanie Ratsifandrihamanana, Joel Ratsirarson, Alison Richard, Gonçalo Rosa, Roger Safford, George Schatz, Rob Soutter, Xavier Vincke, Malika Virah-Sawmy and Lucienne Wilmé. We also asked many friends, colleagues and family members to read chapters and comment on aspects of style, and are grateful to Ian Bride, Sue Davies, Wayne Edwards, Debbie Fogel, Tom Gardner, May Gerraoui, Ian Henderson, Richard Hughes, Carol Jasper, Jim Labisko, Martina Lippuner (several chapters), Tess

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Misaotra!



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