Department of Agriculture and Fisheries
Biosecsurity Queensland

Invasive plant risk assessment

Karroo thorn

Acacia karroo

Steve Csurhes, Jason Weber and Yuchan Zhou

First published 2010
Updated 2016

Queensland Government

Contents

Summary

Acacia karroo (*A. karroo*) is native to southern Africa, where it is abundant across a range of soil types, generally within subtropical rangelands where annual rainfall is between 200 mm and 1500 mm. *A. karroo* is considered a significant weed within its native range, since it has dominated large areas of grazing land. It has naturalised in Portugal and Spain.

A. karroo has the potential to become a major weed in Queensland. This is because of its:

- climatic pre-adaptation
- ability to thrive in a range of habitats and soil types
- status as a significant weed of grazing land within its native range.

Climate-based modelling predicts that *A. karroo* is well suited to substantial areas of rangelands in subcoastal, semi-arid and arid southern Queensland. *A. karroo* grows more rapidly and produces more seeds than one of Queensland's worst weeds, *Acacia nilotica*. The latter causes losses of $3 million to $5 million per annum in Queensland.

In 2008, about 20 naturalised specimens of *A. karroo* were detected on the Darling Downs, Queensland. Fortunately, the population was highly localised, so all specimens were easily destroyed. The site is currently being monitored for seedlings and it is expected that this site will become one of the first well-documented cases of early detection and eradication of a potentially serious weed in Queensland.

Introduction

Identity and taxonomy

Species: *Acacia karroo* Hayne

Synonyms: *Vachellia karroo* (Hayne) Banfi and Galasso

Acacia dekindtiana A. Chev.

Acacia horrida sensu Sim

Acacia horrida var. *transvaalensis* Burtt Davy

Acacia karroo var. *transvaalensis* (Burtt Davy) Burtt Davy

Acacia natalitia E. Mey.

Acacia inconflagrabilis Gerstner

Acacia campbellii Arn.

Acacia pseudowightii Thoth.

Acacia roxburghii Wight and Arn.

Mimosa eburnean L.f.

Common names: Karroo thorn (English), sweet-thorn (English), Soetdoring (Afrikaans), cape gum (English), cassie à piquants blancs (Portuguese), cockspur thorn (English), Deo-babool (Hindu), doorn boom, kaludai (Tamil), kikar (Hindu), mormati (Hindu), pahari kikar (Hindu) and udai vel (Tamil)

Family: Fabaceae

(Barnes et al. 1996; United States Department of Agriculture 2010; International Legume Database and Information Service 2010)

Taxonomy

A. karroo is a phenotypically variable species, but progressively less distinguishable intermediaries generally link variants to a central type. This led Ross (1979) to conclude that *A. karroo* should preferably be considered an inherently variable polymorphic species in which no formal intraspecific taxa are recognised.

In 2008, *A. karroo* was renamed '*Vachellia karroo* (Hayne) Banfi and Galasso' following a review of the *Acacia* genus by the International Botanical Congress (Carruthers and Robin 2010). This was a reasonably controversial decision, given that the *Acacia* type specimen was African in origin and most sources still refer to the species as '*Acacia karroo*'.

Description

A. karroo ranges in height from a shrub to a tree. It is generally between 1 m and 15 m tall, but can grow up to 25 m tall. Its shape is variable (although it typically has a rounded or flattened crown) because it is influenced by the prevailing environmental conditions, especially fire frequency (Archibald and Bond 2003). Occasionally the tree is very slender, spindle-like and sparsely branched. Apart from a 'typical' karroo form of the species, there are at least seven distinct morphological variants (Ross 1979). The bark is longitudinally fissured. In some plants it is reddish-brown to dark brown or black and rough; in others it is pale greyish-white or greyish-brown and smooth. Young branches (less than 50 mm in diameter) are conspicuously rusty red because the outer bark peels off to expose red underbark. Young branchlets are bright green, typically glabrous but occasionally densely pubescent. Stipules are spinescent. The plant's most distinctive features include its paired white spines, which are very strong and straight, generally around 10 cm long, but sometimes up to 25 cm long (see Figure 1).

Figure 1. Spines and leaves of *A. karroo* (Photo: Craig Hunter, Biosecurity Queensland).

The leaves are typically glabrous but occasionally densely pubescent. The petioles are 0.5–1.8 cm long and adaxial glands are usually present. The rachises are 1–5 cm long and there is a gland at the junction of each or some pinnae pairs. There are 2–7 pinnae pairs, each bearing 5–20 pairs of leaflets. Leaflets are linear to obovate-oblong, 3.5–8 mm × 1–3 mm. The inflorescences (flowers) are yellow and ball-shaped (globose, capitate, fascicled or solitary on peduncles), 10–15 mm in diameter and generally arranged in clusters of 4–6. The pods are flat, brown, smooth, somewhat restricted between seeds, sickle-shaped, woody and dehiscent; they are up to 16 cm long and 1 cm wide. The seeds are 3.5–9 mm × 2–7 mm,

elliptic and lenticular but sometimes quadrate and compressed. One thousand air-dried seeds weigh about 19 g (Ross 1979; Palgrave 1996; Van Wyk and Van Wyk 1997; ePic 2002; see Barnes et al. 1996 for more detail). The tree is usually evergreen but loses its leaves in droughts or in very cold or dry conditions.

Reproduction and dispersal

A. karroo reproduces from seeds, with large specimens producing up to 19 000 seeds per year (Story 1952). Du Toit (1972) found that *A. karroo* seeds can remain viable for up to 7 years when buried in soil. However, Story (1952) found that seeds from herbarium specimens were still viable 57 years after collection.

In laboratory tests simulating temperatures experienced by seeds on the soil surface during the day, seeds were kept for 4 weeks at 50°C and 70°C and had 69.6% and 4.8% viability respectively. Seeds kept for 5 minutes and 1 minute at 150°C and 200°C respectively (simulating conditions experienced by seeds on the soil surface during a fire) maintained viability of 35.5% and 19.2% respectively (Mbalo and Witkowski 1997). Despite this apparent resistance to heat, some authors suggest that a seedling-bank is more important than a seed-bank for persistence (O'Connor 1995).

Germination of *A. karroo* seeds is delayed by a hard seed coat and a water-soluble inhibitor in the seed coat (Du Toit 1966). Seeds can remain damp for 29 months without rotting or germinating, but once the seed coat is penetrated by water, germination takes place in 3 to 4 days (Barnes et al. 1996). Seeds can germinate at temperatures between 10°C and 40°C, but optimum germination occurs between 10°C and 20°C. Temperatures for optimum growth are higher, between 25°C and 33°C (Du Toit 1966). Seedlings are resistant to browsing by domestic and wild herbivores but are killed by fire if less than 8 weeks old. Seedlings that are 12 months old die back following fire, but resprout from the base, giving rise to 3 or 4 new stems (Barnes et al. 1996).

A. karroo is one of the most widely distributed *Acacia* species in southern Africa, and so aspects of its life history change with climatic zones. For example, a population located in the Transvaal, South Africa, was observed to produce flowers on green shoots throughout the growing season, with most flowering in summer, from December to February (Milton 1987). However, in Zimbabwe, flowering lasted from November to late April, with individual trees, and sometimes whole populations, flowering three or four times a year, particularly in sunny spells following heavy rain (Barnes et al. 1994).

A. karroo is generally an out-crossing species (i.e. usually not self-pollinated). Within any given population, there is a predominance of male flowers and a number of entirely male trees. This ensures abundant pollen production, although some self-pollination does still occur (Oballa 1993). *A. karroo* is principally insect-pollinated, and geographically isolated plants often fail to produce seeds, due to limitations of insect movement (Barnes et al. 1996; Gerstner 1948). The flowers are frequented by large numbers of insects, including species in the orders Coleoptera, Lepidoptera, Hymenoptera and Diptera (Barnes et al. 1996).

In its native range, pods ripen between February and June. The pods are dehiscent and open (when dry) on the tree. The seeds are suspended from the pod by a thin, threadlike funicle. As this funicle dries, it becomes brittle and the seeds fall, or are eaten by animals. The pods fall 2 to 3 months later. The seeds are dispersed principally by cattle and other herbivores that

ingest the seeds and void them through their dung (Story 1952). It appears that voiding only aids in dispersal and not germination (O'Connor 1995). Wind and water are less significant dispersal vectors (Story 1952).

In natural stands of *A. karroo*, the highest stem diameter growth rate generally occurs about 20 years after establishment. Growth rate declines rapidly when trees are parasitised by mistletoes and most specimens collapse at around 30 years of age (Gourlay et al. 1996). However, under optimum soil nutrient and moisture conditions, longevity may reach 40 years (Barnes et al. 1996).

To take advantage of episodic rainfall, *A. karroo* can grow opportunistically at any time of the year (Teague 1987).

Seedlings grow faster during their first 3 months than those of most other African *Acacia* species and can reach 2 m in their first year under favourable conditions (Scott 1991).

The plant coppices readily if cut.

Origin and distribution

A. karroo is native to southern Africa, including Zimbabwe, Botswana, Swaziland, Lesotho, Namibia, South Africa, Mozambique, Zambia, Malawi and the south of Angola (Barnes et al. 1996). It is one of the most widespread native tree species in southern Africa. This species has also been introduced into Libya, Morocco, Myanmar, India, Iraq, Corsica, Portugal, Sicily, Argentina, Bolivia, Chile, Paraguay, Spain and Mauritius (LegumeWeb 2004; International Legume Database and Information Service 2010; Kew 2010).

Preferred habitat

Within its native range, *A. karroo* occurs in a wide range of habitats, from sea level to 1800 m. It grows on a wide range of soil types from unconsolidated sand to cracking clays. Annual rainfall across its range varies from 200 mm to 1500 mm (Barnes et al. 1996). Some parts of its range are characterised by a summer-dominated rainfall pattern, whereas other areas receive most rain over winter.

A. karroo is drought tolerant due to its extensive root system; once established, it does not rely on surface water (Barnes et al. 1996). However, seedlings are very sensitive to desiccation, and rapid drying of the topsoil has a deleterious effect (Du Toit 1966). The species can survive all but the most severe frosts in southern Africa (c. –12°C) as well as wind and salt spray (Barnes et al. 1996; Venter 1971).

A. karroo is generally considered a pioneer species; it can establish shortly after a disturbance with no shade, shelter or protection from fire (Barnes et al. 1996; Von Maltitz et al. 1996). Subject to local environmental variables such as soil or climatic conditions and/or human interference, *A. karroo* stands sometimes regenerate themselves. However, Von Maltitz et al. (1996) found that on abandoned agricultural land, mature stands started to senesce after about 25 years, leading to the formation of gaps that were seldom recolonised by *A. karroo* seedlings. In these gaps, later seral stage species such as *Celtis africana* and

Teclea gerrardii became established (Von Maltitz et al. 1996). Parasitism by mistletoes often causes the death of mature *A. karroo* trees (Barnes et al. 1996).

There is debate over the role of fire and overgrazing in the increasing encroachment of *A. karroo* into grasslands in Africa. One hypothesis is that overgrazing removes grass biomass, allowing seedlings to establish in greater numbers (O'Connor 1995). However, O'Connor (1995), Bond et al. (2001) and Chirara (2001) found no evidence to support this hypothesis and suggested *A. karroo* probably benefits from the microclimate created by long grass for the first year of growth. Long grass can, however, carry fire, which kills seedlings and suppresses mature trees. If grazing occurs, or if fire frequency is reduced in some other way, a greater number of *A. karroo* juveniles reach maturity (Skowno et al. 1999; Bond et al. 2001). Once the plants reach 3 m in height, even relatively high intensity fires cause only a minor percentage canopy reduction (Trollope 1984).

A. karroo forms a dominant part of many plant communities in southern Africa. The following are examples of recorded plant associations found in certain areas of South Africa:

- *Acacia karroo – Protasparagus suaveolens* woodland on plains with shallow soils and around 700 mm rain per annum (Du Preez et al. 1990).
- *Acacia karroo – Asparagus laricinus* woodland on stream banks and valleys (Dingaan et al. 2001).
- *Acacia karroo – Heteropyxis dehniae* woodland on the drier sides of hills (Mapaure 1997).

In areas that receive less than 400 mm rainfall per annum, *A. karroo* tends to be restricted to the banks of watercourses (Story 1952). In the very dry parts of South Africa known as the 'Great Karoo' and the 'Little Karoo', where annual rainfall is between 150 mm and 300 mm, *A. karroo* is a dominant component of river bed vegetation (Scott 1991). In areas where annual rainfall is between 400 mm and 900 mm, *A. karroo* thrives and forms a dominant part of the thornveld vegetation (Acocks 1975, Scott 1991). In Natal, it grows within coastal dune forest (where annual summer rainfall is between 750 mm and 900 mm). It is absent from areas with frequent frost, at altitudes above 1500 m and areas with annual rainfall in excess of 750 mm (Brain 1989).

History as a weed

Overseas

In South Africa, *A. karroo* is considered one of the most important grassland invaders (Du Toit 1966) and is a declared noxious weed. It can change grasslands into forests and even displace other woody species (Bond et al. 2001; Von Maltitz et al. 1996). It is generally considered that the encroachment of *A. karroo* into grasslands is the result of poor management. Stem densities of 1000 to 2000 trees per hectare have been recorded in South Africa (Aucamp 1976). A primary successional forest (predominantly consisting of *A. karroo* trees) is considered to have lower species richness than nearby forests of similar ages that have followed different successional pathways (Maltitz et al. 1996).

In Portugal and south-western Spain, *A. karroo* has become naturalised on coastal dunes and alluvial soil near rivers (Castroviejo 2010; Valdés et al. 2010).

Australia

The first naturalised specimen of *A. karroo* collected in Australia was from the banks of the Swan River in Midlands, Perth, in 1967. An additional specimen was collected in 1989 (Scott 1991).

A. karroo has been planted in many rural and metropolitan zoos as well as botanical gardens in Victoria, South Australia, New South Wales and probably Western Australia (Blood 2003; Department of Environment and Heritage 2003). There is a record of seeds of *A. karroo* (when it was known as *Acacia roxburghii*) being planted on Percy Island in Queensland around 1872 (Hannan-Jones 2009) and a record of a single specimen in a garden in Buderim (south-eastern Queensland).

The first naturalised specimens of *A. karroo* detected in Queensland were found on private property north of Millmerran on the Darling Downs in 2008. About 20 plants were found over an area of about 10 m × 20 m (see Figure 2). The owner of the property had cut down and burned a single large specimen at the site several years before this. All specimens were subsequently destroyed and the site is being monitored for seedlings as part of an ongoing early detection and eradication campaign. The origin of the specimens is unknown.

Figure 2. *A. karroo* on the Darling Downs, Queensland, just prior to destruction/eradication (Photo: Craig Hunter, Biosecurity Queensland).

Current distribution and impact in Queensland

Naturalised *A. karroo* is restricted to a single site near Millmerran in Queensland, where all plants have been destroyed and the site is being monitored for seedlings. (It is highly likely that there is a soil seed-bank.) Therefore, its impact in Queensland is limited to the cost of ongoing surveillance. Isolated garden specimens may exist and need to be detected.

Uses

The gum from *A. karroo* is used as a gum arabic substitute. It is used in the food, pharmaceutical, glue, detergent, ink, paint and agrochemical industries as well as for glazing pottery (Kew 2010). Components and extracts from *A. karroo* are used in traditional and veterinary medicines. The wood is dense, hard and durable and is used for a variety purposes, including charcoal and fuel. The bark yields a yellow-brown leather dye (Kew 2010). This species is often planted in zoos to enhance the 'African appearance' of animal enclosures (Department of Environment and Heritage 2003).

Pest potential in Queensland

Climate modelling suggests that *A. karroo* is suited to a large area of southern and eastern Australia, as shown in Figure 3.

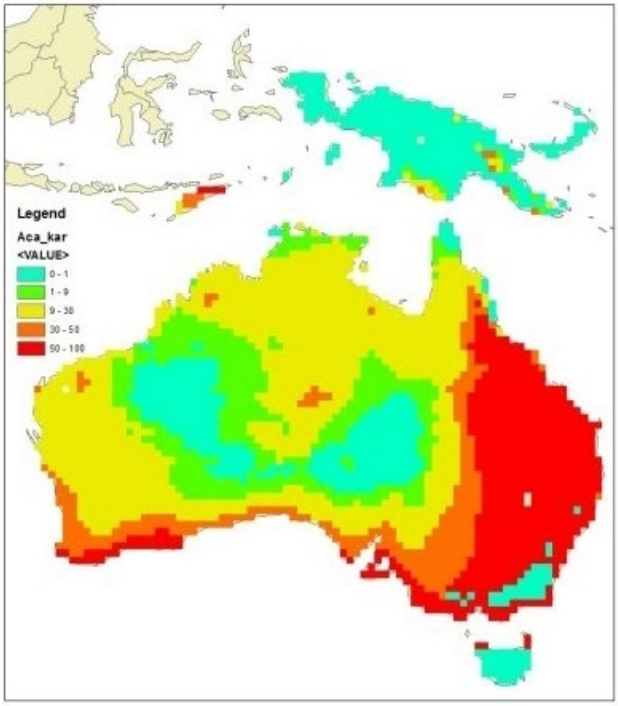

Figure 3. Suitability of areas of Australia to *A. karroo*: red indicates areas where the climate is highly suitable; orange and yellow areas are marginally suitable; and green and blue areas are unsuitable (Map produced using CLIMEX computer software).

Since *A. karroo* is a dominant plant within a range of subtropical vegetation types in South Africa, it is reasonable to predict that it could occupy a range of comparable habitat types in Queensland. It appears well suited to riparian habitats (creek banks and the beds of watercourses) in the arid zone of south-western Queensland, since it dominates similar

habitats in South Africa. Similarly, it is expected to thrive in virtually all open, semi-arid shrublands and native pastures across south-western Queensland. It is not expected to persist in tall forest areas or rainforest in coastal Queensland, but could persist at low levels in some open coastal dune vegetation. The fact that a small population was detected on the Darling Downs suggests that subcoastal open forest/woodland vegetation is also at risk.

If *A. karroo* became widely naturalised in Queensland, its impact could be substantial. A congener, *A. nilotica*, is currently one of the worst weeds in Queensland's grazing land. It costs landholders an estimated $3 million to $5 million per annum to control and has infested more than 6 million hectares of grazing land (Barker et al. 1996). Bryant et al. (1989) found that *A. karroo* grows faster than *A. nilotica*, and therefore is likely to invade suitable habitats more aggressively than *A. nilotica*, generating larger control costs. *A. karroo* has the potential to dominate extensive areas of arid, semi-arid and subcoastal subtropical rangeland/ savanna, converting open pasture and woodland into thornveld (extensive thorny shrubland). The economic losses to beef and wool grazing could easily run into tens of millions of dollars per annum if *A. karroo* replaces pastures and hinders stock movement.

A. karroo could displace native plant species and alter fire regimes, causing serious damage to remnant native vegetation and dependent fauna. The social impacts associated with large areas of impenetrable thorny thickets could also be significant. Simple recreational activities such as bushwalking could be affected.

References

Acocks, JPH (1975). Veld types of South Africa, 2nd edn. *Memoirs of the Botanical Survey of South Africa* 40: 1–128.

Archibald, S and Bond, WJ (2003). Growing tall vs growing wide: tree architecture and allometry of *Acacia karroo* in forest, savanna, and arid environments. *Oikos* 102(1): 3–14.

Aucamp, AJ (1976). The role of the browser in the bushveld of the eastern Cape. *Proceedings of the Grassland Society of Southern Africa* 11: 135–138.

Barker, M, Dorney, W, James, P, Jeffrey, P, March, N, Marohasey, J and Panetta, D (1996). Prickly acacia (*Acacia nilotica*) pest status assessment. Queensland Department of Natural Resources, Brisbane.

Barnes, RD, Filer, DL, Lockhart, LA and Gourlay, ID (1994). Final report of ODA forestry research scheme (unpublished) R. 4526. Oxford Forestry Institute, Oxford.

Barnes, RD, Filer, DL and Milton, SJ (1996). *Acacia karroo*: monograph and annotated bibliography. Tropical Forestry Paper 32.
Blood, K (2003). Weed alert—two South African *Acacia* spp. threatening Victoria. *Under Control* 24: 10–11.

Bond, WJ, Smythe, KA and Balfour, DA (2001). *Acacia* species turnover in space and time in an African savanna. *Journal of Biogeography* 28(1): 117–128.

Brain, P (1989). Genetic races in a ring species, *Acacia karroo. South African Journal of Science* 85: 181–185.

Bryant, JP, Kuropat, PJ, Cooper, SM, Frisby, K and Owen-Smith, N (1989). Resource availability hypothesis of plant antiherbivore defence tested in a South African savanna ecosystem. *Nature* 340: 227–229.

Carruthers, J and Robin, L (2010). Taxonomic imperialism in the battles for *Acacia*: identity and science in South Africa and Australia. *Transactions of the Royal Society of South Africa*, 65(1): 48–64.

Castroviejo (2010). Flora Iberica. ‹http://www.floraiberica.org/›, viewed 27 July 2010.

Chirara, C (2001). Tree invasion in a semi-arid savanna in Zimbabwe—seedling recruitment of *Acacia karroo*. Print Partners Ipskamp, Enschede, Zimbabwe.

Department of Environment and Heritage (2003). Weed management guide—karroo thorn (*Acacia karroo*). Department of Environment and Heritage, Canberra.

Dingaan, MNV, Du Preez, PJ and Venter, HJT (2001). Riparian and wetland vegetation of natural open spaces in Bloemfontein, Free State. *South African Journal of Botany* 67(2): 294–302.

Du Preez, PJ and Venter, HJT (1990). The phytosociology of the woody vegetation in the southern part of the Vredefort Dome Area. Part I: Communities of the plains, riverbanks and islands. *South African Journal of Botany* 56(6): 631–636.

Du Toit, PF (1966). Outekologiese studie van die *Acacia karroo* saailing (An autecological study of *Acacia karroo* seedling). PhD thesis, University of Pretoria, South Africa.

Du Toit, PF (1972). *Acacia karroo* intrusion: the effect of burning and sparing. *Proceedings of the Grassland Society of Southern Africa* 7: 23–27.

ePic (2002). Electronic Plant Information Centre—*Acacia karroo*, Royal Botanic Gardens, Kew. ‹http://www.kew.org/epic/›, viewed 20 November 2004.

Gerstner, J (1948). Three closely related *Acacias* of southern Africa. *Journal of South African Botany* 14: 19–27.

Gourlay, ID, Smith, JP and Barnes, RD (1996). Wood production in a natural stand of *Acacia karroo* in Zimbabwe. *Forest Ecology and Management* 88(3): 289–295.

Hannan-Jones, M (2009). The plantings of exotic trees on the islands off the Queensland coast. *Weedshine: a newsletter of the Weed Society of Queensland* 41.

International Legume Database and Information Service (ILDIS) (2010). ‹http://www.catalogueoflife.org/annual-checklist/2008/show_species_details .php?record_id=607756›, viewed 27 July 2010.

Kew (2010). Kew Botanical Gardens—Plants and Fungi. ‹http://www.kew.org/plants-fungi/Acacia-karroo.htm›, viewed 27 July 2010.

LegumeWeb (2004). *Acacia karroo.* International Legume Database and Information Service. ‹http://biodiversity.soton.ac.uk/LegumeWeb›, viewed 16 November 2004.

Mapaure, I (1997). A floristic classification of the vegetation of a forest–savanna boundary in southeastern Zimbabwe. *Bothalia* 27(2): 185–193.

Mbalo, BA and Witkowski, ETF (1997). Tolerance to soil temperatures experienced during and after the passage of fire in seeds of *Acacia karroo*, *A. tortilis* and *Chromolaena odorata*: a laboratory study. *South African Journal of Botany* 63(6): 421–425.

Milton, SJ (1987). Phenology of seven *Acacia* species in South Africa. *South African Journal of Wildlife Research* 17(1): 1–6.

Oballa, PO (1993). Genetic variation within *Acacia karroo* Hayne. University of Oxford.

O'Connor, TG (1995). *Acacia karroo* invasion of grassland: environmental and biotic effects influencing seedling emergence and establishment. *Oecologia* 103(2): 214–223.

Palgrave, KC (1996). Trees of southern Africa. Struik Publishers, Cape Town, South Africa.

Ross, JH (1979). A conspectus of the African *Acacia* species. *Memoirs of the Botanical Survey of South Africa* 44.

Scott, JK (1991). *Acacia karroo* Hayne (Mimosaceae), a potentially serious weed in Australia. *Plant Protection Quarterly* 6(1): 16–18.

Skowno, AL, Midgley, JJ, Bond, WJ and Balfour, D (1999). Secondary succession in *Acacia nilotica* (L.) savanna in the Hluhluwe Game Reserve, South Africa. *Plant Ecology* 145(1): 1–9.

Story, RA (1952). A botanical survey of the Keiskammahoek District. *Botanical Survey of South Africa Memoirs* 27.

Teague, WR (1987). Defoliation and browse production of *Acacia karroo* Hayne in the Eastern Cape, South Africa. PhD thesis, University of the Witwatersrand, Johannesburg, South Africa.

Trollope, WSW (1984). Fire in savanna. In Ecological effects of fire in South African ecosystems. PdeV Booysen and NM Tainton (eds). Springer-Verlag, Berlin, Germany. 149–175.

United States Department of Agriculture (2010). Germplasm Resources Information Network (GRIN). ‹http://www.ars-grin.gov/cgi-bin/npgs/html/tax_search.pl›, viewed 27 July 2010.

Valdés, B, Talavera, S and Fernández-Galiano, E (2010). Flora Vascular de Andalucía Occidental. ‹http://www.bioscripts.net/flora/index.php?spp=Acacia›, viewed 27 July 2010.

Van Wyk, B and Van Wyk, P (1997). Field guide to trees of southern Africa. Struik Publishers, Cape Town, South Africa.

Venter, HJT (1971). Ekologie van die plantegroei van Richardsbaai (Ecology of the vegetation of Richards Bay). *South African Journal of Science* 67(2): 52–55.

Von Maltitz, GP, Van Wyk, GF and Everard, DA (1996). Successional pathways in disturbed coastal dune forest on the coastal dunes in north-east KwaZulu-Natal, South Africa. *South African Journal of Botany* 62(4): 188–195.