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Remnant Vegetation in the Kwongan

Poor soil has led to rich plant diversity in this region of South West Australia.

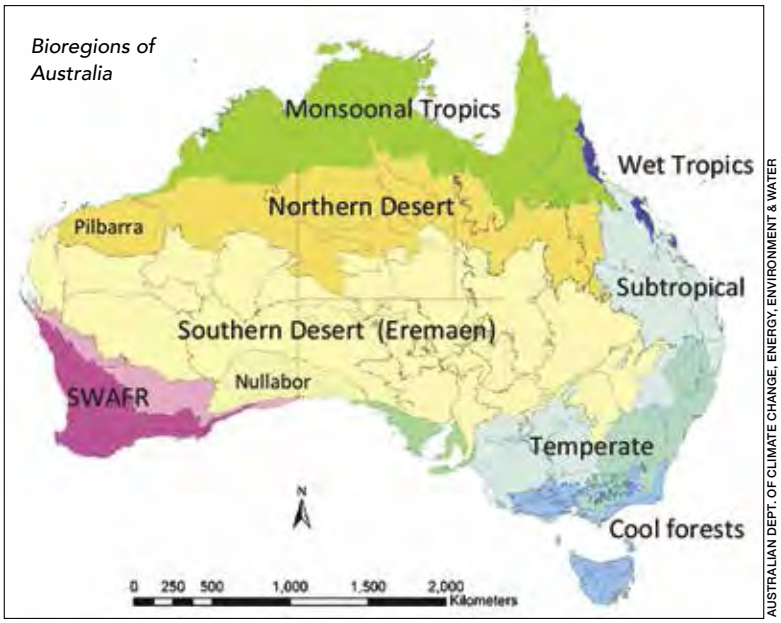
By Terry Domico

In the summer of 1850, at the Yardarino Crossing of the Irwin River in Western Australia, a sixty-three-year-old Scottish-born botanist named James Drummond (ca. 1787–1863) was suddenly surrounded by a yelling band of Aboriginal men. Clutching a shotgun, Drummond prepared for the worst. But the men abruptly began to sing and Drummond noticed that they were wearing bright red blossoms in their hair: his favorite flower, *Verticordia grandis*. He quickly realized that they were not there to attack him, but to honor him.

Drummond's passion for collecting native flora had become well known to nearly everyone in colonial Western Australia. Among Aboriginal groups, he was dubbed "the old man with white hair who walks with his eyes down"

[looking for plants]. Apparently, his abiding love of these plants had struck a spiritual chord with some of them. Today, his legacy includes over sixty species of native Australian flora named after him.

During his long career, most of Drummond's plant-collecting expeditions were concentrated within a large, roughly triangular-shaped, area of southwestern Australia that is now known as the Southwest Australian Floristic Region (SWAFR). Extending from Shark Bay in the north to the western end of the Great Australian Bight on the south coast, it encompasses some 357,500 square kilometers (km^2) of heath and woodland habitat. In the year 2000, this region was formally recognized as a globally significant "biodiversity hotspot." It is one of two diversity hotspots recognized on the Australian continent and one of thirty-six known throughout the world today.



Bioregions of Australia

AUSTRALIAN DEPT. OF CLIMATE CHANGE, ENERGY, ENVIRONMENT & WATER

To qualify as a global biodiversity hotspot, an area must contain at least 1,500 endemic vascular plant species, with less than 30 percent of the original habitat remaining. The SWAFR supports a stunning 8,700 plus plant species and subspecies, of which nearly half are endemic to the region. With much of its native habitat already cleared, a large

ENJOSMITH/FLICKR

*Endemic to the Kwongan is the parasitic Western Australian Christmas tree (*Nuytsia floribunda*), which severs the roots of other plants and drains them of moisture and nutrients.*

part of SWAFR's unique flora exists only within protected areas, such as national parks or nature reserves. Furthermore, more than 399 plant species in the SWAFR are listed as Threatened, with six presumed Extinct. An additional 2,075 species are considered Rare.

The fauna list for the SWAFR also has an exceptional number of endemic species—thirteen of the 230 known bird species, fifty-four reptiles, twenty-seven out of thirty-two frogs, and sixteen out of seventy-seven mammals.

The climate of the SWAFR is considered predominantly Mediterranean, bounded and interspersed with semi-arid zones. It is characterized by hot, dry summers (December through February) and cool, wet winters (June through August). The Noongar Aboriginal people of this region acknowledge six distinct seasons for each year, with the most pleasant, *Djeran*, occurring in April and May.

TERRY DOMICO

Arrowsmith spider orchid (Caladenia crebra)

In late 2019, after my work had come to an end surveying seagrasses and wetlands for the Marine Parks Association in the Myall Lakes/Port Stephens district of New South Wales, I was visiting the binomial coastal municipality of Dongara/Port Denison, located about 360 km north of Perth. Centered along the lower reaches of the Irwin River, this small town overlooks the blue-green waters of the Indian Ocean. It is also located on the edge of a large section of the SWAFR known as the "Kwongan"—the Noongar term for "sandplain." Most of the native vegetation here is dominated by a mosaic of shrubs and low trees. Beneath these, an understory of incredibly diverse plant species grows—ranging from showy orchids to carnivorous sundews.

My visit lasted longer than expected. Because of the COVID-19 pandemic, the Western Australia government isolated the state from the rest of the country, and, indeed, from the rest of the world. All border crossings and airports were closed. In larger cities, people were restricted to a radius of a few blocks. Public roads were reserved primarily for trips to the grocery store, post office, and pharmacy. However, I could freely explore the trails in the countryside on my mountain bike.

It was nearly two and a half years before Australia reopened to international travel. In the interim, I began studying, initially on my own, the native flora and local habitats. It was not long before I realized that both were in serious trouble. Soon, I was joined by two botanist/naturalist friends who grew up in the region. They introduced me to over 500 species of plants. Not only did they know the botanical landscape, but they also knew the remote station managers who gave us permission to access important sites in the Kwongan.

Occupying a wide swath of rather semi-arid country that stretches from north of Geraldton southward past Mount Lesueur National Park, the Kwongan covers more than a quarter of the SWAFR, or about 75,656 km^2. In 1994, a survey of the native plants occurring on these sandplains between Geraldton and Perth listed over 2,500 species. Since then, the tally has more than doubled to include nearly 70 percent of the 8,700 plus species of plants known to occur within the entire SWAFR.

One of the main drivers for this biodiversity is the Kwongan's extremely poor soil conditions. Some of the world's oldest soils, comprised mostly of sand, they have been weathered and leached of most nutrients, especially phosphorous (P), but also nitrogen (N), potassium (K), and a wide range of very scarce micronutrients. Since extreme soil poverty inflicts powerful constraints on plant growth, one might expect the flora of the Kwongan to have low diversity restricted to a few species that have adapted to these conditions. However, just the opposite is true. The Kwongan soils that are the most P-im-

JULIE NUNN

Regeneration after bushfire

(LEFT) BYRON LAMONT/PHILIP GROOM, (RIGHT) AINSLEY CALLADINE/JOHN PATE

(left) Haustoria on root and telephone cable, (right) Nuytsia *secateur-like cutting device*

poverished support the greatest plant species diversity.

Low soil nutrient availability has led to many different adaptations for survival. Some plants have formed symbiotic relationships with soil fungi and bacteria to obtain these vital nutrients. Others, like the carnivorous genus *Drosera*, consume insects for their nutrient content and have developed tuberous roots to enable these essentially wetland plants to withstand the long, hot, dry season. Still others have developed special structures, called "cluster roots," which maximize the plant's surface contact with the soil. Another common strategy, especially among trees and shrubs, is the development of hardened, long-life leaves that are retained for as long as possible so that a plant does not have to expend much of its resources to replenish them.

Paradoxically, the seeds of the Kwongan's *Proteaceae* (banksias, grevilleas, and hakeas) contain some of the highest levels of P and N found in any seeds worldwide. This accumulation of critical nutrients by the parent plant appears to provide the seedlings with a head start, enabling a rapid establishment of deep roots in an otherwise impoverished environment.

One iconic species of plant found on the Kwongan, known as the Western Australian Christmas tree (*Nuytsia floribunda*), has developed a completely different strategy to obtain its P, K, and N. Named for its stunning, bright orange flowers that bloom during the Christmas season, *Nuytsia* has become the world's largest parasite. Growing to a height of more than forty feet, it outwardly appears to be a free-living tree. But botanists early to this region long suspected that it had a secret life.

That secret was finally revealed in 1919 by Andrew D. Herbert (1898-1976), who at twenty-one years of age was appointed government botanist for the state's department of agriculture. During a meeting of the Royal Society in Perth, Herbert presented his discovery, illustrated with lantern slides, to a rapt audience.

Outwardly, *Nuytsia* behaves like an ordinary tree. That is until one of its underground searching roots meets the root of a neighboring tree, bush, herb, grass, or nearly any other plant. At the point of contact, two fleshy "arms" start to grow around the attacked root in opposite directions. When the two arms meet on the other side, they fuse to form a "haustorium"—a swollen, white-colored ring, encircling the root like a clamp.

Inside the haustorium, *Nuytsia* begins to create a hardened cutting device that resembles open secateurs. Powered by hydrostatic forces, the cutter is pressed through the host root, completely severing it. *Nuytsia* then attaches itself to the open ends of the host root and begins to steal its moisture and nutrients. A single *Nuytsia* tree may have thousands of these attachments in a root network that can spread as far as 360 feet in every direction. Little wonder why this "Christmas tree" always looks green and fresh, even in the most severe of droughts.

Sometimes, a *Nuytsia* mistakenly attacks underground power and telephone cables, causing electrical shorts and outages. One infamous case occurred in the early 1960s at a space tracking station during NASA's Project Mercury. According to one account, the station was linked by "underground cables two centimeters in diameter, buried more than a foot deep in the sandy soil, and insulated with a polymer coating to thwart fungi, termites, acids, and other agents of decay." In spite of every precaution, after about six months the cables had short-circuited somewhere. When an engineer raised the cables, he discovered rings of white fleshy haustoria attached to them. In effect, the *Nuytsia* had taste-tested the wires inside.

Because it is believed that *Nuytsia* can live either with or without attachments to roots and cables, it is termed a "hemiparasite." In addition to *Nuytsia*, there are four other tree species (sandalwoods and quandongs) in the Kwongan that are hemiparasitic.

Because they depended on the Kwongan's rich diversity for their survival, the Aboriginal people in the area were the land's stewards for millennia. Since the ar-

rival of European-style agriculture, however, that custodianship has been largely usurped. The wisdom of those ancient practices, tested and improved over an immense time, is just now beginning to be appreciated, especially in the proper application of periodic fire to aid in the renewal of the landscape and prevention of catastrophic bushfires (*see "Takeaways from Australia's Black Summer" by James Aronson and Philip Zylstra*, Natural History, *March 2021*).

By 1905, clearing of native vegetation by farmers and grazers was well underway in this region. In fact, until rather recently, the government often required occupiers of leasehold properties to clear a certain percentage of their land for crops or grazing each year...or they could lose their lease and be forced to move. So, bit by bit, the biodiverse native vegetation slowly disappeared, replaced by monocultures of wheat, barley, and pasture grass.

At the same time, there were special picnic excursion trains that traveled regularly from the Perth region to visit key spots along the tracks so that city dwellers could enjoy some of the remaining displays of native wildflowers. These trains would stop frequently, allowing passengers to step out and pick bouquets of flowers as mementos of their outing.

1880s map of Coastal Stock Route near Arrowsmith Lake

Wildflower tourism is still an important part of the economy for this region. But today's wildflower viewing areas have drastically shrunk from what the tourists on those picnic trains were seeing back in the early 1900s. Estimates vary, but it appears that today only 3 to 5 percent of the original vegetation still remains within the Kwongan. These appraisals include national parks and Class-A reserves.

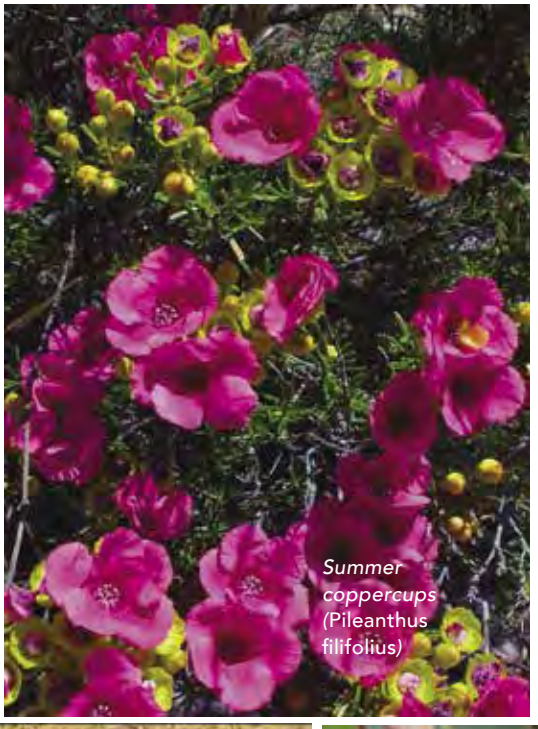
For most of the year—except during that brief but spectacular spring flowering period—much of the Kwongan's remnant vegetation appears to the casual viewer to be just uninteresting scrub. And as one farmer recently told me, as we stood by his "ute" (an Australian term for pickup truck) gazing at a stretch of native bush, "Scrub is something that you clear away to plant crops." It is a common attitude in regard to the native flora around here, especially among people who make a living from the land.

By the mid-1880s, a traveling stock route had been established from Perth north to Mullewa, the Murchison River, and beyond. Long before the days of railroads and giant road-train trucks, this was how cattlemen and shepherds moved their cattle, sheep, and horses from the auction yards near the big city out to their properties. Then, after they had raised enough surplus animals to sell, they would move their "mobs" (Australian for "herded stock") back along this 735-mile-long track to the abattoirs in Perth. As described by the colonial government of the time, the Coastal Stock Route was on average about a mile wide.

As access to water is extremely important in this dry country, the government also established a series of wells along the way—Eight Mile Well, for example, was located eight miles south of the Yardarino Crossing on the Irwin River. Here, the stock could drink and rest up for the next leg of the trip. The reserve areas around these wells often encompassed more than four or five square miles of country—large enough areas to provide the stock with plenty of feed.

Made obsolete by modern transportation methods, the traveling stock route was eventually decommissioned in 1960. Many, but not all, of the landholders whose properties bordered the old route absorbed that portion of the route into their own holdings. Well over a year ago, aided by old historic maps, modern satellite imagery, and a sophisticated camera drone, I began to explore the old coastal stock route to see what had become of the land. Indeed, many portions had been cleared for farming and grazing.

Hooker's banksia (Banksia hookeriana)



Summer coppercups (Pileanthus filifolius)

Cowslip orchid (Caladenia flava)

Wreath plant (Lechenaultia macrantha)

Red-flowering mallee (Eucalyptus caesia var.)

TERRY DOMICO

But other parts still exist in their natural state, some as unallocated Crown land (state-owned public land).

Remarkably, I have found nearly two-dozen fairly large fragments of land along the old stock route that support rich communities of remnant vegetation. However, only a handful of these sites have received any acknowledged protection. The best of these are the 7,900-hectare (ha) Urawa Nature Reserve located north of Mullewa, the 864-ha Depot Hill Reserve north of Minginew, and the 1,400-ha Minginew Nature Reserve that incorporates Minginew Hill. Some of the other high-value sites along the old stock route, such as Arrowsmith Lake and Eight Mile Well, remain at risk from various forms of development, including sand mining and gas-well exploration.

There are other threats to the Kwongan besides vegetation clearing and land development. One is a rather re-

cent arrival, the pathogenic fungus *Phytophthora cinnamoni*, which can create huge swaths of dieback in forest and shrub-land. Various estimates put the number of native plant species that are at risk from *Phytophthora* dieback at well over a thousand. Also, wildfires have become more intense in recent years, threatening local populations of rare plants. Some of these unique plants occupy very small territories. One species of banksia, *Banksia prionophylla*, for instance, has only a single recorded population of about seventy individuals.

Another species, Foote's grevillea (*Grevillea calliantha*), was first discovered in a small area near Cataby in 1981. During the initial assessment, its entire population was found to be less than 150 plants. Unfortunately, that number has since declined to about twenty-five individuals. But there is still hope: The state's Department of Biodiversity, Conservation, and Attractions and a non-government conservation organization, the Northern Agriculture Catchments Council Natural Resource Management (NACC NRM), are attempting to rescue this native species from extinction by collecting seeds, growing them in nurseries, and establishing new off-site colonies.

TERRY DOMICO

Mixed wildflowers in the protected Depot Hill Reserve north of Minginew, Western Australia

Part of the Kwongan's potential for recovery lies within the soil. It is known as the soil seed-bank. Having evolved in a hostile environment for millions of years, many (if not most) of the Kwongan's native species produce long-lived seeds that, once buried, can exist in the soil for many years—perhaps even for hundreds of years—waiting for the right conditions to germinate. This phenomenon becomes especially evident after a farm is allowed to become fallow. Within a few years, plant species that have not been seen for decades begin appearing as the land cover slowly reverts to native vegetation.

Recognition of the uniqueness and importance of plant diversity in the Kwongan has been slow. Few members of the public understand the reasons to protect it. However, positive changes are happening. During her recent tenure as State Minister of Agriculture and Food, Alannah MacTiernan advocated that farmers should set aside up to 20 percent of their cropping land for revegetation. One farmer, I know, has exceeded that goal, allowing almost 28 percent of his property to develop into a mosaic of native scrub. He has found that he now uses less pesticide, less fertilizer, less water for irrigation, and seems to have a growing assortment of birds, native pollinators, and insect predators. Other farmers within the region have purportedly exceeded 30–35 percent.

Terry Domico, naturalist and conservation biologist, is the author of numerous books, including *Bears of the World*. Because of his study of the Kwongan, he is now a board director of the NACC NRM. He is also a frequent contributor to *Natural History*. His most recent article, "The Great Cactus War," appeared in the October 2018 issue. And his Endpaper, "Me and Miss Rufous," appeared in the December 2019/January 2020 issue.