CHAPTER 3

ACACIA ERIOLOBA IN THE KALAHARI GEMSBOK NATIONAL PARK

3.1 NATURAL DISTRIBUTION

As useful pioneers, species of the genus *Acacia* are unrivalled by any other group of trees and shrubs in the combined importance of their distribution throughout the seasonally dry to arid regions of the African continent, their varied ecologies, their ability to colonize and rehabilitate degraded sites and fix sand dunes, and their relatively fast growth. They are commonly found throughout the continent and are of great ecological and socio-economic importance (Barnes & Fagg 1995).

Acacia erioloba is largely restricted in its natural occurrence to the Kalahari sand formations of the north-western and central side of southern Africa where it is often the only tree of any size and forms a conspicuous feature of the landscape (Figure 3.1) (Ross 1979; Barnes *et al.* 1997).

In the drier parts of its range, the tree establishes itself in rare periods of rainfall when the seed germinates, after passing through the digestive tract of a herbivore, and uses the transient surface moisture to send a taproot deep down to permanent water supply after which it is independent of annual rainfall and can live for hundreds of years. In these situations *Acacia erioloba* is often the only tree in the environment, whereas in the better watered parts, it is a component of savanna woodland communities (Barnes *et al.* 1997).

3.2 CHARACTERISTICS OF THE SPECIES

Acacia erioloba's habit varies from a small, very spiny shrub barely 2 m high, to a tree up to 16 m in height with a wide, spreading crown. The bark is grey to blackish-brown, rough, fissured often flaking off when old. Stipules are spinescent, with strongly developed spines up to 60 cm in length. Leaves have 2 to 5 pairs of pinnae and the flowers are bright golden-yellow balls. The fruit is an indehiscent, thickened, comparatively short pod densely covered with grey velvety hairs (Palgrave 1977).

A detailed botanical description of *Acacia erioloba* is given by Barnes *et al.* (1997).

It has been recorded that *Acacia erioloba* has a deep root system. Timberlake (1980) recorded roots found at 46 metres deep in a borehole in Namibia. As a result of the deep root system, fluctuations in annual rainfall are buffered by the permanent access to ground water. Some of the water that is drawn from the depths is released into the surface soil enabling its shallow feeder roots to dissolve and absorb the accumulated nutrients. This water may also benefit the shrubs and annuals under its canopy (Milton & Dean 1999).

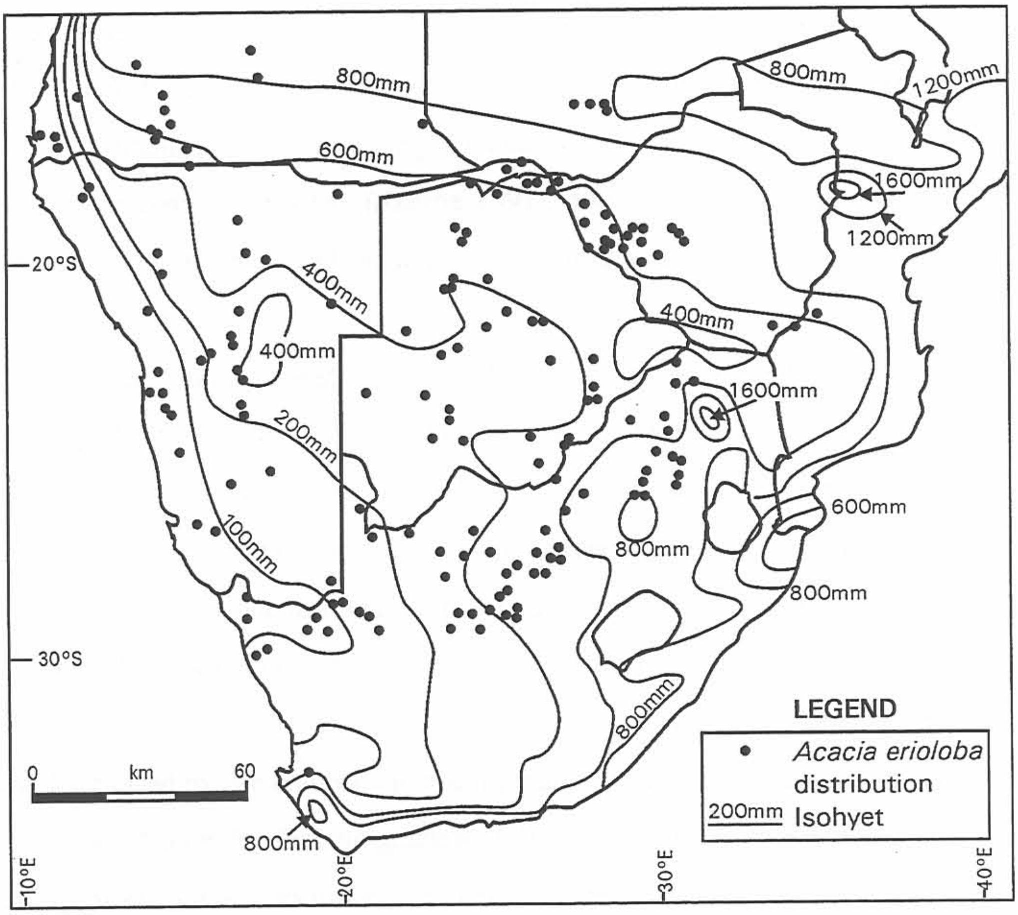


Figure 3.1 Distribution of *Acacia erioloba* (after Barnes *et al.* 1997).

Fluctuations in rainfall do not affect flower production. It is probably because of this that pod production is high and consistent from year to year compared to most other *Acacia* species. *Acacia erioloba* is insect pollinated (Barnes *et al.* 1997).

The highly variable rainfall and seasonality in the south-western range of *Acacia erioloba* apparently leads to episodic recruitment. Size-class distributions of *Acacia erioloba* populations indicate that seedlings germinate and survive more abundantly in high than in low rainfall years (Hoffman *et al.* 1995) and seedlings and saplings suffer high mortality rates in dry years (Van Rooyen *et al.* 1984, 1990; Theron *et al.* 1985).

Recruitment is spatially as well as temporally variable (Skarpe 1991). The presence of large quantities of scarified seed, or even germinated seedlings, does not necessarily guarantee survival. Other factors in the environment, such as rainfall distribution, grass competition and sizes of predatory insect and rodent populations, have to be favourable and coincide with the presence of scarified seed for successful stand establishment. Young *Acacia erioloba* trees tend to be closely spaced, while old trees are widely and randomly spaced. The spatial distribution has been attributed to competition and fire (Skarpe 1991), and can be simulated by spatially explicit models that include physical and biotic factors (Jeltsch *et al.* 1996).

In the Kalahari savanna, dense stands of small trees do not perform the same function as large, scattered trees (Milton & Dean 1995). Scholes and Walker (1993) suggest that episodic mortality of mature trees, through various agents of disturbance (fire, herbivory, drought, frost, lightning, wind and wood harvesting) prevent the trees from reaching the upper limit of density imposed by intertree competition, and thus maintain coexistence of trees and grass in savannas. This view is supported by the savanna model of Jeltsch *et al.* (1996). The simulation results also indicated that the scattered distribution of trees which is typical of a number of semi-arid savannas is probably not caused by the combination of inter and intraspecific competition for soil water or large-scale disturbances by fire and grazing. Jeltsch *et al.* (1996) hypothesised that the isolated distribution pattern of the trees is predetermined by other factors, e.g. small-scale heterogeneities in grass density, soil water or nutrient distribution. Trees in certain localities therefore have a better chance for establishment and survival. Another possible effect of small-scale heterogeneities is the local accumulation of tree seeds, which increases the establishment probabilities in these sites. Possible processes that leads to local tree seed accumulation in savannas range from rare but important floods (Ward & Breen 1983) to seed dispersal in herbivore dung (Leistner 1961; Hoffman *et al.* 1989).

Lightning fires occur only rarely, especially after years of above average rainfall and it is particularly the *Acacia erioloba* communities in the rivers that are damaged. Large fires can sweep through the Kalahari and burn down large *Acacia erioloba* trees. The occurrence and influence of fire on the vegetation of the Kalahari are also discussed by Van der Walt (1974,1975), Skarpe (1980), Van der Walt and Le Riche (1984) and Van Rooyen *et al.* (1996). In November 1976 the Nossob River valley was damaged by a fire originating from the interior duneveld (Van Rooyen *et al.* 1996). The influence of fires on spatial distribution is evident in the Nossob River valley. Numerous dead trees in the Nossob River valley bear testimony of the influence of fire (Figure 3.2). In the sites monitored by Van der Walt and Le Riche (1984), nearly 33% of the trees were destroyed while approximately 50% suffered from different intensities of burning. During November to December 1994, fires occurred in the central dune areas of the Kalahari Gemsbok National Park and affected approximately 35% of the total area of the park.

Mature trees do show some fire resistance, except where large social weaver nests occur in the crown and where a high percentage of dead material or rat nests increase fuel loads. When these are set alight by a fire they burn with such intense heat that the tree can be de-limbed or even completely destroyed. This apparently happened on large scale after the 1974 and 1976 rainy seasons when there were severe lightning fires. These fires were set off in the dense grass cover (*Setaria verticillata* and *Schmidtia kalihariensis*) that developed after the rain. There was a high correlation between tree size and death due to fire (Van der Walt & Le Riche 1984; Van Rooyen *et al.* 1996).

Figure 3.2 Numerous dead trees in the Nossob River valley bear testimony of fire damage.

3.3 CLIMATIC REQUIREMENTS

Where the annual rainfall is less than 250 mm, *Acacia erioloba* probably depends upon its extraordinary capacity to root to great depths to gain access to ground water supply. In these areas the presence of *Acacia erioloba* is said to indicate underground water (Timberlake 1980).

Acacia erioloba tolerates extremes of temperature in the desert region and it is soil rather than freezing conditions that provide the constraints to its distribution. It can probably withstand temperatures as low as -15°C to -20°C although flowerbuds may be damaged by less extreme temperatures (Barnes *et al.* 1997).

The ability of *Acacia* species to tolerate drought and adverse soil conditions, notably salinity and alkalinity, and their successful adaptation to herbivore pressure, are major reasons for their dominant position in the woody vegetation of arid and semi-arid areas (Fagg & Stewart 1994).

Although it was pointed out that mature *Acacia* trees have the ability to tolerate drought, Van Rooyen *et al*. (1984) pointed out that seedlings and saplings of *Acacia erioloba* in the Kalahari are sensitive to drought.

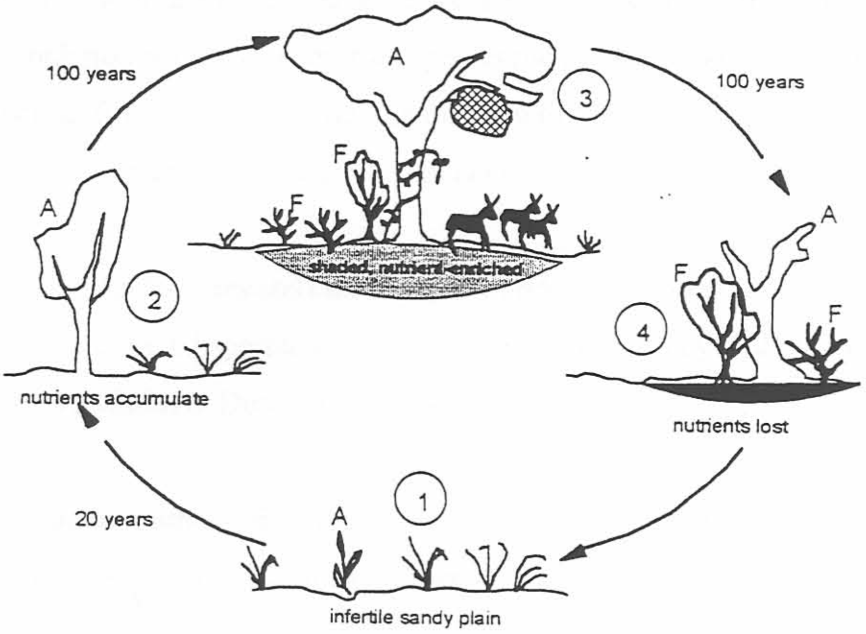
3.4 SOIL REQUIREMENTS

Throughout its range, *Acacia erioloba* is invariably confined to the wind-blown sandy soils on the Kalahari sand sheet. It reaches its best development on the deep alluvial soils in the valleys, drainage lines and riverbeds (Leistner 1967; Barnes *et al*. 1997; Acocks 1988). *Acacia erioloba* communities serve as indicators of deep Hutton soil form and are confined to soils generally deeper than 1 m. Although the sandy nature of the soil allows for maximum absorption of rain water, their water holding capacity is low (Van Rooyen & Burger 1974).

3.5 GROWTH PATTERNS

Acacia erioloba grows very slow for the first four or five years although it develops a deep root system during this period. After this the tree can grow quite rapidly and attain a stem diameter at ankle height in the region of 300 mm and a height of about 7 m after another 15 to 20 years (Barnes *et al*. 1997). On sandy soils saplings reach a height of up to 1 m in their first year.

The following is a diagrammatic representation of the life cycle of an *Acacia erioloba* tree as depicted by Milton and Dean (1999):



Life cycle of a camel thorn tree: (1) In 1750 a seedling (A) establishes in a small clearing near a pan on the grassy plains; (2) In 1770, at 20 years of age, the young tree begins to shade out desert grasses and attracts birds and antelope that fertilise the soil and disperse seeds to the soil beneath its canopy; (3) One hundred years later, in 1870, fruit-bearing shrubs (F) have established on fertile soil in the shade beneath the tree, and cavity-nesting birds and mammals are living inside the trunk; (4) By 2000 the tree is dying back, offering less shade and attracting fewer animals. Its dead trunk will eventually be hidden by the fruit-bearing shrubs that outlive it. On the plains 10 km away one of the seedlings has grown tall enough to escape the browsing springbok.

Figure 3.3 Life cycle of an *Acacia erioloba* tree (after Milton & Dean 1999).

3.6 ECOLOGICAL IMPORTANCE

Acacia erioloba is regarded as a keystone species in the Kalahari because it facilitates the processes (e.g. seed dispersal, site modification) which maintain heterogeneity and species diversity. Keystone species are defined as those species upon which many other plant and animal species depend (Milton & Dean 1995; Jeltsch *et al.* 1996).

The character of the Kalahari ecosystem depends on spatial heterogeneity (nutrient-rich, shaded islands) which increases biotic diversity in an otherwise exposed and oligotrophic system. The role of *Acacia erioloba* in generating patchiness depends on the structure of its population. By role of *Acacia erioloba* in generating patchiness depends on the structure of its population. By changing the population structure of keystone species such as *Acacia erioloba* through management action such as fire and overgrazing, the function of the species in the ecosystem can be altered, indirectly influencing pattern and diversity (Barnes *et al.* 1997).

Many fleshy-fruited shrubs, trees and climbers grow under the canopies of old *Acacia erioloba* trees, where they have been dispersed to nutrient-rich, shaded sites by birds and jackals (Figure 3.3) (Leistner 1967; Milton & Dean 1995; 1999).

The life cycles of many animals, birds and insects are intimately bound up with *Acacia erioloba* wherever it occurs. The most extreme instances are in the most arid areas where the trees provide the primary, if not the only, source of food and shelter as evidenced by the tracks of large animals, e.g. the gemsbok, *Oryx gazelle* (Smithers 1983). Use of *Acacia erioloba* trees by birds and sheltering antelope and other animals, concentrates nutrients and disturbs the soils beneath the tree canopy, leading to the development of distinctive plant assemblages under the trees (Figure 3.3) (Leistner 1967; Milton & Dean 1995; 1999). Milton and Dean (1995) found carbon, nitrogen and phosphorus levels greater beneath *Acacia erioloba* trees than in soils from matrix vegetation in their study conducted in the Nossob River valley. Although these trees may bring nutrients from deep soil layers and distribute it on the surface in the form of litter, much of the nutrient enrichment of soils under the trees is probably the result of animal activity.

Of the many birds that are associated with *Acacia erioloba* the most conspicuous are two species of weavers that build large nests in the crowns of the trees. The sociable weaver, *Philetairus socius*, occurs in the west of the species' range and builds huge nests that make the tree vulnerable to fire. The white-browed sparrow weaver, *Plocapasser mahali*, occurs throughout the range of *Acacia erioloba* and builds smaller but numerous grass nests on the south-western side of trees that are over 3 m high.

Large *Acacia erioloba* trees also provide essential perches for large raptors, owls and vultures and cover for hunting leopards (Bothma & Le Riche 1984) (Figure 3.4).

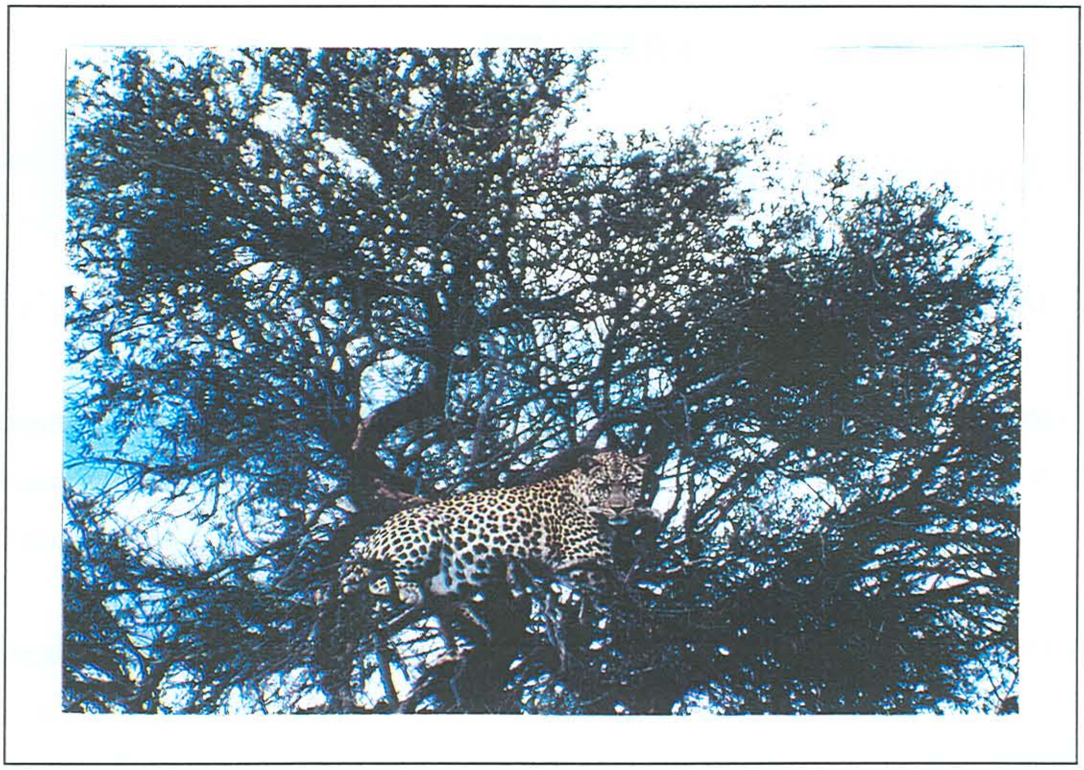


Figure 3.4 Leopard (*Panthera pardus*) in an *Acacia erioloba* tree.

Although *Acacia erioloba* does not appear to nodulate, there is evidence that it draws nitrogen from deep ground water. It cycles nutrients from great depths and this provides conditions for the growth of nutritious grass species under and near its canopy. The trees and their associated herb and grass assemblages are often the only support for animal life in these environments (Barnes & Fagg 1995).

The relationship between *Acacia erioloba* and termites is clearly important for both insect and tree, but is not yet understood. Young trees are periodically encased in the earthworks when the termites remove dead bark, but they rarely damage the tree. It is possible that termite activity may play some role in what appears to be the allelopathic effect of *Acacia erioloba* (Milton & Dean 1995). In the literature studied no indication is given of any role played by termites in seed dispersal or scarification of seeds.