OXFORD FORESTRY INSTITUTE

TROPICAL FORESTRY PAPERS **35**

Acacia erioloba

MONOGRAPH AND ANNOTATED BIBLIOGRAPHY

R.D. Barnes, C.W. Fagg and S.J. Milton

OXFORD FORESTRY INSTITUTE
DEPARTMENT OF PLANT SCIENCES
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TFP35 *Acacia erioloba* Barnes, Fagg and Milton OFI

COVER ILLUSTRATIONS:

Front cover: Large *Acacia erioloba* trees are dwarfed by an immense sand dune in the Tsauchab River Valley near Sossus Vlei in the Namib desert where the mean annual rainfall is less than 50 mm. The trees are established after infrequent storms send floodwater down the valley. Seeds that have passed through the gut of the larger herbivores germinate within a few days and immediately put down deep tap roots to reach a permanent water supply that might be as much as 40 m below the surface. Once established, the trees become the prime source of sustenance for many species of animals, birds and insects.

Back cover: **Above**. A stand of young *Acacia erioloba* trees near Toteng in Botswana. The extraordinarily level browse line shows that livestock take every leaf that is within reach in this arid area where there is virtually no grazing or browse other than that on the trees. The limit of the browse is the height to which a goat can reach when standing on its hind legs.

Below. Under favourable conditions, *Acacia erioloba* trees can grow to very large sizes like this specimen, near the Dett Vlei in Zimbabwe, that dwarfs the vehicle. The high browse line on this tree is maintained by elephants reaching for the pods with their trunks.

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No. 35

Acacia erioloba

MONOGRAPH AND ANNOTATED BIBLIOGRAPHY

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PREFACE

This monograph compiles the results of range-wide studies of the distribution, ecology, taxonomy and variation of an important African acacia species. It follows the style of an earlier OFI Tropical Forestry Paper (No. 32) on *Acacia karroo* and, like the former volume, it provides an exhaustive annotated bibliography. These species, together with other African acacias, are exceptionally important for the survival of humans and their domestic animals in the dry regions of Africa while some have potential elsewhere. It is therefore timely that the series of projects undertaken in the last decade by staff of the Oxford Forestry Institute, particularly Dr Barnes and Mr Fagg, in association with Dr Suzanne Milton, should be published and disseminated widely since they have obtained information that is vital for the rehabilitation of degraded sites and for the improved management and conservation of other environments.

J Burley
Director, Oxford Forestry Institute

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INTRODUCTION

One of the most crucial environmental challenges in Africa is how to restore and increase the productivity of non-arable lands in the drier parts of the continent. Increasing population pressures coupled with periodic droughts have brought about deforestation in these areas and, without trees to protect and maintain soil fertility, annual grasses replace the more nutritious perennial species and most of the productive potential is lost. Many exotic tree species have been introduced in attempts to find a rapid solution to the problem but the success that these have had in the better watered parts has not been repeated in the semi-arid regions where the ravages of droughts, termites and browsing animals, among other hardships, have made it difficult for them to survive. It is now generally accepted that the solution lies in the management and cultivation of the indigenous trees, particularly the pioneer legumes that are the natural re-colonizers of disturbed land in these environments. Most prominent among these are the acacias which have the attributes required in this situation, including an ability to use nutrients and water from great depths, to fix nitrogen and to produce fuelwood and food for domestic stock.

In 1987, a series of projects, funded by the Overseas Development Administration of the Government of the United Kingdom, was started at the Oxford Forestry Institute to explore, assemble and evaluate the genetic resources of *Acacia* species in Africa. Those initially selected were *A. nilotica, A. senegal, A. tortilis* and *Faidherbia* (then *Acacia*) *albida*, the four most important species with an Africa-wide distribution. During fieldwork carried out in southern Africa in the course of the first three-year project, the regional importance of *A. erioloba* was recognized and it was added as a fifth species for attention in the five collection, evaluation and dissemination projects that have followed (Fagg and Barnes, 1995; Barnes *et al.*, 1996c).

Acacia erioloba is specifically adapted to the wind-blown sands of the ancient Kalahari desert that once covered a large part of south-western Africa during a much drier period in geological time. Today, its distribution is still wholly determined by the presence of these sands regardless of rainfall that now varies from <40 in the Namib Desert to *c.* 900 mm in the north of its distribution in Zambia.

The range of mean daily temperatures are no less extreme and vary from <15°C up to >45°C. Very severe frosts are common over much of its natural distribution. 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 a permanent water supply after which it is independent of annual rainfall and can live for hundreds of years. In these situations *A. erioloba* is often the only tree in the environment, whereas in the better watered parts, it is a component of savanna woodland communities. It rarely nodulates but there is evidence that it draws its nitrogen from deep ground-water. It cycles nutrients from great depths and this provides conditions for the growth of perennial grass species under and near its canopy.

Although the pods of *Acacia erioloba* are used as livestock feed over much of its range, neither the value of the pods nor the beneficial effects that it has on the quality of grazing beneath and between the trees have ever been quantified. If this information were available, the species would be more highly prized for its potential to increase productivity in these marginal areas and it might be conserved, regenerated and managed more intensively. There might also be the prospects for improving the species through selection in these operations if the pattern and extent of its genetic variation were known. Further, although *A. erioloba* has a restricted distribution in southern Africa, there are many other parts of the world where similar environmental conditions exist where it might be introduced if more were known about its economic worth measured against the hazards of invasion.

This monograph and bibliography has been produced to make available all the information on the species that has been found in the published and grey literature and the observations that have been made during the course of the African acacia projects that have been undertaken by the Oxford Forestry Institute.

NOMENCLATURE AND TAXONOMY

Acacia erioloba in the genus *Acacia*

The genus *Acacia* Mill. is pantropical and there are now some 1250 species (840 in Australia; 230 in the New World; 130 in Africa; 18 in India; a few species in Asia; and some island endemics). There has not been a comprehensive revision of the genus since George Bentham's taxonomic study in 1875 when 432 species were recognized and divided into six series (Bentham, 1875). Guinet and Vassal (1978) have since divided *Acacia* Mill. into three subgenera broadly following Bentham's six series: *Heterophyllum* (series *Phyllodineae, Botryocephalae* and *Pulchellae* Benth.), *Aculeiferum* (series *Vulgares* and *Filicinae* Benth.) and *Acacia* (series *Gummiferae* Benth.). *Heterophyllum* is virtually restricted to the Australian continent and the majority of species (except sect. *Botrycephalae* and sect. *Pulchellae*) have phyllodes (large strap-like foliage) and an absence of thorns. The subgenera *Acacia* (all bearing thorns) and *Aculeiferum* (some bearing prickles) have bipinnate leaves and occur on all other continents.

Given its size, the genus is the largest in the *Mimosoideae* and the second largest in the family *Leguminosae* and, because of its complexity, efforts have been made to split it. Pedley (1986) has recently divided the genus into three separate genera *Racosperma*, *Senegalia* and *Acacia*, corresponding to the subgenera of Guinet and Vassal (1978), but these divisions have generally been considered to be premature without further research.

In Africa the acacias belong to two subgenera, *Aculeiferum*, whose species, typified by *Acacia senegal*, are mostly diploid with prickles and spicate inflorescences and *Acacia*, typified by *A. nilotica*, whose species are mostly polyploids with thorns and capitate inflorescences. The polyploid species of *Acacia* occupy a greater range of habitats and are more widely distributed than those of *Acueliferum*, possibly due to greater genetic plasticity. *A. erioloba* is placed in the subgenus *Acacia* (series *Gummiferae* Benth.). In addition to bearing thorns, the pod anatomy of the species, a fibre stratum with longitudinal fibres only and a continuous stone cell stratum outside vascular bundles, places it in the *Gummiferae* (Robbertse, 1975b). The morphology and anatomy of the proximal and distal leaves also place it in this series (Robbertse, 1975c). *A. erioloba* has narrow wood rays, a feature of the *Gummiferae*, although it is unusual in the series in having distinct heartwood (Robbertse *et al.*, 1980). According to Bentham (1875), *A. erioloba* belongs to the *Gummiferae* series sub-series *Summibracteatae*.

Acacia erioloba is generally restricted in its natural occurrence to the Kalahari sand formations of the western side of southern Africa where it is often the only tree of any size and forms a conspicuous feature of the landscape (Ross, 1979). It is easily distinguished from other acacias and taxonomically varies little over its range.

[References:- 9, 28, 52, 90, 93, 94, 95, 96, 97, 98, 103, 104]

Nomenclature (Modified from Ross, 1979)

Acacia erioloba E. Mey., Comm. 1: 171 (1836). Type: South Africa, Namaqualand (herbarium unknown); Traansvaal, Wolmaransstad Distr., between Kommandodrif and Makwassie, J.W. Morris 1042 (K, neotype!; PRE isoneotype).

syn. *Acacia giraffae* sensu auct. mult. non *A. giraffae* Willd., Enum. Hort. Berol. 1054 (1809) sensu stricto.: Burch., Trav. 2: 240 (1824).

syn. *Mimosa* sp. sensu Paterson, Journeys into Country of Hotentots and Caffraria 133, tt.16 17 (1789).

syn. *A. giraffae* var. *espinosa* Kuntze in Jhrb. K. bot. Gart. Mus. Berl. 4:264 (1886). Type: South West Africa, Hereroland, *Pechuel-Loesche sn.* (B, holo.†)

[References:- 100, 103]

Vernacular names

Mogotlho (Tswana), mokala (Kgalagadi, Rolong), omumbonde (Herero), ghuthu (Mbukushu), //ah (!xo Bushmen), /ana (!kung Bushmen), //kara (g//ana Bushmen), go (kua Bushmen), umHohlo (Ndebele), isiNga (Ndebele), umFola (Ndebele), maHota (Lozi), maHoto (Lozi), Mupombe (Mungambo), Omuande (Kwanyama), ano (Kwanyama), Amutok (Kwanyama), omuonde (Wambo), //ganab (Nama), munto ghutu (Kavango), camel thorn (English), giraffe thorn (English), kameeldoring (Afrikaans).

The specific epithet, *erioloba*, means half-moon and refers to the shape of the pod.

[References:- 22, 33, 108, 127, 139, 140]

Botanical description (See Figure 1)

Tree to 15m high (frontispiece and Plate 6A-I) or occasionally a shrub, crown fastigiate in young trees (Plate 7A) but rounded to flattened in mature trees (Frontispiece and Plate 6H), the branches often drooping somewhat, or flattened and spreading. *Bark* (Plates 2G and 7E) dark greyish brown to blackish, rough, fissured, often flaking off in thick woody sections when old: *Branchlets* (Plate 7I grey- or reddish-brown to purple, sometimes as though white-washed over a purplish background especially in the previous season's growth (Plate 1G), usually glabrous but sometimes pubescent. *Stipules* (Plates 1G and 1H)

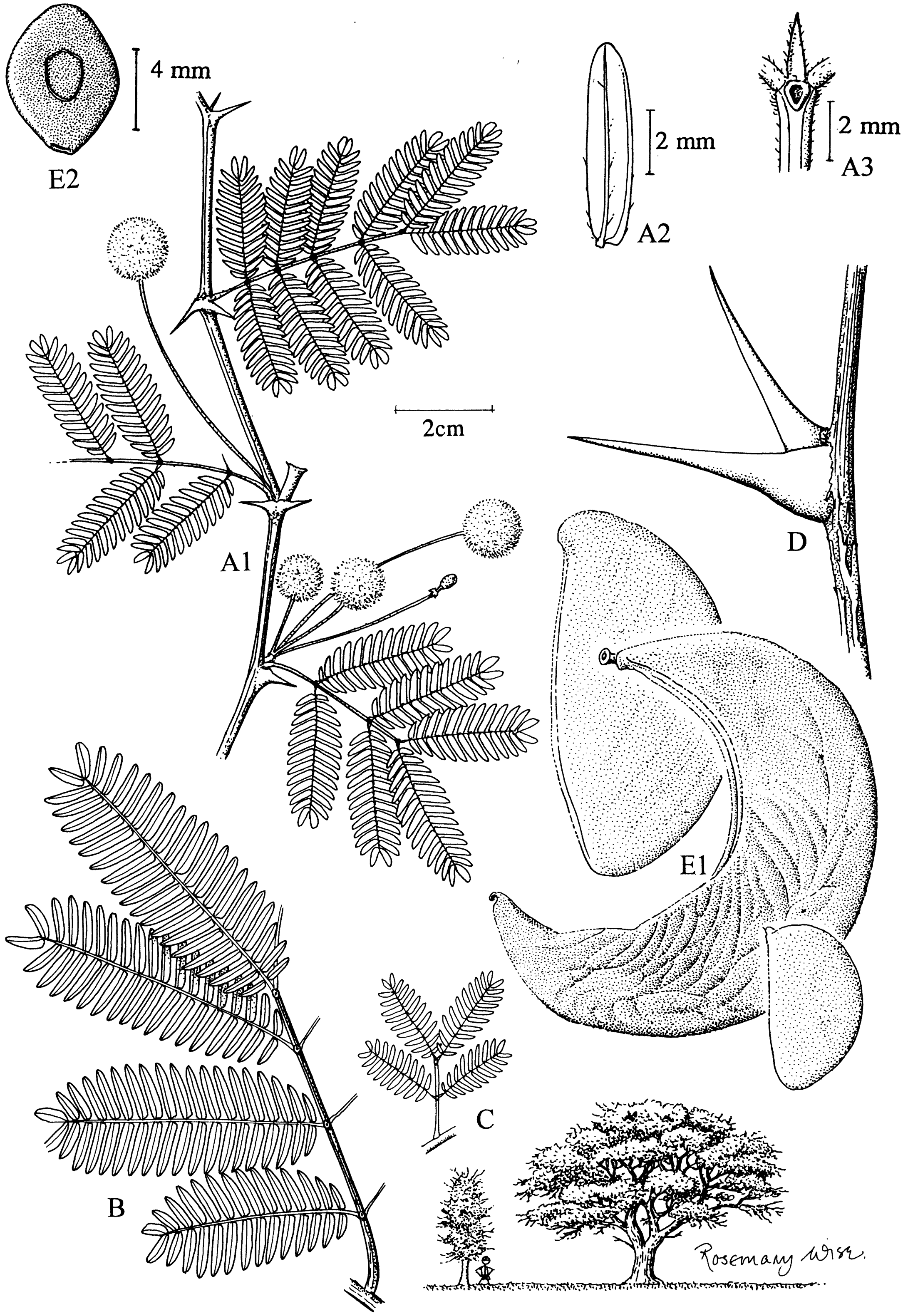

Figure 1. *Acacia erioloba*. A1 flowering branchlet, A2 leaflet, A3 tip of leaf rhachis showing nectary (Barnes 543); variation in leaf size across range: A Zimbabwe, B Zambia (Fagg 372), C Botswana (Fagg 582); D inflated thorns (Barnes 533); E1 variation in pods within populations, E2 seed (Barnes 2049).

spinescent, in pairs, 0.5-5 (10) cm long, usually rather stout, often thickened below and fused together basally into a large ant-gall 1.5-2.0 x 2.0-2.5cm, sometimes furrowed down the middle, tapering to a sharp point apically. *Leaves* (Plates 1A, 1B, 1D and 1G) usually glabrous or subglabrous;: petiole 0.4-1.4cm long, adaxial gland absent; rachis 1.5-5.0cm long, a small gland at the junction of each pinnae pair; pinnae 2-5 (6) pairs; rachillae 1.3-4.2cm long; leaflets (6) 8-18 pairs per pinnae, 4-13 x 1.5-4.5mm, oblong to narrowly obovate, apex rounded to subacute, eglandular, glabrous throughout or with marginal cilia, seldom pubescent, lateral nerves prominent and conspicuous beneath. *Inflorescences* (Plates 1A and 1B) capitate, on axillary, solitary or fascicled, glabrous or subglabrous, eglandular peduncles 1.8-4.0cm long; involucel apical. *Flowers* (Plate 1A) bright golden yellow. *Calyx* 2-2.5mm long, glabrous or lobes with few hairs. *Corolla* 2.7-3.6mm long, glabrous or lobes with few hairs. *Stamen-filaments* free or connate basally into groups. *Pods* (Plates 1C-F, 2E and 8D) densely grey to grey-brown velutinous, with numerous minute dark reddish-brown to purplish glands especially when young, (5) 6-13 x 1.8-5 cm, thick, semi-woody, indehiscent, semi-lunate to sub-orbicular, spongy within, seeds irregularly scattered. *Seeds* (Plates 5B and 6A) 8-14 x 7-10 mm, lenticular to elliptic; areole 3-9 x 2-5.5mm. (Modified from Ross (1979)).

[References:- 15, 22, 58, 102, 103, 126, 139]

Citation

The following herbarium specimens of *Acacia erioloba* have been logged in to the BRAHMS database at the OFI.

ANGOLA <u>Cuando Cubango:</u> **Menongue,** *14° 30'S 17° 30'E,* (31 Jan 1960), *Mendes EJ 2247 (LISC);* **Rivungo,** *16° 20'S 22° 02'E,* (24 Aug 1966), *Mendes Dos Santos R 2364 (LISC);* <u>Huila:</u> **Catequero,** *16° 30'S 14° 55'E,* (9 Oct 1957), *Teixeira JB 2791 (LISC);* **Catequero,** *16° 30'S 14° 55'E,* (9 Oct 1957), *Teixeira JB 2790 (LISC);* **Chibemba,** *16° 20'S 15° 20'E,* (12 Aug 1963), *Azancot De Menezes 637 (K, P, SRGH);* **Chibembe,** *15° 10'S 17° 40'E,* (12 Aug 1963), *Azancot De Menezes 657 (LISC);* **Chimbolelo,** (14 Sep 1963), *Barbosa G 10782 (LISC);* **Chimbolelo,** (1 Sep 1963), *Henriques C 169 (LISC);* **Hauda,** (11 Dec 1965), *Correia Rui 3347 (LISC);* **Humbe,** *16° 40'S 14° 55'E,* (7 Jun 1937), *Gossweiler J 11032 (K);* **Humbe,** *16° 40'S 14° 55'E,* (9 Feb 1956), *Torre AR 8718 (LISC, SRGH);* **Humbe,** *16° 40'S 14° 55'E,* (23 Oct 1970), *Henriques C 1261 (LISC);* **Humbe,** *16° 50'S 14° 58'E,* (26 Feb 1974), *Dechamps R Murta F & Da Silva M 1256 (EA, K, LISC);* **Mulondo,** *15° 40'S 15° 14'E,* (21 Sep 1963), *Azancot De Menezes 703 (SRGH);* **Mulondo,** *15° 40'S 15° 14'E,* (24 Sep 1963), *Barbosa G 10817 (LISC);* **Pereira d'Eca,** *17° 00'S 15° 47'E,* (5 Nov 1941), *Gossweiler J 12846 (LISC, SRGH);* **Pereira d'Eca,** *17° 00'S 15° 47'E,* (4 Apr 1960), *Grandvaux Barbosa & Correia Rui 9026 (LISC, SRGH);* **Quipungo,** *14° 50'S 14° 30'E,* (26 Jun 1959), *Pereina L 799 (LISC);* **Quiteve,** *16° 00'S 15° 12'E,* (21 Sep 1963), *Azancot De Menezes 783 (K, LISC, P);* **Rocadas,** *16° 40'S 15° 01'E,* (31 Mar 1970), *Da Silva M 3004 (LISC);* <u>Mocamedes:</u> **Baia dos Tigres,** *16° 40'S 11° 56'E,* (12 Jan 1956), *Mendes EJ 1274 (LISC);* **Lagoa de S. Joao do Sul,** (30 Jan 1955), *Torre AR 8351 (LISC);* **Mulola,** (10 Oct 1968), *Brito Teixeira J et al 12690 (LISC);* **Virei,** *15° 40'S 12° 58'E,* (10 May 1973), *Menezes A Barroso et Sousa 4909 (LISC, SRGH);* <u>Namibe:</u> **Espinheira,** *16° 50'S 12° 22'E,* (30 Apr 1969), *Brito Teixeira J et al 13027 (LISC);*

BOTSWANA <u>Central:</u> **Mahalapye,** *23° 00'S 26° 50'E,* (Sep 1961), *Yalala AM 136 (K, PRE, SRGH);* **Mahalapye,** *23° 10'S 26° 52'E,* (22 Sep 1977), *Camerik AM 204 (PRE);* **Mahalapye rd.,** (7 Sep 1905), *Burtt-Davy J PRE 1375 (PRE);* **Mahalapye village,** (30 Apr 1923), *Swynnerton CFM 4039 (EA, K);* **Orapa,** *21° 20'S 25° 22'E,* (20 Aug 1974), *Allen AM 156 (PRE);* **Orapa,** *21° 20'S 25° 07'E,* (7 Dec 1974), *Allen AM 221BCD (PRE);* **Pilane,** *23° 20'S 26° 42'E,* (4 Sep 1977), *Hansen OJ 3176 (K, PRE, SRGH);* **Serowe,** *22° 20'S 26° 43'E,* (22 Dec 1974), *Woollard J 121 (SRGH);* <u>Chobe:</u> **Chobe river,** *17° 50'S 24° 52'E,* (28 Jul 1950), *Robertson & Elffers 70 (K, PRE);* **Kasane,** *17° 50'S 25° 05'E,* (28 Aug 1970), *Mavi S 1164 (K, PRE, SRGH);* **Makalamabedi,** *20° 20'S 23° 49'E,* (1 Sep 1962), *Yalala AM 226 (K);* <u>Ghanzi:</u> *20° 30'S 22° 51'E,* (24 Oct 1973), *Smith PA 738 (K, SRGH);* **Central Kalahari reserve,** (Mar 1968), *Tanaka J 47 (PRE);* **Chukudu pan,** *22° 00'S 23° 00'E,* (20 Jun 1955), *Story R 4945 (K, PRE);* **Deception pan,** (17 Sep 1975), *Owens M 103 (K, PRE, SRGH);* **Ghanzi,** *21° 40'S 21° 37'E,* (28 Jul 1955), *Story R 5069 (K, PRE);* **Ghanzi camp,** *21° 40'S 21° 39'E,* (15 Sep 1969), *Brown RC 6619 (K, PRE, SRGH);* **Lokalane,** *23° 10'S 22° 13'E,* (8 Sep 1988), *Barnes RD 533* **Rakops,** *21° 10'S 24° 22'E,* (31 Dec 1972), *Thompson MF 1683 (PRE);* <u>Kgalagadi:</u> *26° 40'S 21° 41'E,* (20 Mar 1991), *Cook FEM Linington S & Sydes C 90 (K);* **Bokspits,** *26° 50'S 20° 42'E,* (16 Mar 1979), *Timberlake JR 2000 (SRGH);* **Damara pan,** *22° 10'S 22° 37'E,* (20 Apr 1930), *van Son G TM 28869 (PRE);* **Dondong,** *23° 10'S 20° 32'E,* (20 Sep 1976), *Bergstrom R 16 (K, SRGH);* **Kang,** *23° 50'S 22° 50'E,* (6 Mar 1987), *Long DG & Rae DAH 104 (K);* **Kang,** *23° 40'S 22° 50'E,* (20 Oct 1975), *Mott PJ 789 (PRE, SRGH);* <u>Kgatleng:</u> **Makgobokgobo,** (Sep 1967), *Henry PWT 65 (SRGH);* **Mochudi,** *24° 20'S 26° 07'E,* (8 Sep 1905), *Galpin EE 7010 (PRE);* <u>Kweneng:</u> **Lephephe,** *22° 20'S 25° 37'E,* (Feb 1982), *Snyman & Noailles 260 (PRE);* **Molepolole,** *24° 10'S 25° 09'E,* (18 Jan 1975), *Mott PJ 556 (SRGH);* <u>Ngamiland:</u> (24 Jul 1976), *Mott PJ 982 (K, PRE, SRGH);* **Kinkogo Tetse camp,** (16 Mar 1961), *Richards HM Mrs 14716 (K);* **Lake Ngami,** (Oct 1861), *Baines J S.N. (K);* **Mosu camp,** (Jun 1958), *Robertson FJ 726 (K, SRGH);* **Mukoba kraal,** *19° 20'S 23° 07'E,* (14 Jun 1972), *Babich K 3 (PRE);* **Santawan camp,** *19° 40'S 23° 43'E,* (27 Jun 1992), *Fagg CW 582 (FHO, SRGH);* **Toteng,** (Jun 1946), *Miller OB B/419 (PRE);* **Toteng,** *20° 20'S 22° 52'E,* (Jun 1946), *Miller OB B/427 (PRE);* <u>Northern Division:</u> **Beacon island,** *19° 00'S 23° 00'E,* (10 Sep 1975), *Hiemstra H 264 (K, PRE, SRGH);* **Dobe,** *21° 00'S 19° 35'E,* (4 Apr 1964), *Lee RB DA17 (SRGH);* **Gobega lagoon,** *19° 10'S 23° 13'E,* (7 Mar 1972), *Biegel HM & Russell G 3896 (SRGH);* <u>South East:</u> **Kolobeng,** *24° 30'S 26° 03'E,* (16 Nov 1974), *Woollard J 87 (SRGH);* <u>Southern:</u> *24° 20'S 23° 15'E,* (13 Mar 1989), *Terry J Cook FEM Sydes CL & Kalake E 81 (K);* **Kanye,** *24° 60'S 25° 20'E,* (22 Jan 1979), *Timberlake JR 1922 (SRGH);* <u>Unknown:</u> **Boro island,** (15 Aug 1974), *Biggs RC M650 (SRGH);* **Mahudutlachi Pan,** *24° 10'S 22° 23'E,* (22 May 1967), *Cox TJ 401 (K);* **Mahudutlake pan,** (22 May 1967), *Cox TJ 338 (K);* **Mathethe,** (18 Nov 1948), *Hilliard & Robe 605 (PRE);* **Mathethe,** (18 Nov 1948), *Hillary & Robertson 605 (K);*

Mathkwane, (13 Sep 1955), *Reyneke J 411 (PRE);* **Padda Pan,** (19 Apr 1929), *Pole Evans IB 2483 (K, PRE);* **Ramathlabama dist.,** (4 Aug 1956), *Clarke B 172 (PRE);*

MOZAMBIQUE Manica: **Juer,** *21° 10'S 32° 49'E,* (24 Jul 1949), *Pedro & Pedrogao 7701 (LMA);*

NAMIBIA Caprivi: **Kongola,** *17° 50'S 23° 22'E,* (27 Sep 1970), *Vahrmeijer J 2123 (PRE);* **Linyati,** (27 Dec 1958), *Killick WGB & Leistner OA 3141 (K, PRE, SRGH, WIND);* Damaraland: **Brandberg,** *21° 10'S 14° 35'E,* (May 1949), *Liebenberg LCC 5032 (PRE, WIND);* **Fransfontein,** *20° 10'S 15° 01'E,* (May 1949), *Liebenberg LCC 4917 (PRE, WIND);* Grootfontein: **Kududamm,** *19° 50'S 17° 52'E,* (16 Dec 1938), *Volk OH 415 (PRE);* **Otavi,** *19° 40'S 17° 20'E,* (19 Mar 1955), *de Winter B 2843 (K, PRE, WIND);* Kaokoland: (12 Jul 1975), *Griffin RE 161 (WIND);* **Otjiwero,** *17° 60'S 13° 17'E,* (3 Apr 1957), *de Winter B & Leistner 5361 (K, PRE, WIND);* Karasburg: **Ariamsvlei,** *28° 20'S 19° 37'E,* (12 May 1973), *Bayliss RDA 328 (K, PRE);* **Pella Drift,** *28° 56'S 19° 09'E,* (8 Jan 1909), *Pearson HHW 3584 (K);* Karibib: **Okomitundu,** *22° 10'S 16° 19'E,* (27 Sep 1962), *Seydel R 3176 (SRGH);* **Otjimbingue,** *22° 21'S 16° 08'E,* (May 1886), *Lindner sn (K);* **Otjimbingwe,** *22° 20'S 16° 07'E,* (May 1886), *Marloth HWR 1398 (PRE);* Kavango: **Uramba river,** (30 Nov 1955), *de Winter B 3771 (K, PRE, WIND);* Luderitz: **Aus,** *26° 40'S 16° 16'E,* (6 Mar 1929), *Dinter 6140 (K);* **Namib,** *26° 30'S 15° 44'E,* (22 Feb 1947), *Gerstner JJ 6308 (PRE);* Maltahohe: **Chamchawab farm,** *25° 30'S 16° 48'E,* (17 Dec 1978), *van Greuning J 441 (PRE);* Mariental: **Wereldend,** *25° 10'S 17° 52'E,* (5 Feb 1974), *Davidse G & Loxton 6410 (PRE);* Namibrand: **Naibrivier,** (23 Aug 1954), *Seydel R 304 (K, SRGH);* Okahandja: **Okahandja,** *21° 50'S 16° 52'E,* (26 Oct 1947), *Rodin RJ 2128 (K, PRE);* **Okahandja,** *21° 60'S 16° 55'E, Marloth HWR 1193 (OXF);* **Okahanja,** *21° 59'S 16° 55'E,* (Sep 1906), *Dinter 267 (K, P);* Otjiwarongo: **Quickborn,** *21° 10'S 17° 07'E,* (17 Sep 1928), *Bradfield RD 11 (PRE);* Outjo: **Beulah farm,** (7 Apr 1955), *de Winter B 3105 (K, PRE, WIND);* Owambo: **Oshikango,** *17° 24'S 15° 53'E,* (14 Feb 1973), *Rodin RJ 8931 (K);* Rehoboth: **Awasab reh 333 farm,** *23° 40'S 17° 07'E,* (21 Sep 1973), *Giess W 13080 (PRE, WIND);* **Awasab reh 333 farm,** *23° 30'S 17° 08'E,* (22 May 1974), *Goldblatt P 1895 (PRE, WIND);* Swakopmund: *23° 30'S 15° 02'E,* (24 Aug 1989), *Barnes RD 2049 (FHO, PRE, SRGH);* **Goanikontes,** (31 Oct 1947), *Rodin RJ 2154 (K, PRE);* **Kuiseb,** *23° 40'S 15° 07'E,* (27 Feb 1972), *Schmidt EAF 83 (PRE, WIND);* **Laer kuiseb,** *23° 10'S 14° 37'E,* (Jul 1977), *Theron GK 3758 (PRE, WIND);* **Sossus vlei,** *24° 40'S 15° 22'E,* (10 May 1976), *Oliver & Muller & Steenkamp 6534 (PRE);* **Souss vlei,** *24° 40'S 15° 22'E,* (23 Dec 1982), *Erasmus H S.N. (PRE);* Tsumeb: **Nas. Etosha wildtuin,** *18° 50'S 17° 07'E,* (14 Oct 1980), *Goosen D 21 (K, PRE);* Unknown: (6 Jan 1909), *Pearson 2951 (K);* **Okambahe,** (May 1949), *Liebenberg 5032 (K);* **Omdiramba,** (Jan 1948), *Wiss HJ & Kinges H 851 (PRE);* Windhoek: **Friedenau win 16 far,** (3 Mar 1955), *de Winter B 2590 (K, PRE, WIND);* **Leutwein,** *22° 50'S 17° 07'E,* (Sep 1924), *Dinter K PRE 52911 (PRE);* **Windhoek,** *22° 40'S 17° 07'E,* (20 Nov 1949), *Codd LEW 5770 (PRE, WIND);* **Windhoek,** *22° 35'S 17° 05'E,* (Oct 1948), *Keet AD 1679 (K);* **Windhoek district,** *22° 40'S 17° 05'E,* (Oct 1948), *Keet JDM 1679 (PRE, WIND);*

SOUTH AFRICA Cape: (6 Feb 1974), *Davidse G & Loxton 6424 (PRE); Marloth HWR PRE 30311 (PRE); 32° 50'S 18° 52'E,* (25 Oct 1983), *Taylor HC 10744 (PRE);* **Augrabieswaterfal,** *28° 40'S 20° 22'E,* (12 Sep 1985), *Zietsman & zietsman 618 (PRE);* **Auob river,** *26° 10'S 20° 22'E,* (21 Sep 1959), *Barnard PJ 726 (PRE);* **Buffels river valley,** *29° 40'S 17° 37'E,* (7 Dec 1973), *Tolken HR 5209 (PRE);* **Campbell,** *28° 50'S 23° 37'E, Sim TR 20187 (PRE);* **Douglas,** *29° 10'S 23° 52'E,* (Nov 1929), *Kotze PC 793 (PRE);* **Griqualand west,** *Sim TR PRE 30310 (PRE);* **Grootberg,** *28° 20'S 17° 07'E,* (1 Sep 1925), *Marloth HWR 12408 (PRE);* **Hartbeest river,** *29° 10'S 20° 52'E,* (10 Jun 1973), *Lange C 1 (PRE);* **Hellsberg,** *28° 20'S 17° 07'E,* (10 Oct 1947), *Rodin RJ 1576 (K, PRE);* **Kakamas,** *28° 50'S 20° 37'E,* (Oct 1925), *Gill GA 20A (PRE);* **Kalahari gemsbok nat,** (13 Sep 1971), *Balsinhas A & Kersberg H 1962 (PRE);* **Kenhardt div.,** (7 Feb 1961), *Barclay & Acocks 977 (PRE);* **Kimberley,** *28° 40'S 24° 52'E,* (8 Oct 1936), *Hafstrom A 762 (PRE);* **Kimberley,** *28° 50'S 24° 52'E,* (Oct 1917), *Wilman M PRE 52947 (PRE);* **Kimberley,** *28° 40'S 24° 52'E,* (24 Aug 1961), *Leistner OA & Joynt V 2657 (PRE, SRGH);* **Kimberley div.,** (Nov 1950), *Badenhorst PJ 87 (PRE);* **Klaarwater,** *28° 51'S 23° 15'E, Burchell WJ 1952 (K);* **Komaggas,** *29° 50'S 17° 22'E,* (7 Dec 1973), *Tolken HR 5222 (PRE);* **Kuruman,** *27° 20'S 23° 22'E,* (30 Jan 1974), *Davidse G & Loxton 6075 (PRE);* **Kuruman district,** *27° 10'S 22° 37'E,* (4 Nov 1976), *Robbertse PJ 1126 (PRE);* **Lekkersing,** *28° 50'S 17° 07'E,* (12 Dec 1973), *Tolken HR 5315 (PRE);* **Middeldeurvlei,** *32° 50'S 18° 52'E,* (11 Dec 1982), *Taylor HC 10530 (PRE);* **Nous,** *28° 40'S 19° 52'E,* (13 Sep 1973), *Coetzee & Werger 1741 (K, PRE);* **Numees,** *28° 20'S 17° 07'E,* (13 Oct 1948), *Werdermann & Oberdieck 564 (K, PRE);* **Olifantshoek,** *27° 50'S 22° 52'E,* (Apr 1933), *Lang H TM 31705 (PRE);* **Orange river,** *28° 40'S 19° 37'E,* (29 Sep 1987), *van Hoepen E 1943 (PRE);* **Pofadder,** *29° 10'S 19° 22'E,* (17 Oct 1928), *Hutchinson J 942 (K, PRE);* **Polar,** *26° 40'S 23° 37'E,* (1 Dec 1977), *Peeters & Geric 17 (PRE);* **Rooibrak,** *28° 10'S 24° 37'E,* (19 Sep 1959), *Leistner OA 1492 (K, PRE, SRGH);* **Rosynebos,** *29° 10'S 18° 52'E,* (16 Nov 1972), *van Der Westhuysen PM 322 (PRE);* **Schmidtsdrift,** *28° 40'S 24° 07'E,* (22 Sep 1936), *Acocks JPH 735 (PRE);* **Spoeg river,** (23 Sep 1948), *Acocks JPH 14943 (K, PRE);* **Taungs,** *27° 40'S 24° 37'E,* (22 Sep 1917), *Pole Evans IB PRE 15833 (PRE);* **Taungs,** *27° 32'S 24° 48'E,* (29 Sep 1919), *Shantz HL 222 (K);* **Vaalbos (suid),** *28° 20'S 24° 22'E,* (21 Feb 1989), *Zietsman DC 847 (PRE);* **Zoet vley,** *27° 10'S 24° 07'E,* (1988), *Speedy J G 16/10 (PRE);* Orange Free State: (May 1874), *Barber Mrs sn (K);* **Boshof dist.,** (24 Mar 1933), *Schweickerdt H 1105 (FHO, PRE);* **Kommandodrif,** *27° 00'S 26° 00'E,* (18 Oct 1987), *Joffe H 415 (PRE);* **Oppermansdrift dam,** *27° 40'S 25° 22'E,* (10 Dec 1974), *O'Connor TG 116 (PRE);* **Sandveld nature reserve,** *27° 40'S 25° 37'E,* (19 Jan 1989), *Du Preez PJ 1545 (PRE);* **Smitskraal,** (30 Nov 1911), *Burtt-Davy J 11296 (FHO, PRE);* Transvaal: (24 Sep 1945), *Gerstner JJ 5534 (K, SRGH); 22° 50'S 29° 07'E,* (31 Jan 1968), *Huntley BJ 1162 (PRE);* **Arabie Landboukoll.,** *24° 50'S 29° 22'E,* (19 Sep 1978), *Lessing P 12 (PRE);* **Barberspan nat reserve,** *26° 40'S 25° 37'E,* (14 Mar 1973), *Zambatis N 154 (PRE);* **Bloemhof,** *27° 39'S 25° 36'E,* (17 Feb 1929), *Hutchinson J 2988 (K);* **Bloemhof dist.,** (18 Feb 1904), *Burtt-Davy J 1685 (K, PRE);* **Buffelsdrift,** (15 Dec 1965), *Vahrmeijer J 1290 (K, PRE);* **Elands river,** (17 Nov 1955), *Marais W 1098 (PRE);* **Gopane,** *25° 20'S 25° 52'E,* (Jan 1977), *Snyman JW 53B (PRE);* **Greylingsrust,** *27° 20'S 26° 07'E,* (11 Jan 1969), *Morris JW 1247 (PRE);* **Groblersdal,** *25° 10'S 29°*

22'E, (18 Sep 1965), *Grobbelaar N 397 (PRE);* **Groot Marico dist**; (26 Apr 1927), *Liebenberg BAM S.113 (PRE);* **Haenertsburg,** *25° 40'S 28° 07'E*, (Sep 1935), *Obermeyer AA TM 34738 (PRE);* **Hamanskraal,** *25° 24'S 28° 16'E*, (26 Sep 1931), *Trapnell CG 503 (K);* **Hendriksdal,** *26° 10'S 26° 07'E*, (30 Jan 1968), *Morris JW 1162 (PRE);* **Kameelpan,** *28° 50'S 24° 37'E*, (24 Jan 1934), *Theron JJ S.662 (PRE);* **Koedoesrand,** (20 Feb 1936), *Irvine LF 91 (PRE);* **Kommandodrif,** *27° 20'S 26° 07'E*, (22 Jan 1968), *Morris JW 1042 (K, PRE);* **Langjan nature reserve,** *22° 50'S 29° 07'E*, (Nov 1974), *Zwanziger S 94 (PRE);* **Limpopo river,** (12 Sep 1920), *Leipoldt CL 4 (PRE);* **Loskop dam,** (30 Apr 1944), *Mogg AOD 17311 (PRE, SRGH);* **Makwassie,** *27° 20'S 25° 52'E*, (11 Mar 1967), *Scheepers JC 1509 (PRE);* **Mogol nature reserve,** *23° 50'S 27° 52'E*, (Feb 1981), *Fourie SP M 067 (PRE);* **Naboomspruit,** *24° 40'S 28° 37'E*, (26 Sep 1918), *Galpin EE M 108 (PRE);* **Oranjefontein,** (27 Sep 1972), *Mogg AOD 37059 (K, PRE);* **Pienaars river,** *25° 10'S 28° 22'E*, (1974), *Codd LEW PRE 52928 (PRE);* **Pienaars river,** *25° 20'S 28° 22'E*, (Sep 1976), *Swartz P 139 (K, PRE);* **Potgietersrust,** (1 Nov 1968), *Strey RG 8005 (SRGH);* **Potgietersrust,** *24° 10'S 29° 07'E*, (Jan 1906), *Burtt-Davy J PRE 2300 (PRE);* **Potgietersrust,** *24° 00'S 29° 00'E*, (9 Feb 1966), *de Winter B 8438 (PRE);* **Potgietersrust,** *24° 10'S 29° 07'E*, (24 Aug 1908), *Leendertz R 1146 (PRE);* **Potgietersrust,** (1 Apr 1957), *Meeuse ADJ 10143 (K, PRE);* **Potgietersrust,** *24° 10'S 29° 07'E*, (14 Jan 1931), *Rowland J 164 (PRE);* **Pretoria Nat. Bot. gardens,** *25° 40'S 28° 22'E*, (17 Sep 1965), *Gerber H 30 (PRE);* **Rust de Winter,** *25° 10'S 28° 22'E*, (24 Sep 1945), *Gerstner JJ 5535 (PRE);* **Schweizer-reneke,** *27° 10'S 25° 22'E*, (17 Feb 1904), *Burtt-Davy J 1660 (PRE);* **Sekukuniland,** (11 Jan 1939), *Barnard & Mogg 1163 (PRE);* **Soja mineral baths,** *22° 50'S 29° 37'E*, (19 Apr 1976), *van Jaarsveld 1247 (K, PRE);* **Soutpansberg district,** *22° 20'S 29° 07'E*, (11 Jul 1981), *Straub C 10 (PRE);* **Swartruggens,** *25° 40'S 26° 37'E*, (22 Oct 1937), *Sutton JD 1180 (PRE);* **Swerwerskraal,** (22 Jan 1929), *Hutchinson J 2633 (K, PRE);* **Waterberg district,** (11 Sep 1919), *Galpin EE M 108 (PRE);* **Wolmaransstad,** *27° 20'S 25° 52'E*, (11 Oct 1930), *Fries TCE Norlindh T Weimarck H 1861 (K, PRE, SRGH);* **Wonderboom,** *25° 40'S 28° 07'E*, (2 Oct 1912), *Theiler AC TM 12364 (PRE);* **Wonderboom poort,** *25° 40'S 28° 07'E*, (15 Mar 1932), *Smith CA 6096 (PRE);* **Unknown:** **Bushmans Bank,** (Oct 1926), *Pillans NS 5102 (K);*

ZAMBIA **Copperbelt:** (4 Oct 1958), *Fanshawe DB 4943 (K);* Sesheke: Masese, (11 Aug 1947), *Brenan JPM & Keay RWJ 7682 (EA, K);* **Southern:** *15° 50'S 26° 02'E*, (18 Oct 1988), *Fagg CW 372 (FHO, SRGH);* **Kabulamwanda,** *15° 50'S 26° 53'E*, (12 Aug 1963), *van Rensburg HJ 2425 (K);* **Makotoolo,** *15° 60'S 26° 54'E*, (19 Jun 1992), *Fagg CW 575 (FHO, SRGH);* **Namwala,** *15° 50'S 26° 27'E*, (23 Jun 1952), *White F 2977 (FHO, K);* **Namwala boma,** (20 Apr 1963), *van Rensburg HJ 2075 (K, SRGH);* **Western: Masese,** *17° 20'S 24° 40'E*, (16 Aug 1960), *Fanshawe DB 5800 (K);* **Masese,** (15 Apr 1958), *Fanshawe DB 4571 (K);* **Masese,** (6 Sep 1969), *Mutimushi JM 3597 (K, NDO);* **Sesheke boma,** (20 Sep 1969), *Mutimushi JM 3683 (K);* **Shesheke,** *17° 30'S 24° 18'E*, (31 Jan 1952), *White F 1983 (FHO, K);* **Sibuana,** (Aug 1933), *Trapnell CG 1279 (K);*

ZIMBABWE **Bulawayo:** *19° 60'S 28° 32'E*, (22 Sep 1988) *Barnes RD 543* **Chipinge:** *19° 60'S 28° 31'E*, (1 May 1990), *Barnes RD 2306 (FHO);* **Gweru:** **Vungu mine,** *19° 10'S 29° 02'E*, (26 May 1970), *Kelly RD 242 (K, SRGH);* **Hwange:** *18° 40'S 26° 57'E*, (13 Sep 1958), *Guy GL 55/58 (SRGH); 18° 50'S 27° 08'E*, (19 Sep 1990), *Barnes RD 2602 (FHO); 18° 40'S 26° 59'E*, (19 Sep 1990), *Barnes RD 2603 (FHO); 18° 50'S 26° 53'E*, (17 Feb 1996), **Deka river,** *18° 20'S 26° 25'E*, (Jun 1931), *Jack RW 5051 (SRGH);* **Inkwazi valley,** *19° 00'S 27° 13'E*, (1961), *Tapping J 27/61 (SRGH);* **Kandahar fishing camp,** (5 Mar 1985), *Martin C 95 (MSA);* **Ngamo forest reserve,** *19° 00'S 27° 44'E*, (Mar 1960), *Armitage FB 120/60 (SRGH);* **Lupane:** **Gwaai,** *19° 20'S 27° 55'E*, (Mar 1949), *Davies RM 49 (SRGH);* **Mwenezi:** **Marhumbini mission,** *21° 30'S 32° 15'E*, (12 Sep 1967), *Muller T 659 (K, SRGH);* **Shabani fly gate,** *21° 30'S 31° 44'E*, (2 Jun 1971), *Mavi S 1287 (SRGH);* **Nkayi:** **Nkayi,** *18° 60'S 28° 52'E*, (28 May 1970), *Kelly RD 243 (SRGH);* **Nyamandhlovu:** *19° 60'S 28° 21'E*, (18 May 1961), *Denny RP NRSH 204 (SRGH); 19° 40'S 28° 25'E*, (Jul 1959), *Armitage FB 84/59 (SRGH);* **Red leaf,** *19° 60'S 28° 20'E*, (Jun 1946), *West O 2193 (MRSH, SRGH);* **Red leaf farm,** *19° 60'S 28° 20'E*, (20 Oct 1967), *Steyn J MRSH 4332 (MRSH);* **Redbank,** *19° 60'S 28° 26'E*, (Oct 1924), *Eyles F 4037 (SRGH);* **Redbank,** *20° 00'S 28° 28'E*, (20 Jul 1967), *Kennan TCD 283 (MRSH, SRGH).*

Karyotype

Acacia erioloba has been reported as having both diploid 2n = 26 (Robbertse and van der Schijff, 1971) and polyploid 2n = 52 (Hamant *et al.*, 1975) chromosomes.

[References:- 54, 97, 137]

Related species

Robbertse (1974) examined the surface structures of pollen grains of *Acacia giraffae* (now *erioloba*) and *Acacia* (now *Faidherbia*) *albida* in a study to elucidate their taxonomic relationship. *A. albida* was found to be distinct from other species in the series Vulgares in that (1) unlike all southern African acacias it has no glandular appendages on its anthers, (2) it has polyads with un-grooved monads like the acacias in the series *Vulgares* (which all have 16 cell polyads) but, (3) it has up to 32 cells in the polyad and (4) two peripheral monads on each lateral side of the polyad undergo a single division to form a double layer (unlike all others except *A. giraffae*). *A. giraffae* also differed from other members in the series Gummiferae, in the arrangement of the monods and their number in the polyad (26-48). The conclusion is that *A. giraffae* and *A. albida* must be relicts of the parental stock of the African *Acacia* species (Robbertse, 1974). In a further study, Robbertse (1975) found that *A. albida* closely resembles *A. giraffae* (Gummiferae) in the anatomy of the petiole but that in the anatomy of the pinnule, *A. albida* corresponds to the Vulgares series.

In fact *A. erioloba* has no close relatives with which it can be confused, though it will hybridise with *A. haematoxylon* Willd.

[References:- 28, 93, 94, 95, 96]

Natural hybrids

In the late 1940s, specimens of a hybrid between *Acacia giraffae* Willd. and *A. haematoxylon* Willd. were collected in the Hay district of the Cape Province. These were later confirmed by Ross (1971) as a hybrid. Some characteristics displayed by the hybrid, for example number of pinna pairs (Plate 2F), were found to be intermediate between the values recorded for the parent species, while other characters, for example the degree of pubescence and the presence of glands, tended to be inherited from one parent species only. There was a marked tendency for the characters associated together in one of the parent species to remain associated in the hybrid (Ross, 1979). It is not yet known which species functions as a male and which as the female or whether the cross is always made the same way round (Ross, 1979). *A. erioloba* flowers in August-October and *A. haematoxylon* in October-January so there will be some individuals whose flowering times overlap. Although the intermediate individuals produce copious pods that contain some fully formed seeds there are relatively few hybrid swarms. Interestingly, although the parents of the hybrid also overlap in Namibia and Botswana, the hybrid has only been recorded in the northern Cape (see Plate 4B). Field studies and controlled crossing are required to elucidate this interesting natural hybrid.

Later Ross (1975a) found that the holotype of *Acacia giraffae*, described by Willdenow in 1809, was infact an *A. erioloba* x *A. haematoxylon* hybrid. The name *A. giraffae* has therefore been widely misapplied to the species and was subsequently changed to *A. erioloba* E. Mey., the name assigned by Meyer in 1836.

[References:- 22, 99, 100, 101, 103]

GENETIC VARIATION

Morphological and chemical variation

Acacia erioloba varies greatly in stature over its range from a shrub to a very large tree depending upon rainfall and availability of water at depth. This variation extends to leaf and leaflet size but not to seedling morphology as it does, for example, in *A. karroo*. The most marked variation between individual trees is in pod size, shape, phenology and production. Within a single population, throughout the species' range, pods can vary from tree to tree from being small (50 x 20mm) and almost cylindrical in shape to being large (130 x 70mm) flat and almost semicircular.

In a recent study of production and phenology in a young (*c.* 20 years) natural stand of *Acacia erioloba* near Bulawayo (Plate 3E) in Zimbabwe (Barnes *et al.*, 1996c), there have been indications of a large amount of variation in the nutritional value of the pods and seeds as well as in pod size. The results of the laboratory analyses for 52 trees (out of a total of 500 in the study area) that produced 25 or more pods in 1994 are shown in the Table 1 below. These trees are a cohort that were established on previously cultivated land when its use was changed to grazing; the cattle were fed pods of *A. erioloba* and the seeds germinated rapidly after passing through their digestive systems. Although there is no way of separating genetic from environmental variation with this data, a substantial amount of the variation in important characteristics such as crude protein and starch is likely to be under genetic control, given the uniformity of age and site.

Significant differences have been found in height growth in the nursery among half-sib families of *Acacia erioloba* (Gwaze *et al.*, 1988).

Where there is not extreme pressure for browse and pods, there can be preferential selection by stock for pods from some trees. This may be due to differences in palatability that are associated with nutritional value or to differences in the production of prussic acid. There also seems to be a very large variation in the amount of bruchid damage that occurs from tree to tree. This might be due to differences in flowering times or to inherent chemical differences and hence attractiveness to the beetles.

[References:- 6, 7, 53]

Molecular variation

Few studies of molecular variation have been published for *Acacia erioloba*. In a study of alcohol dehydrogenase in the ontogeny of the species during germination and induction in seedling roots (Small *et al.*, 1990), it was found that dry seeds contained high levels of ADH (alcohol dehydrogenase) which separate into six electrophoretic bands in axes and five bands in cotyledons. It is proposed that ADH in this species is coded by three genes and that the isoenzymes arise from intergenic and intragenic dimerization of protomers. The number of ADH isoenzymes and activity decreased after germination more rapidly in axes than in cotyledons. The decline in activity appeared to require active protein synthesis. Cycloheximide and nitrogen prevented, but oxygen enhanced loss of ADH activity. An ADH inactivator was shown to be present in developing axes and may be involved in the regulation of ADH activity. Anoxia, in contrast to hypoxia and 2,4-D were largely ineffective in inducing ADH activity in seedling roots. Roots of well aerated plants showed one ADH electrophoretic band. Induction caused an increase in activity in five ADH isoenzymes with most activity occurring in two isoenzymes.

[References:- 112, 113]

Table 1. Tree size, pod production, pod and seed weight (for 25 pods) and percentage crude protein, fibre, lignin, carbohydrate and starch for a sample of 52 (out of 500) trees in a *c.* 20-year-old natural population of *Acacia erioloba* at Umguza, near Bulawayo, Zimbabwe. (Data from Barnes *et al.*, 1996c)

Trait	Mean	St. dev.	Min. - Max.
Ht (m)	5.70	0.99	3.70 - 7.30
DAH (cm)	18.43	4.55	10.10 - 35.00
Total no. pods	339	252	25 - 1204
Pod weight (g)	337	95	186-755
No. of seeds	387	105	124-545
Pods			
Wt. before grinding (g)	239.3	71.5	114.5 - 498.6
Wt. after grinding (g)	202.0	63.3	101.0 - 454.5
Crude protein (%)	9.93	1.39	6.56 - 12.78
Fibre - NDF (%)	44.92	5.21	33.36 - 58.84
Fibre - ADF (%)	34.31	3.54	28.60 - 44.97
Lignin (%)	4.33	1.32	1.31 - 7.57
Carbohydrate (%)	10.86	2.68	4.37 - 16.96
Starch (%)	25.82	5.11	13.20 - 36.10
Seeds			
Wt. before grinding (g)	94.8	40.1	29.3 - 240.7
Wt. after grinding (g)	77.1	32.4	19.4 - 199.5
Crude protein (%)	27.42	2.00	23.10 - 31.39
Fibre - NDF (%)	32.05	6.81	21.71 - 47.78
Fibre - ADF (%)	20.91	2.41	17.35 - 29.98
Lignin (%)	4.22	0.92	2.46 - 6.17
Carbohydrate (%)	5.70	1.19	3.56 - 9.31
Starch (%)	26.05	6.25	15.20 - 35.10

Sampling genetic variation for provenance testing

There has been a series of Research Schemes carried out by the Oxford Forestry Institute, funded by the Forest Research Programme of the Overseas Development Administration of the Government of the United Kingdom, to explore and assemble the genetic resources of six important African *Acacia* species including *Acacia erioloba* (Fagg and Barnes, 1995) of which 10 provenances were selected to cover the range (Table 2).

This is not a large number of provenances compared to the collections made for the other species included in the projects but, despite its considerable geographic range, *A. erioloba* is very specific to the Kalahari sand formations and there is little indication of adaptive or morphological variation across its range. The provenances were selected, therefore, to give good coverage of the geographic range and also to include material from the climatic extremes and isolated occurrences (Plates 3A-I). It was thought that genetic improvement was more likely to come from the very considerable variation of important traits found within rather than between populations.

Table 2. List of selected provenances from which seed has been collected to test the genetic variation of *Acacia erioloba* across its natural range.

Provenance	Country	Lat./Long.	Alt (m)	MAR (mm)	MAT (°C)
Imhohloweni	Zimbabwe	19.58S 28.31E	1195	541	19.6
Umguza	Zimbabwe	19.58S 28.30E	1180	541	19.6
Makatoolo	Zambia	15.56S 26.54E	1000	871	21.0
Potgietersrus	South Africa	24.12S 29.01E	1020	622	18.7
Twee Rivieren	South Africa	26.29S 20.37E	900	197	20.1
Nossob	South Africa	25.25S 20.36E	960	271	19.7
Shorobe	Botswana	17.37S 23.43E	945	453	21.9
Dordabis	Namibia	22.56S 17.38E	1500	330	18.8
Sossus vlei	Namibia	24.53S 15.18E	600	10	15.2
Hoarusib River	Namibia	18.16S 13.13E	850	c. 200	c. 22.8

Five of the ten provenances selected were included in screening trials of 70 entries of the six species planted over eight sites in Matabeleland, Zimbabwe, in 1994-1995 (Barnes *et al.*, 1996c). Survival, frost resistance and growth were assessed at 12 months from planting in the field and the results are summarized in Table 3. Greatest variation and differences between provenances were shown for height for which the entry means over all trials ranked exactly inversely to the latitude of the provenance origin. Makatoolo from Zambia, the northern-most provenance, consistently ranked highest at all but one site and Twee Rivieren from South Africa, the southern-most provenance, most often ranked lowest (Plate 3F). The Makatoolo provenance was most frost resistant followed by Twee Rivieren and then the other three with nothing between them. This result was unexpected in that Makatoolo should have been least affected by frost since it is from the northern-most part of the range where minimum temperatures are highest. The resistance of trees in this provenance, however, may have been due to their greater size rather than to any physiological difference.

[References:- 7, 40]

Table 3. Survival, height, crown width and frost resistance for five provenances of *Acacia erioloba* at 12 months after planting in eight screening trials in Matabeleland, Zimbabwe (data from Barnes *et al.*, 1996c).

Provenance	Frost-damage (% resistant)	Survival (%)	Height (cm)	Crown width (cm)
	Provenance mean for most frost-susceptible trial	Provenance mean over all eight trials (range of means for individal trials)		
Shorobe (BOT)	71	52 (13-86)	55 (23-79)	65 (08-95)
Potgietersrus (RSA)	71	51 (19-83)	48 (18-75)	51 (06-73)
Twee Rivieren (RSA)	75	54 (15-80)	44 (27-64)	48 (17-71)
Makatoolo (ZAM)	85	55 (23-86)	63 (32-90)	67 (13-80)
Imhohloweni (ZIM)	71	56 (09-91)	53 (21-69)	57 (04-94)

REPRODUCTIVE BIOLOGY

Mating system

There are no reports of studies being carried out on the mating system of *Acacia erioloba*.

Flower and fruit phenology

Acacia erioloba usually starts to flower at about 10 years (Plate 6D) and by 20 years it can be producing regular large pod crops. In the Kuiseb River valley, Namibia, *A. erioloba* trees produce no pods until they exceed 3 m in height and develop spreading canopies (van Wyk *et al.* 1985). It is among the first acacias to flower in early spring, August to October in southern Africa, on the previous year's growth (Leistner, 1967; Poynton, 1984). Poynton (1984) records that the main flowering period is in the spring but that it can start in winter and end in summer. At the peak of its flowering period, the temperatures are likely to be high, frosts infrequent and thunderstorms unusual. Insect activity is therefore consistently high, the pollination process generally uninterrupted and the young pods are not subjected to damage by violent weather. *A. erioloba* is deep-rooted and Story (1958) records roots found at 45 meters deep in a borehole in Namibia. Fluctuations in annual rainfall are buffered by this permanent access to groundwater and 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. In fact, it has been described as being acyclic (Seely *et. al.*, 1979) although there have been records of rainfall affecting the pod crop (Nel *et al.*, 1985). The very occasional severe late frost can damage the flower initials and the odd un-seasonally early severe thunderstorm with attendant high winds can break off the developing pods (Plates 1C and 1D) and reduce the year's production (Nel, 1983). There is tree to tree variation in flowering time and this is periodically expressed by the odd tree bearing heavy pod crops in a year that has otherwise been bad for the pod crop; but the species generally flowers over a comparatively short period within a population and, if one of these occasional damaging events has occurred, overall pod production is severely prejudiced. It is quite possible that the genetic evaluation trials now being established (Barnes *et al.*, 1996c) will show there to be between-population differences in flowering phenology and this will provide the opportunity to assemble material to create populations whose pod production will fluctuate little even in the worst years.

Acacia erioloba pods ripen in autumn and winter (Poynton, 1984). Individual trees vary greatly in the time their pods ripen and fall and they become available for browsing animals over an extended period from April over the major part of the species' range. In the Kuiseb River valley in the Namib Desert, Namibia, pod fall one year was found to peak in April (Nel, 1983) although it has generally been found to be spread over the period from May to August (van Wyk *et al.*, 1985). In the Umguza Valley in Matabeleland, Zimbabwe, pod fall peaked in May-June in 1994 (Figure 2).

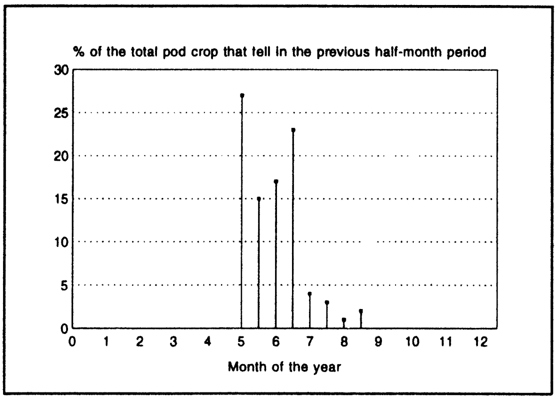

Figure 2. Pod fall in a 20-year-old natural stand of *Acacia erioloba* in the Umguza Valley in Zimbabwe in 1994 (January = 1). The observations were made on 500 trees growing on 3.8 ha. (Data from Barnes *et al.*, 1996c)

Detailed information on phenological variation between populations of *Acacia erioloba* cannot be obtained without making regular observations in many populations over long periods; this has not yet been done. However, an attempt has been made to extract as much information as possible on this subject from the herbarium specimen data logged into the Oxford Forestry Institute's BRAHMS *Acacia* database. Most of these sheets had been assessed for flowering and fruiting status. The overall phenological picture for flowering and fruiting for the species was produced by plotting the number of specimens categorized as "buds and flowers" and "mature fruits" against the month (Figure 3) (Fagg and Barnes, 1995). The data show that ripe pods can be found throughout the year, and on any tree pod drop can occur over several months. It should be noted that in collecting herbarium specimens, collectors will search out a tree to find a pod even if it is out of the main season for the population. The data on flowering are more informative and suggest that, on average across the range, the flowering peak occurs in September but can start in July and end in November. At any one site it can be as short as six weeks.

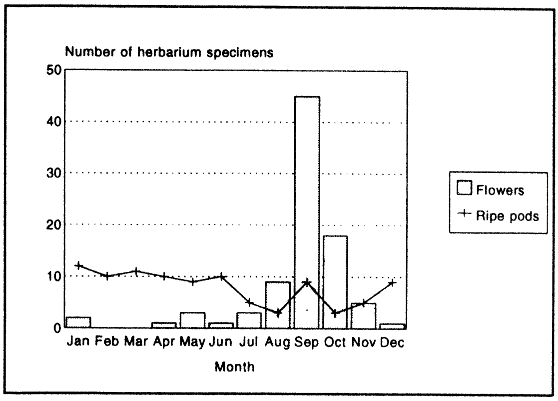

Figure 3. Flowering and fruiting phenology of *Acacia erioloba*. Data taken from flowering and fruiting status of herbarium specimens logged into the BRAHMS database at the Oxford Forestry Institute.

[References:- 7, 10, 40, 71, 85, 86, 92, 106, 119, 136]

Pollinating and seed dispersal agents

Acacia erioloba is insect pollinated. A list of insect species that act as pollinating agents does not appear to have been produced. There is a belief that honey bees do not visit *A. erioloba*. Compared to other *Acacia* species that are sympatric with it, an *A. erioloba* tree in full flower does have remarkably few insect visitors during the day. There have been reports, however, of much greater insect activity during the early hours of the morning before sunrise (Bickle, pers. comm.)[1].

The indehiscent pods of *Acacia erioloba* are favoured by large browsing herbivores which disperse the seeds. In southern Botswana, cattle will eat the pods and disperse the seeds at least 2-3 km away (Ernst and Tolsma, 1990). The seeds are thick and robust and resist the shearing forces of the molar teeth of large herbivores much better than dehiscent seeds. The pods reach their full size before the seeds swell, thus conserving their nutrients (Coe and Coe, 1987).

Viable seeds of *Acacia erioloba* are found in the dung of Eland (Eloff, 1959; Leistner 1961), cattle (Hoffman *et al.*, 1989; Tietema *et al.*, 1990), goats and elephant. *A. erioloba* figures significantly in an investigation (Austmyr, 1994) into

[1] A.G. Bickle, Umgusa Valley Estates, P.O. Box 1648, Bulawayo, Zimbabwe

the dispersal and survival of tree seeds ingested by elephants (*Loxodonta africana*) in Namibia. Elephant dung analysis yielded seed of nine different species of six families. Most seeds were found in dung from elephants in the juvenile to adult cow age range suggesting that they did most of the seed dispersal. Laboratory examination and germination trials were carried out on seed of the three most abundant species (*Grewia* spp. (82%), *Acacia erioloba* (13%) and *Faidherbia albida* (4%) collected from dung and pods. Scanning electron microscopy showed that although non-ingested seeds were scarified, passage through the elephant's digestive system greatly increased scarification, particularly in *A. erioloba* seeds. It is also suggested that ingestion by elephant protects *A. erioloba* seed from bruchid attack. The percentage of seeds germinating from dung and pods was greatest in *A. erioloba* and least in *Grewia* spp. Overall, *A. erioloba* seeds had a significantly higher germination rate, germination percentage and seedling survival. Ingestion by elephants significantly increased the germination percentage and establishment rates of *A. erioloba* but not *F. albida*. Statistical analysis of the survival data using the hazard function revealed that, for both species, ingestion by the elephant decreased death rate, hence increased survival.

[References:- 3, 27, 28, 34, 37, 62, 70, 93, 126, 141]

Natural recruitment

Seedlings germinate and survive more abundantly in high than in low rainfall years. The highly variable rainfall quantity and seasonality in the south-western range of *Acacia erioloba* apparently leads to episodic recruitment. Size class distributions of *A. erioloba* populations indicate this rather than continuous recruitment (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). Dense stands of saplings develop on abandoned ploughed lands (Milton and Dean, 1995) and in abandoned stock pens (Hoffman *et al.*, 1995); However, the presence of large quantities of scarified seed, or even germinated seedlings, does not necessarily guarantee survival; many other factors in the environment, such as rainfall amount and distribution, grass competition, and population levels of predatory insects and rodents have to be favourable and coincide with the presence of scarified seed for successful stand establishment. Young *A. 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 a study of *A. erioloba* woodlands in northern Botswana, the numbers of new seedlings per hectare recorded over a period of two years was 109 out of a total number of 233, and the total number of shrubs per hectare was 121, and the total number of trees per hectare was 165 (Ben-Shahar, 1996).

[References:- 8, 14, 63, 66, 81, 110, 122, 123, 133, 134]

DISTRIBUTION AND ECOLOGY

Natural distribution

The Kalahari sand formations are derived from erosion of the southern African landscape from the mountains of Lesotho, down through the catchment of the Orange River which carries the silt out into the Atlantic ocean whence it is washed up on the shores of Namibia and then blown northwards and inland up the extremely arid Namib Desert only to be washed out to sea again by major rivers, such as the Kuiseb and the Cunene, that flood periodically and halt the sand's progress until it is washed up by the sea again to the north of them. In drier epochs, this sand sheet reached far into the continent covering huge areas of Namibia, Botswana, the western parts of South Africa, Zimbabwe and Zambia, and southern Angola with outliers eastwards in Zimbabwe and Zambia and even in the extreme south-east of Mozambique. *Acacia erioloba* is almost entirely restricted to the remains of this Kalahari sandsheet.

The map (Plate 4A) shows the natural distribution of *Acacia erioloba* as indicated by plotting the positions of those botanical specimens logged into BRAHMS that have their precise location of collection recorded. This is the first published record for Mozambique.

[References:-1, 10, 13, 14, 16, 18, 19, 20, 21, 24, 28, 33, 56, 57, 78, 79, 103, 106, 118, 127, 147]

Climate

Although *Acacia erioloba* is a species that typifies the tree component of the arid zones of southern Africa, it still flourishes on stabilized sand dunes in the higher rainfall areas as a component of the fringes of the *Baikiaea plurijuga* forests. In the most arid areas of its occurrence in the Namib Desert of Namibia, mean annual rainfall can be <50 mm whereas on outliers of Kalahari sand in Zambia, rainfall can be as high as 900 mm (Plate 4B). Where rainfall is less than 250 mm, the presence of *A. erioloba* is said to indicate that there is underground water (Timberlake 1980).

Acacia erioloba tolerates extremes of temperature in the desert regions and it is soil rather than freezing conditions that provide the constraints to its distribution. After the periodic severe frosts that occur in Matabeleland in Zimbabwe, *A. erioloba* has been conspicuous among the tree species in the lack of damage it suffered.

[References:- 78, 118, 127]

Soils

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 river beds (Pardy, 1953; Leistner, 1967; Tinley, 1973; Timberlake, 1980; Milton, 1991). In South Africa, Acocks (1975) describes *A. erioloba* as being generally associated with deep sand over limestone in the flat, hot semi-arid to arid country of the Kalahari thornveld. It is restricted to sand-filled potholes in shallow soils overlying dolomite in the Western Transvaal Provence of South Africa (Bezuidenhout *et al.*, 1994). It also forms a distinct veld type on light turfy soils and extends as a component into the broken veld of Namaqualand and the Orange River. It is reputed to be tolerant of brackish water (Poynton, 1984).

[References:- 1, 11, 12, 71, 80, 89, 92, 127, 128]

Ecology

The rainfall over the Kalahari sandsheet in the western half of southern Africa increases north-westwards from an annual average of <10 mm in parts of the Namib Desert to nearly 900 mm at its extremities in Zambia. In the driest part of its range, *Acacia erioloba* is the only tree and often the only vegetation that is noticeable in the landscape (see cover photograph) and it can grow to a large size in the most arid conditions. With increasing rainfall, the vegetation becomes more species rich and *A. erioloba* is a component in a more diverse tree community. For example, in the Sossus Vlei of Namibia, *A. erioloba* is the only tree species (Plate 3B); in the Kuiseb River system where there is more reliable underground water, it is associated with at least nine other species of perennial plants including *Faidherbia albida, Tamarix usneoides, Euclea pseudebenus, Salvadora persica, Phoenix dactylifera, Ficus sycomorus, F. cordata, Maerua schinzii* and *Acanthosicyos horrida* (Seely *et al.*, 1979) (Plate 3A). In that part of the Kalahari sand sheet in Botswana between Kanye and Kokong where it has not been invaded by the more diverse woody flora to the east and north there are only four species of larger trees, *viz. Acacia erioloba, A. gillettiae [A. luederitzii var. retinens], A. detinens [A. mellifera ssp. detinens]* and *Boscia albitrunca*. Here again, *A. erioloba* is the largest of these, up to 60 cm in diameter and 9 m in height (Plate 3G). The small number of woody plants in these areas is ascribed to a combination of factors associated with the recent stabilization of the sand sheet and to the lower temperatures (Miller, 1946). In the extreme south-west of its range, it is low temperatures and winter rainfall that may limit associated woody species to *A. haematoxylon, Boscia albitrunca* and *Parkinsonia africana* (Plates 2D and 3C). In its north-western parts in western Namibia, northern Botswana, south-western Zimbabwe, Eastern Zambia and south-eastern Angola, the Kalahari sand sheet carries the much more species-rich and commercially important *Baikiaea plurijuga* (Zambezi teak) forests of which *Acacia erioloba* is a component at the forest edges, and in the river valleys particularly on the deep alluvial soils, where its resistance to the severe frosts that occur periodically gives it a competitive advantage over most other forest species (Plates 3D, 3H, 3I and back cover).

Although it can be an invader of disturbed land, *Acacia erioloba* rarely forms thickets and the cohort of seedlings rapidly develops into a parkland of well-spaced trees (Plate 3E). In the north of the Kalahari Gemsbok National Park, *Acacia erioloba* seedlings occurred at 10-30 stems ha^{-1} and mature trees at densities of about 6-10 tree ha^{-1} (Bothma *et al.*, 1994). The mechanism for this may be some form of allelopathy. The absence of bush-encroachment species such as *Dichrostachys cinerea* immediately beneath the crowns of large *A. erioloba* trees (Plate 5D) may be due to allelopathy. On the other hand, in parts of Matabeleland, large specimens of *A. erioloba* are rarely without a single companion tree of *Ziziphus mucronata* beneath their canopies (Plate 5F). Many fleshy-fruited shrubs, trees and climbers grow under the canopies of old *A. erioloba* trees, where they have been dispersed to nutrient-rich, shaded sites by birds, jackals and foxes (Leistner, 1967; Milton and Dean 1995).

The grass cover becomes more luxuriant and there is a change in species composition to the perennial more palatable species immediately beneath the crowns of large *Acacia erioloba* trees in the better watered parts of its range (Plate 7F). In the Moremi Wildlife Reserve in Botswana the understorey is dominated by *Panicum* species but where there is heavy grazing near water it is dominated by the less palatable *Aristida* species and *Cynodum dactylum* (van den Eynden *et al.*, 1992).

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, which are well worn from tree to tree (Plate 5H). Use of *A. 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 communities under the trees (Leistner, 1967; Milton and Dean 1995). In sandy pockets in the chert soils of the western Transvaal, these communities commonly consist of a variety of fleshy-fruited shrubs including *Rhus lancea, Maytenus heterophylla, Ehretia rigida, Grewia flava* and *Asparagus* species (Bezuidenhout *et al.*, 1994).

Of the many birds that are associated with *Acacia erioloba*, the most conspicuous are two species of weaver 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 (Plate 7B) that make the tree vulnerable to fire (see under fire). The white-browed sparrow-weaver (*Plocapasser mahali*) (Plate 7A) occurs throughout the range of *A. erioloba* and builds smaller but numerous grass nests on the south-west side of trees that are over 3 m high (Ferguson, 1989). Termites are an important sparrow-weaver food taxon and similarities were found between the geographical distributions of *Trinervitermes trinervoides* and sparrow-weavers. Large *A. erioloba* trees also provide essential perches for large raptors, owls and vultures (Maclean, 1970) and cover for hunting leopards (Bothma *et al.*, 1994).

The relationships between *Acacia erioloba* and termites are clearly important for both insect and tree but are not understood (Plates 5A, 5C and 5E). Young trees are periodically encased in the earthworks (Plate 5E) when the termites remove dead bark; but they rarely damage the tree. It is possible that termite activity may play some part in what appears to be the allelopathic effect of *A. erioloba*. Unusually large thorns that are hollowed out by moth larvae are commonly used as nest sites by spine-dwelling ants. The hollow thorns are also used by other insects as well as by spiders (Gubb, 1988).

[References:-1, 3, 8, 11, 12, 13, 14, 40, 41, 45, 51, 63, 65, 71, 72, 73, 74, 81, 84, 106, 129, 134]

Nodulation

Seeds were collected from 16 *Acacia erioloba* trees in the Matabeleland North Provence of Zimbabwe. Seeds were scarified for 30 minutes with concentrated sulphuric acid before sowing in a soil mixture including a component collected from an area with indigenous acacias but not *A. erioloba.* Only 2 out of 240 seedlings of *A. erioloba* had nodules whereas 64% of the *F. albida* seedlings nodulated. Despite this, seedlings of *A. erioloba* were more vigorous (Gwaze *et al.*, 1988). Corby (1988) also recorded nodules on *A. erioloba*, classifying them as a Caesalpinoid type.

In a genetic evaluation project on *Acacia karroo* (Barnes *et al.*, 1996a), seedlings of six African *Acacia* species (*A. karroo, A. tortilis, A. senegal, A. nilotica, A. erioloba* and *Faidherbia (Acacia) albida*) were raised in six nurseries in different environments throughout Zimbabwe and nodules collected for a study on rhizobia technology. The specific objectives of the project were "to isolate, identify and test the effectiveness and competitiveness of *Rhizobium* strains and produce inocula for six Zimbabwean *Acacia* species". The *A. erioloba* seedlings were the only ones that did not nodulate.

Table 4. An analysis of percentage of leaf nitrogen (%N), nitrogen 15 ratio (^{15}N) and carbon 13 ratio (^{13}C) for leaf samples from *Acacia erioloba, A. fleckii, A. karroo, A. nilotica* spp. *kraussiana, A. tortilis* ssp. *heteracantha* and *Faidherbia albida* growing in close proximity (within 2 km) to each other on Umguza Valley Estates, Zimbabwe. Figures are an average for six trees for each species except for *A. tortilis* ssp. *heteracantha* for which there were four. The subscripts are the standard errors. Increasing ^{15}N means that a higher proportion of nitrogen comes from the soil or ground water; increasing ^{13}C (*i.e.* the lower the negative value) indicates greater efficiency in water usage. (Data from Sutherland, pers. comm.)[2].

Species	%N	^{15}N	^{13}C
A. erioloba	$2.36_{.22}$	$10.47_{.58}$	$-27.80_{.41}$
A. fleckii	$2.79_{.12}$	$0.77_{.29}$	$-27.52_{.25}$
A. karroo	$2.45_{.18}$	$3.10_{.34}$	$-28.00_{.23}$
A. nilotica	$2.23_{.02}$	$1.35_{.65}$	$-26.99_{.18}$
A. tortilis	$2.73_{.39}$	$7.67_{1.89}$	$-28.66_{.04}$
F. albida	$4.47_{.38}$	$2.13_{.70}$	$-27.79_{.63}$

[2] Dr J. Sutherland, University of Dundee, Dundee, U.K.

During the course of the above research (Barnes *et al.*, 1996a), leaf samples were collected from *Acacia erioloba* and five other *Acacia* species growing sympatrically with it for laboratory analysis to compare their efficiency in fixing atmospheric nitrogen and in ground water usage. Foliage samples from the six species were collected from Umguza Valley Estates in Zimbabwe and the resultant analysis of the percentage of nitrogen and stable isotope ratios are given in Table 4. The data suggest that *A. erioloba* obtains most of its nitrogen from ground water rather than from the atmosphere which might explain the rarity of nodules found in its seedlings. The fact that the species obtains its nitrogen from this source makes it no less valuable than species that fix it from the atmosphere because the nitrogen in the ground water is not available to any other plant in the community and the *A. erioloba* is bringing it into circulation at the surface.

[References:- 5, 30, 53]

GROWTH HABITS

Life cycle

Acacia erioloba germinates rapidly after distribution in the dung of herbivores that do not crush the seed by their chewing action (Plates 5A and 6B). Like most pioneer acacias, it establishes itself in disturbed ground when climatic conditions are favourable and grass competition light. *A. erioloba* is very long-lived for an acacia; individual trees are reputed to reach ages of 300 years (Timberlake, 1980). Unlike species such as *A. karroo*, which can be heavily parasitized by mistletoes, and *A. tortilis*, which can be destroyed by elephants, *A. erioloba* is relatively free from predators in its old age and its decline takes place over a very long period. Its longevity, its resistance to frost and its ability to root rapidly down to permanent water at great depth give it a permanence in the plant communities in which it occurs that are unusual attributes when taken together with its pioneer behaviour. Branches die back and are shed as the trees age (Milton and Dean, 1995). Dead wood and tree rat (*Thallomys)* nests in hollows increase the flammability of old trees, and they consequently suffer more mortality (56-66%) during fires than small trees (28-39%) or saplings (5-12%) (van der Walt and Le Riche, 1984).

[References:- 81, 127, 131]

Growth patterns

Acacia erioloba is very slow-growing above ground for the first four or five years of its life while it develops a deep root system. After this it can grow quite rapidly and attain a stem diameter at ankle height in the region of 30 cm and a height of about 7 m after another 15 to 20 years (Plates 3E and 6F) (Barnes *et. al.*, 1996c). For the first 30 years of its life, some trees can keep a more or less fastigiate habit (Plates 6D-G and 7A) but after this the typical spreading umbrageous crown is progressively developed (back cover and Plates 6H, 6I and 7F). On sandy soils saplings reach 1 m height in their first year, but grow more slowly on heavier soils. Canopies begin to spread at 17 years. Old trees can reach 12 m in height with a canopy diameter of 22 m (Carr, 1976). Tap roots can reach to depths of up to 45 m (Henkel, 1931; Story, 1952; Acocks, 1979).

Acacia erioloba flowers only once in the season and almost exclusively on the previous year's growth (Plate 1B). New vegetative growth starts immediately flowering ends in about September. The branchlets extend very rapidly and can grow more than a metre in length in the following six weeks (Plate 7I) after which the stem and spines thicken; there is no further shoot extension until the following spring. This is quite unlike species such as *A. karroo* that can respond to favourable climatic conditions and flower several times during the season on repeated flushes of new shoot growth.

There are references to the ability of *Acacia erioloba* to "sucker freely" (Sim 1921; Pardy, 1953; von Breitenbach, 1965). Root suckering is not commonly seen but the reference might be to the species' ability to produce stem roots when buried by a sand dune (Plate 7E).

[References:- 1, 7, 22, 48, 89, 108, 118, 139]

PREDATORS, DISEASES AND HARMFUL PHYSICAL AGENCIES

Biotic

Mammals

Although many mammals depend on *Acacia erioloba* for their browse for a large part of the year, they have co-evolved and neither they nor domestic stock seriously damage the tree. Even elephants rarely break or strip the branches (as they do with many other species) when they shake the trees for their pods or eat the bark, probably because of the immense strength of the wood. It is possible that the high prussic acid content of the green pods and fresh foliage makes it unprofitable for elephants to break whole branches down for the green fodder. Ring-barking by porcupine can kill established *A. erioloba* trees. The tree rat *Thallomys paedulcus* feeds mainly on *A. erioloba* seeds and nests in the hollows and branches (Leistner 1967).

It has been observed that pods produced on an *Acacia erioloba* tree below the browse line are significantly lighter in weight than those produced higher up in the canopy (Coe, pers. comm.)[3]. This suggests that the tree puts more resources into pods that will mature fully before ingestion.

Insects

Acacia erioloba is remarkably free from defoliating insects throughout its range. Its most important insect pests are those that infest the seeds, mainly the larvae of bruchid beetles. The larger bruchids favour the seeds of species with indehiscent rather than dehiscent pods; therefore, with its indehiscent pods and particularly large seeds, *A. erioloba* is particularly prone to attack. Virtually all seeds on a tree may be colonized by these beetles on occasion although the percentage varies with season (Southgate, 1978; Coe and Coe, 1987).

The female bruchid beetle lays an egg on a ripening pod. The larva bores through the pod wall and burrows into a ripening seed within which it creates a chamber. In its final stages the larva eats away the inner layers of the seed until only a thin circular 'window' of testa remains. After pupation, the beetle emerges through the 'window' (Southgate, 1978). Normally the seed is not re-infested after the adult beetle has emerged. However, the larva of some of the bruchid species that attack *Acacia erioloba*, *e.g.* *Caryodon multinotatus*, is so large that it not only consumes the whole inside of the seed, but has to emerge and pupate in the soil or within the pod wall and this allows further attack by medium sized bruchids that lay their eggs inside the old emergence hole; a new generation of beetles emerges in almost exactly two months and continues to reinfest the seeds until the contents have been totally consumed (Coe and Beentje, 1991). One bruchid species, *Bruchidius sahlbergi* has been shown to have multivoline cycles and reinfest the seeds of *A. erioloba* (Ernst 1992; Ernst and Tolsma, 1990).

Fourteen of the 61 *Acacia* species recorded in East Africa are known to be the hosts of one or more species of bruchid (Southgate, 1978). Species with very different seed pods may be parasitized by the same bruchid, *e.g.* that which parasitizes *A. erioloba* in Botswana also attacks the *A. tortilis* complex in East Africa, *A. malacocephala* and probably *A. abyssinica* ssp. *calophylla* in Tanzania, *A. karroo* in Natal and *A. hockii* in Ethiopia. Early indications from phytochemical investigations indicate that the concentrations of certain amino acids (pipecolic acid and some heteropoly-saccharides) determine whether or not a bruchid larva can survive in a seed.

X-ray studies show that up to 16% of acacia seeds can be digested in their passage through the gut of large herbivores (Coe and Coe, 1987), probably principally those that have been damaged by bruchids. Bruchid larvae are usually killed during their passage through the gut of a herbivore and, if they have not killed the seed's embryo, their minute entrance holes will allow water to enter the seed and stimulate rapid germination in the dung (Coe and Beentje, 1991). Therefore, consumption by these mammals not only aids in the dispersal of seeds but also reduces bruchid damage (Coe and Coe, 1987).

The interactions between mammalian herbivores, bruchid seed predators and *Acacia erioloba* seeds have been investigated in Namibia (Hoffman *et. al.*, 1989). Predation by bruchids was significantly less in canopy-held pods than in pods on the ground. Germination success was higher for ingested seeds than for an untreated control and was almost zero for predated seed. The study supports the theory of a mutualistic relationship between mammalian herbivores and acacias; for example, the indehiscent pods of *A. erioloba* are eaten and the seed dispersed over large areas in the dung (Plates 5A and 6B). In Botswana, seed of *A. erioloba* collected from the tree and stored for six months were found to be 64.5% infested by *Bruchidius sahlbergi*, but the seed collected from cattle droppings and stored for a similar time resulted in only 3% infestation (Ernst and Tolsma, 1990). In the South African Plant Protection Research Institute's checklist of insects on forest trees and shrubs in South Africa (SAPPRI, 1970), many species are listed for the genus *Acacia* but only two as affecting *A. erioloba* itself, *Bruchus albosparsus*, a bruchid, and *Gonometa postica*, a lasiocampid larval defoliator.

The spines of *Acacia erioloba* can be swollen at the base and it is thought that this might be genetically controlled by the tree rather than a gall response to insects (Gubb, 1988) (Plate 1H). Swollen thorns seem to be more numerous in years of high rainfall. In this study in the Kalahari thornveld, more than half the swollen spines were occupied by a succession of insects starting with moth larvae, followed by various species of spine-dwelling ants that feed on exudations from the extra-floral nectaries on the leaves and finally by spiders.

Periodically patchy dieback mainly in the crowns of mature *Acacia erioloba* trees has been noticed in the Umguza and Khami valleys in Zimbabwe. This does not appear to be related to drought years or frost but it has been suggested that it may be related to disturbance of the environment by agricultural activities, particularly cultivation for crops round the trees. Recently, the activities of an as yet unidentified bark beetle have been found to be associated with the dead branches. The larvae make broad flat tunnels in branches of 3-5 cm diameter and may effectively partially or wholly ring-bark the branch causing it to die. The tunnels are not conspicuous due to their being tightly packed with fras behind the beetle (Plate 5G). It has yet to be shown conclusively whether or not the beetles are the primary cause of the die-back but it seems likely that a combination of stress, caused by drought, senility or a changing environment, and the beetles could be the cause of this phenomenon.

Acacia erioloba is resistant to termites in all its life stages

[3] M. Coe, Department of Zoology, University of Oxford

(Poynton, 1984) including the germinating seedling (Plate 5A).

Parasitic plants and fungi

Although *Loranthus* and *Viscum* spp. are known to parasitize *Acacia erioloba* (von Breitenbach 1975), mistletoes are rare in the crowns even of old moribund trees.

The bark has reportedly suffered from the black spot fungus *Hysterographium acaciae* Doidge (von Breitenbach, 1975).

[References:- 3, 26, 27, 35, 36, 37, 38, 51, 62, 71, 92, 114, 115, 135]

Abiotic factors

Fire

Fierce bushfires can kill *Acacia erioloba* to the ground but it coppices vigorously soon afterwards (Plate 7C). Mature trees are very fire resistant except where large social weaver nests in the crown (Plate 7B), dead branches 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 (Plate 7D) if there are is a large number of nests in the tree. This apparently happened on a large scale in the Nossob River Valley in the Kalahari Gemsbok National Park in south Africa after the 1974-6 floods when there were severe lightning fires in the valley set off in the dense grass cover that resulted from the rain (van der Walt and Le Riche, 1984). There was a high correlation between tree size and death from fire. In northern Botswana, recruitment rates in *A. erioloba* woodlands appeared to be much less affected by fires than the baikiaea and mopane woodlands studied, and under moderate elephant and fire damage regimes that woodlands are unlikely to decline (Ben-Shahar, 1996).

Drought

Acacia erioloba extends into more arid parts of the desert than any other tree species. Where the annual rainfall is less than 250 mm however, it probably depends upon its extraordinary capacity to root to great depths to gain access to a ground water supply. Water extraction from the Kuiseb River valley, Namibia, lowered the water table leading to mortality of large old trees of *Faidherbia albida*, but it had less effect on young trees of *A. erioloba* with its rapidly-growing tap roots; *A. erioloba* was generally less sensitive to lowered water table than *F. albida* (Ward and Breen, 1983). Densities of *A. erioloba* seedlings and saplings decreased in the Kalahari during drought (van Rooyen *et al.*, 1984). During a dry period in the Namib, greatest mortality occurred in the 1-50 cm *A. erioloba* stem circumference size class (Theron *et al.*, 1985).

Frost

Acacia erioloba can probably withstand temperatures as low as -15 to -20°C although flower initials may be damaged by less extreme temperatures. In genetic evaluation trials in Matabeleland, Zimbabwe, the *A. erioloba* provenances were significantly more frost resistant than all entries of the other six species (Barnes *et al.*, 1996c).

[References:- 7, 8, 32, 92, 123, 131, 133, 142]

PRODUCTS AND USES

Wood

Anatomy

Acacia erioloba has a medium to finely textured wood but it has large vessels that form coarse conspicuous lines both in tangential and in radial section. Rays are few and among the narrowest found in the subgenus *Acacia* (Robbertse *et. al.* 1980). The parenchyma is aliform-confluent. Shiny dark gum deposits are visible in the vessels (Goldsmith and Carter, 1981).

The radial cross sections of wood samples from individual trees of *Acacia erioloba* of known age in six African Acacia species were examined for growth rings (Gourlay and Kanowski, 1991). These were apparent in most species as narrow bands of marginal parenchyma filled with long crystal chains (Plate 7G). The number of bands formed annually corresponded to the number of peaks in rainfall distribution. The results suggested that marginal parenchyma bands and associated crystalliferous chains define growth phases in African *Acacia* species, and may therefore be useful for age determination. The average ring width in these samples was 7.91 mm.

Chemistry

The heartwood of *Acacia erioloba* has been found to have a very high tannin content (Malan and Roux, 1975).

Fuelwood

Wherever it occurs, *Acacia erioloba* is almost invariably known as the best firewood (Pardy, 1953; Leistner, 1967; Heinz and Maguire, 1974; Coates-Palgrave, 1977; Goldsmith and Carter, 1980; Poynton 1984) (Plate 8F). Between Sishen and Olifantshoek large specimens of the species have become rare because most of them were cut down for fuel for the Kimberley diamond mines before coal became available in the area (Sim, 1921; Carr, 1974). The Topnaar of the Namib also use the wood for charcoal making and fencing (van den Eynden *et al.*, 1992). In Matabeleland, Zimbabwe, however, *A. erioloba* is not used as fuelwood for cooking fires in huts because of the strong smelling acrid smoke that it produces. In comparison, for instance, *A. karroo* firewood burns very cleanly with little smoke.

Round and sawn wood

The sapwood of *Acacia erioloba* is wide and pale pinkish while the heartwood is uniformly deep red or purple-red. The wood is very heavy (1,230 kg m^{-3}) and difficult to saw. The sapwood is durable and the heartwood exceptionally so; the heartwood is almost immune to borer, termite and fungal attack. Because of this, the wood of *A. erioloba* has been used extensively in the past for timber and as a building material (Leistner, 1967; Stours, 1982). It must be pre-bored to nail and although it has poor paint-holding properties, it glues well and planes to a lustrous finish. It is unstable in seasoning and tends to be brittle (Goldsmith and Carter, 1981). It has also been used for bearings (Pardy, 1953). The main uses, however, are for piles, fence posts and firewood.

[References:-21, 22, 25, 49, 50, 60, 71, 77, 89, 92, 98, 102, 108, 120, 129]

Bark

Acacia erioloba plays a vital role in local economy of the Topnaar Hottentots, who live in the margins of the Kuiseb river in the Namib desert where the bark, together with that of *Faidherbia albida*, is used for building huts (Palmer and Pitman, 1972).

Elephants eat the bark which is said to be nutritious (Timberlake, 1980).

[References:- 88, 127]

Gum

The gum exudate from *Acacia erioloba* contains protein (53%-56%) and carbohydrate as a mixture of glycoproteins. The protein components have high contents of hydroxyproline and serine, and the carbohydrate is composed mainly of L-arabinose, D-galactose, and 4-0-methyl-D-glucuronic acid residues. Methylation, partial acid hydrolysis, and alkaline hydrolysis studies revealed units of the aldobiouronic acids .alpha. -4MeHlcpA-(l .fwdarw. 4)-Gal, and .beta.-4MeGlcpA-(l .fwdarw. 6)-Gal, and showed that the carbohydrate, mainly in the form of short, linear oligosaccharides, is attached to Hyp residues in the peptide chains. This gum exudate differs markedly from others derived from the same taxonomic series of *Acacia* (Gammon *et. al.*, 1987). The gum is edible and eaten by Bushman and Kwanyama Ovambos (Peters *et al.* 1992; Hedberg and Staugard 1989).

[References:- 2, , 23, 25, 35, 47, 59, 60, 91, 129]

Fodder

The pods, young shoots and flowers of *Acacia erioloba* are relished by stock and game (Friede, 1960; Berry, 198?). The pods, in particular, have a high nutritional value (Steyn, 1943; Nel, 1983; Barnes *et al.*, 1996b) and are known to increase milk yields in cows (Coates-Palgrave,1977). In a study of tree to tree variation in nutritional value of pods from trees in a 15- to 20-year-old natural even-aged population of *Acacia erioloba* in the Umguza Valley near Bulawayo, Zimbabwe, the mean crude protein content of the pods alone was found to be 9.9% and of the seeds 27.4% (See Table 1); the respective values for carbohydrate were 10.9% and 5.7% and for starch, 25.8% and 26.1% (Barnes *et. al.*, 1996c). The seeds contributed on average 27% of the combined weight of seed plus pod. Other estimates of crude protein have been published: 11.4% in the pods (Henkel, 1931); 12% in the pods (Steyn, 1943); 10-16% in the pods (Nel, 1983); 6% in the pods and 33% in the seeds (Timberlake, 1980). Pods collected in the Hwange National Park in Zimbabwe were found to contain 9.4% water, 3.3% acid-soluble ash, 1.6% ether extract, 31,0% fibre, 11.4% crude protein, 0.9% calcium, 0.24% phosphoric oxide and 1.3% potassium (Henkel, 1931). The total digestible organic matter of pods has been estimated at 48% (Nel, 1983).

The leaves of *Acacia erioloba* are also valuable browse (Plate 8A and 8B) and have been said to contain up to 17% protein in February with 35% digestibility (Timberlake, 1980). Stem and leaf digestibility of *A. erioloba* was about 40% in the Namib (Nel, 1983). The flowers are browsed off the tree and picked up off the ground by stock and game and may make a valuable contribution to their nutrition at a time when grass and browse are at their lowest in the range. Antelope, giraffe, elephant, rodents and domestic livestock all browse *A. erioloba* during the dry winter season (Leistner, 1967; Nel, 1983; van den Eynden *et al.*, 1992) (Plate 8A and 8B). It is reputed to produce nectar and pollen (Poynton, 1984) but doubt has been expressed that bees visit the flowers. This needs confirmation.

The fresh green foliage (Plate 7I), the green pods (Plate 1F) and the ripe pods (Frontispiece) of *Acacia erioloba* can all contain dangerous quantities of prussic acid (cyanogenetic glucosides) (Steyn, 1934 and 1943; Mitchell Watt, 1957; Coates Palgrave, 1977). The foliage contains the most and the ripe pods the least. There may be great variation in the amount of prussic acid contained in different trees and at different times of the year. The toxicity of any plant containing prussic acid depends upon the rate at which it is consumed by stock because it is a gas and rapidly eliminated by the lungs. Moistened plants are more dangerous than dry plants, especially of they are eaten some time after moistening. *A. erioloba* pods can be fed safely to stock provided small dry quantities are fed at a time (Steyn, 1934). Their toxicity can also be reduced by boiling the pod or meal before feeding or mixing it with sulphur or molasses (Steyn, 1934; Timberlake, 1980).

The presence of acacipetalin in *Acacia erioloba* was established by chromatographic and NMR spectral analysis (Secor *et.al.*, 1976) and under a listing of cyanogenic compounds of *Acacia* species *A. erioloba* contained proacacipetalin (Seigler and Conn, 1982).

In the Kalahari Gemsbok National Park of South Africa, it is possible to find pods on the ground beneath *Acacia erioloba* trees in the Auob Valley when all are gone from beneath the *A. haematoxylon* and from under *A. erioloba* in the neighbouring Nossob Valley where *A. haematoxylon* is absent. This suggests that the *A. haematoxylon* pods might be more palatable than those of *A. erioloba* or perhaps that they produce less prussic acid and can be eaten in larger quantities at a time.

In drought years when roughage is short for livestock at the end of the dry season, the grass nests of sparrow-weavers are collected from the crowns of *Acacia erioloba* and fed to the domestic animals (O Makoni, pers.comm.)[4]. It is not inconceivable that the bird chick droppings add to the nutritional value of this emergency feed in the same way that chicken manure is used as a stock feed.

[References:- 6, 7, 10, 25, 27, 34, 44, 55,59, 60, 61, 70, 71, 82, 85, 86, 88, 92, 105, 107, 111, 116, 117, 120, 127, 128, 129, 136, 139]

Medicine and food

Acacia erioloba plays a vital role in the local economy of the Topnaar Hottentots, who live along the Kuiseb river in the Namib desert; the pod pulp is used as a food supplement (Palmer and Pitman, 1972; van den Eynden *et al.*, 1992). The gum is clear and eaten by humans and animals (Heinz and Maguire, 1962; Coates-Palgrave, 1977; Timberlake, 1980; Peters *et al.*, 1992). The gum is dissolved in hot water and used as a remedy for coughs and colds. Powder from beneath the bark is used to scent the body and home. A decoction of the bark is used to treat diarrhoea and a root decoction is used to treat coughs (van den Eynden *et al.*, 1992). The powdered roots of *A. erioloba* are used by the Tswana herbalists for treating nose bleeding (Hedberg and Staugard 1989). The seeds have been used as a substitute for coffee (van den Eynden *et al.*, 1992).

[References:- 25, 59, 60, 88, 91, 119, 127, 129, 143]

Soil amelioration and protection

Acacia erioloba is a valuable shade tree (Plate 8C) and is a protected plant in South Africa (Sim, 1921). Soils beneath living *A. erioloba* trees in the Kalahari had higher concentrations of organic carbon, nitrogen and phosphorous than soil from surrounding grasslands and scrubland (Milton and Dean, 1995). Nutritious forage grasses are found beneath *A. erioloba* canopies where the understorey is not overgrazed (Tinley, 1973).

[References:- 25, 81, 108, 128]

ESTABLISHMENT, YIELD AND MANAGEMENT

Establishment

Seed collection and extraction

Seed collection of *Acacia erioloba* is an uncomplicated operation because the pods are indehiscent and can be collected at any time once they are dry. The principal restriction is that where there is livestock or game, any ripe pods that fall from the trees are immediately eaten by animals that visit the trees daily. Shaking the branches with poles when the pods are dry can bring down large quantities provided there has not been a recent wind that might have brought them all down before the visit. The pods on individual trees ripen at different times so several visits to a population to collect seed are desirable if the full range of the genetic material is to be sampled.

If collection of pods is to be made by shaking the branches of *Acacia erioloba*, care should be taken not to damage last year's shoots or the flower buds if these have started to appear. By the time the flower buds appear, the pod pedicels are very brittle and only a very slight shake is sufficient to bring down a rain of pods. Most damage would be done to the next year's crop if the tree is shaken violently before the pods are ready to fall.

Seed should be extracted from the pods as soon as possible after collection by crushing in a wooden pestle and mortar (Plate 8E) or similar device. Seed can be separated from the crushed pod chaff by winnowing in a basket.

Seed storage

The seed retains its viability for many years even at room temperature. Bruchid larvae within the seed, however, can continue to be active after the seed has been extracted and put into store and the adults, or larvae of some species, emerge and may even re-enter the exit holes to lay eggs that will produce a second generation of larvae to feed on the seed. Storage at temperatures near 0°C reduces Bruchid activity and sub-zero temperatures of -20 to -30°C may kill the larvae without damaging the seed.

[4] O. Makoni, Chesa Forest Research Station, P.O. Box 467, Bulawayo, Zimbabwe.

Seed pretreatment

Germination can be hastened by filing the seed coat on two edges or by nicking with a pair of nail clippers (Plate 6A). Fastest germination is achieved by nicking the testa at the micropylar end of the seed, soaking for 12 hours and placing the seed in a germination cabinet at a constant temperature of 32 to 36°C. The radicle will appear within about 48 hours and the seed can then be sown in soil. Care must be taken not to damage the embryo when nicking at the micropylar end. It is safer in this respect to nick the seed at the opposite end to the micropyle but, if this is done, there is a tendency for the testa not to be shed from the plumule resulting later in associated fungal damage of the cotyledons and leaves within. Pretreatment by nicking has the added advantage of providing the opportunity to discard damaged seed before it is sown; bruchid exit holes can be seen at this stage and unhealthy tissue recognized by its colour (brown coloured rather than a healthy white) when it is exposed. This process has been described where it has been used for genetic evaluation trials in Zimbabwe (Barnes *et al.*, 1996c). *A. erioloba* took 12 hours to imbibe water after nicking, 72-96 hours to produce a radicle in the incubator (at 25-30°C) and a further 72 hours for the hypocotyl to emerge after sowing in the nursery.

Germination can also be hastened by boiling the seeds briefly in water and then allowing them to soak for two days (Carr, 1976). Another pretreatment is one minute in hot sulphuric acid or 10 minutes in cold sulphuric acid which was the recommended pretreatment in Botswana to achieve 95-100% germination in 12 days (Tietema *et al.*, 1992). In Namibia, seeds pretreated with sulphuric acid for 30-60 minutes achieved 90% germination (Hoffman *et al.*, 1989).

Nursery

Seed should be sown in May before temperatures have reached their lowest for planting out in the following November to January. The species is not frost tender and there is unlikely to be frost damage.

If the nicking pretreatment and pre-germination practices described above are used, there should be virtually 100% emergence of the seedlings in the nursery.

Seed should be sown into individual polythene tubes, not bags. An ideal container size is 20 cm deep with a diameter of 7 cm. The depth is required to accommodate the species' long taproot which grows very quickly.

Roots will emerge from the bottom of the tube a few weeks after planting; these can be pruned without damage to the plant provided it is done regularly from an early stage until the tree is planted out.

Growth in the nursery is slow (Plate 3F). In genetic evaluation trials, average height growth in the nursery was 6.0, 9.7, 12.9 and 16.5 cm at 1, 2, 5 and 7 months respectively (Barnes *et al.*, 1996c). Planting out should not be delayed or the seedlings will become stunted (Carr, 1976).

It is important not to over-water and to have free circulation of air in the nursery. High humidity can lead to damping-off deaths.

Establishment

The potted seedlings should be planted out after soaking rains so that their roots can follow the moisture down as the soil is recharged to depth. The pots should be soaked and planted deep rather than shallow with the polythene tube carefully removed.

The seedlings are usually very slow growing above ground for the first three to five years while the root system is developed but after that, under favourable conditions, the trees can grow up to a metre per year and attain maximum height of 8 to 10 m after 20 years. In genetic evaluation trials, the average field survival of *A. erioloba* in the first year varied from 16% on the harshest to 80% on the best site under test (Barnes *et al.* 1996c). Average height of the seedlings at 12 months varied from 0.328 to 0.748 m across sites. Among five *A. erioloba* provenances, Makatoolo from Zambia, the northern-most provenance, consistently ranked highest at all but one site and Twee Rivieren from South Africa, the southern-most provenance was most often lowest ranked.

Although there are numerous individual trees planted on farms and in gardens, there has been no widespread establishment of *Acacia erioloba* yet in agricultural systems in Africa. There are, however, some interesting observations on the inadvertent establishment of excellent stands that has come about as a result of a combined set of favourable circumstances. One of these is on Umguza Valley Estates in Zimbabwe where, in the first year that a piece of cultivated land was being returned to pasture, cattle were fed pods of *Acacia erioloba* and then put out to graze on the land at the start of the wet season (Barnes *et al.* 1996c). The combined action of the scarification of the seed passing through the animals' gut, the seedbed created by past cultivation enhanced by the animals' hoof action, the reduction in grass competition resulting from the animals' grazing and the wet weather led to the establishment of a large number of seedlings. These have come through in a cohort that have now established a parkland (Plate 3E) of well-spaced trees that is already producing valuable pod crops after only 20 years (see under fodder above).

There are few records of *Acacia erioloba* being used as an exotic although there must be many parts of the world with semi-arid conditions and windblown sands where the species' potential could be exploited. There is a record (Karschon, 1984) of a survey being conducted in 1975-82 of plantings made by the Palestine Railways in the 1930s at 46 stations. Amenity plantings were established at railway stations and between stations and at the Isdud Sand Dune Plantation. Of 54 tree and shrub species recorded, the potential value of *A. erioloba* was emphasized for planting on sandy soils in arid areas.

There is a record of *Acacia erioloba* being successfully cultivated for miniature (bonsai) trees (Ormond, 1968).

[References:- 4, 7, 17, 22, 33, 53, 62, 68, 84, 87, 124, 125]

Management and yield

Management of natural stands

It has been suggested (West, 1950) that, in Zimbabwe the larger tree species that bear valuable pod crops, such as *Faidherbia albida* and *Acacia erioloba* could be grown on perennial grassland at 5 to 10 trees per hectare without damage to the grass yield. It was recommended that they be grown in the habitats to which they are naturally adapted, *e.g. F. albida* on deep alluvial flood-plains in the lowveld and *A. erioloba* on deep alluvium and sand in the gusu (Kalahari sand) areas.

In a study in progress in an even-aged (*c.* 20 years) natural stand of *A. erioloba* in Matabeleland, Zimbabwe, the mean height of the trees was 5.7 m (3.7-7.3 m), mean stem diameter at ankle height 18.4 cm (10.1-35.0 cm), total number of pods per tree 339 (25-1204), pod weight 13.5 g (7.4- 30.2 g) and weight of seeds per pod 3.8 g (1.8-9.6 g) (Barnes *et al.* 1996c). The was no correlation between tree size and number or weight of pods produced. The area of the observation plot was 3.8 ha and every one of the 500 trees on it was measured. The total weight of pods produced was 600 kg of pods ha^{-1}.

Bush encroachment

Cattle pass large quantities of *Acacia erioloba* seed (about 50 seeds/dropping) in their dung. This facilitates bush encroachment by *A. erioloba* and other acacias with indehiscent pods (Tietema *et al.*, 1990). *A. erioloba* is included amongst 1652 other taxa (including 711 naturalized exotics) that have been shown to be weedy in certain situations in southern Africa. Forty-five *Acacia* taxa (mostly indigenous) are described. *A. erioloba* is included in the National Weed List as having the undesirable characteristics of being competitive (for space, light, nutriment), replacing preferred vegetation (grass), poisonous (sometimes), thorny (plant), and obstructive (access). It is cultivated as a ornamental crop and is the subject of herbicide registration (Wells *et. al.*, 1986). Despite its inclusion in the list, *A. erioloba* is highly valued throughout its range for its pod crops (Plate 8H) and shade (Plate 8C) and rarely is it the subject of eradication measures or even control. Thickening up of well established scrubby *A. erioloba* can follow fire which causes young trees to coppice (Walter, 1954).

Control measures have been mentioned for the species. In Namibia, on deep sandy soil after rain, grasses surrounding the boles of young trees choked and killed *Acacia erioloba* among other troublesome species such as *Dichrostachys cinerea.* In Zimbabwe, arsenic compounds proved the best herbicides tested, although 2,4,5-T gave effective control of a wide range of invasive species (West, 1964).

More recently (Moore *et al.*, 1985) two formulations of tebuthiuron, Graslan 20P and Graslan 40P have been evaluated in the Molopo area of the northern Cape Province of South Africa. Tebuthiuron was applied aerially at ten application rates, in combination with two application dates. After only two seasons, the chemical showed a reasonable selectivity for the woody species. Of these, *Acacia mellifera, A. reficiens* and *Grewia flava* were very sensitive while *A. erioloba* and *Dichrostachys cinerea* were less so and *Boscia albitrunca* was almost resistant to the lower application rates (<1.0 kg active ingredient ha^{-1}). The standing crop of grass on the treated plots increased by between 220 and 740%. Changes in the total grass density and botanical composition was ascribed to an increased density of *Eragrostis lehmanniana.* At this early stage of the trial, its selectivity in favour of the more desirable woody species, suggests that tebuthiuron shows great promise for controlling bush encroachment in the Northern Cape, although a final conclusion would only be possible five years after its application. (Moore *et al.*, 1985). Another compound ethidimuron, sprayed from the air, was also successful in controlling woody species in the northern Cape Province, especially *A. mellifera* and *A. erioloba* (Fourie, 1992).

Yield

At a conservative estimate of one crop every two years, the average annual yield of pods would from a natural parkland of mature *A. erioloba* has been conservatively estimated at 1-2 t ha^{-1} (West, 1950).

In a one-year study in progress in an even-aged (*c.* 20 years) natural stand of *A. erioloba* in Matabeleland, Zimbabwe, the mean height (25 trees) was 5.7 m (3.7-7.3 m), mean stem diameter at ankle height (25 trees) 18.4 cm (10.1-35.0 cm), mean number of pods per tree (500 trees) 127 (0-1252) and mean pod weight (including seeds) (25 trees) 13.5 g (7.4-30.2 g) (Barnes *et al.* 1996c). There was no correlation between tree size and number or weight of pods produced. The area of the observation plot was 3.8 ha and every one of the 500 trees on it was measured. The total weight of pods produced was 226 kg ha^{-1}.

The following is an extract from Barnes *et al.* (1996a). "The crude protein content of the milled *Acacia erioloba* pods plus seeds has been found to be 16.54%; maize stover contains *c.* 4.2% and fresh maize grain *c.* 9.6% (Table 5). Although *A. erioloba* meal has a higher insoluble proanthocyanidin (tannin) component than maize, this is unlikely to prejudice the uptake of nitrogen; the absorption rate of 10 at 550 nm g^{-1} is markedly lower than the equivalent 31.4 for *A. tortilis* (Forsk.) Hayne, 26.8 for *Faidherbia albida* (Del.) A. Chev. and 89.2 for *A. nilotica* (L.) Willd. ex Delile pods (Tanner *et al.*, 1990), all known to be high quality sources of protein. Maize grain is a better source of metabolizable energy but the combined value of this component for grain and stover is lower that for the *A. erioloba* pods; and it is the protein that is the costly element in the feed. A large free-growing *A. erioloba* tree can produce >500 kg of dry pods annually. At 15 stems per hectare the trees would not be competing with each other and if each yielded on average say only 150 kg of pods per year (Figure 4) it would convert to 2.25 t ha^{-1} and a crude protein yield of 372 kg ha^{-1}. The equivalent yield in maize grain from fields grown without inorganic fertilizers on small-holder farms in the parts of Zimbabwe where *A. erioloba* grows naturally, varies from 0.2 to a maximum of about 2.0 t ha^{-1} (average <1 t ha) with up to twice the weight of stover; yields from sorghum crops are similar (Ncube, pers. comm.). The average total yield of crude protein from a maize crop is therefore 180 kg ha^{-1} and even at maximum only 360 kg ha^{-1}, still short of the estimated yield from *A. erioloba*. The metabolizable energy from the acacia pods is only slightly lower (21150 MJ ha^{-1}) than that from the average maize crop (22500 MJ ha^{-1}). In addition, these yields from *A.erioloba* parkland are produced without any input costs of seed and labour other than for collection; and the browse value of its foliage, the high yield of nutritious grasses that grow beneath the canopies of the trees and the environmental benefits are added and very substantial bonuses."

All three of these studies indicate a high levels of pod production from *Acacia erioloba* from an early age. It would be hard to over-estimate the value of a tree that produces regular valuable pod crops of this order and, at the same time, enhance the luxuriance and nutritional value of the grasses associated with it over a period of several hundred years without replacement.

In the arid environmemt of the Kuiseb River valley (Plate 3A), Namibia, the estimates of yields of pods from *Acacia erioloba* have been much lower. Large trees with spreading canopies produced pod crops of up to 290 kg/ha/year and younger trees produced up to 145 kg/ha/year (van Wyk *et al.*, 1985).

[References:- 4, 5, 7, 12, 48, 83, 121, 126, 136, 141, 144, 145, 146]

Table 5. Estimates of crude protein (CP), crude fibre (CF), ether extract (EE), ash, metabolizable energy (ME) and insoluble proanthocyanidins (IP) for a sample of pods plus seeds from 46 *Acacia erioloba* trees on Umguza Valley Estates (Ncube, pers. comm.). The comparative values for maize grain and maize stover are from Göhl (1981) and Tanner *et al.* (1990).

	Acacia erioloba	**Maize grain**	**Maize stover**
CP (%)	16.5	9.6	4.2
CF (%)	27.3	2.3	39.8
EE (%)	6.3	4.9	1.2
Ash (%)	3.8	1.6	7.4
ME (MJ kg^{-1} DM)	9.4	13.3	4.6
IP (Absorb. @ 550 nm g^{-1} NDF)	10.0	0.0	3.2

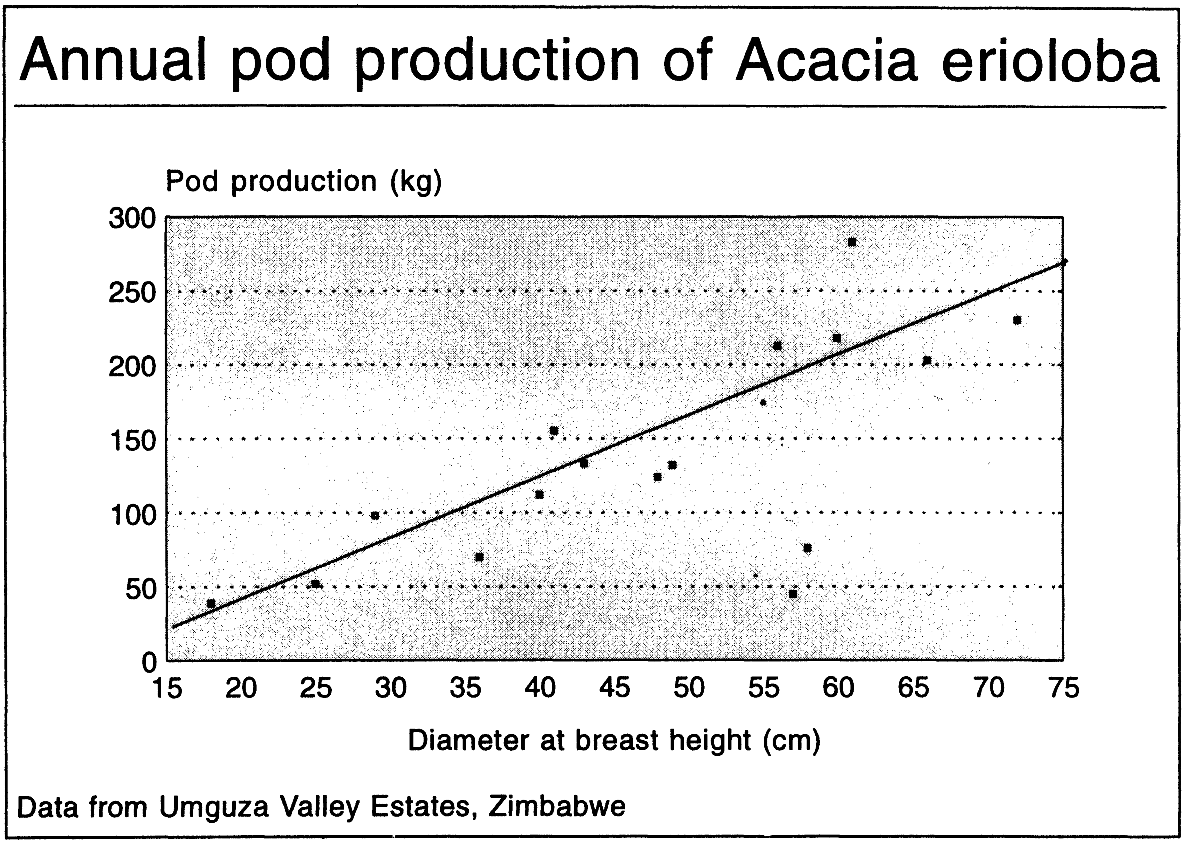

Figure 4. Pod production related to tree diameter for a single year (1993) on Umguza Valley Estates. The trees in the study were within a security fence round farm buildings and a homestead, not in the normal grazing range but they were typical in their production of trees that occurred in the neighbouring paddocks. It was impossible to collect pods for the study where cattle and game had access.

CONCLUSIONS AND FUTURE RESEARCH

Acacia erioloba is a tree with many desirable attributes.

- It grows in some of the most arid climates in the world. Provided that there are herbivores to scarify and spread the seed and the occasional rainstorms to trigger germination and allow the seedling to display its root potential to reach permanent water at depth, it will live for more than one hundred years on virtually no rain.
- It regularly produces large crops of nutritious pods. In terms of crude protein per hectare per annum, a parkland of mature trees will generally out-yield small-farmer grain crops on the same site and with no inputs except pod collection costs.
- Through its ability to cycle nutrients and use water from great depth and with its large spreading, but light, canopy, it ameliorates the environment and provides conditions for an understorey of nutritious grasses, herbs and shrubs.
- It does not have the usual propensity for invasiveness that is so problematical among many of the important African *Acacia* species; indeed, it may actively discourage bush-encroaching species beneath its canopy.
- There are indications that there could be a large amount of tree-to-tree variation within populations in pod size, production and nutritional composition and in fruiting phenology that could be used for improvement through selection.
- It hybridizes naturally with *Acacia haematoxylon* and produces viable individuals that pod freely and may have useful adaptational attributes.

Although *Acacia erioloba* is valued for its pods over much of its natural range, its actual contribution to agricultural production has not been quantified. Research is needed to rectify this if its current value is to be fully appreciated and existing trees conserved. Further work needs to be done to demonstrate the potential for increasing its contribution to productivity in semi-arid environments through management, establishment and selection techniques. Six activities for research have been identified.

- Carry out long-term pod productivity and phenology studies in natural stands. These have been started but need to continue to determine consistency in overall and tree-to-tree production from year-to-year.
- Conduct research to substantiate and quantify the numerous subjective observations of the improvement in grass species composition and amount produced beneath the crowns of the trees.
- Elucidate the dynamics of successful natural regeneration of the species. An understanding of these is essential for management of the range and for artificial establishment. Episodes of cohort establishment are not common and may be many years apart. They obviously occur only when a whole host of environmental conditions happen simultaneously. Among the most important factors may be, for example, the amount and distribution of the rainfall, the amount of grass competition, the amount of seed that has passed through herbivores, the population levels of predatory insects, rodents and browsers *etc*.
- Establish the extent to which the extreme tree-to-tree within-population variation in pod size, chemical composition, production and phenology is under genetic control. This must be done through determining the level of inbreeding in a population by molecular studies and establishing half-sib progeny tests.
- Gain an understanding of the genetics of the hybrid cross with *Acacia haematoxylon*. In particular, it should be established whether or not all the naturally-occurring hybrids are F_1s and whether or not the seedlings raised from the reportedly viable seed from them survive.
- Distribute seed for testing in environments outside its natural range. The species is minimally invasive where it is indigenous and as it would be introduced where trees would be an asset in an otherwise more or less treeless environment, risks of problematical invasion would be low.

Given *Acacia erioloba's* slow initial growth rate and longevity, the genetics research recommended here is long-term. However, it is not expensive and ideally would be funded through "long, thin" projects. On the other hand, the productivity research recommended can be carried out in existing natural stands, the relevant information can be accumulated in a much shorter time and used immediately as a basis for improving conservation and management in existing natural stands.

PLATES

Plate 1.

A. Leaves, buds and flowers of *Acacia erioloba.* This species is one of the earliest acacias to flower. Buds and leaves appear at the same time, usually at the end of August or beginning of September before the rains come in October or November to break the six to eight-month dry season. Many flowers fall to the ground after unsuccessful pollination or through damage by wind; they are picked up by livestock and wild animals and provide an important food source during this drought period when browse and grass is short.

B. *Acacia erioloba* flowers on the previous year's growth. The species flowers only once during the season and the flowers do not occur on the current season's growth. The branchlet below the flowers in the illustration is all the current year's elongating shoot in which initials will be laid down for the next year's flowers.

C. Fertilized ovaries developing into pods from the capitate inflorescence of *Acacia erioloba* at the end of the flowering period. There is remarkably little insect activity round *A. erioloba* trees during the day, even when they are in full flowers. Bees do not appear to visit the trees during the day. There is much more activity in the early hours before sunrise but the species of insects have not yet been identified.

D. Developing pods of *Acacia erioloba* at the end of November about two months after flowering. The pods are quite robust by the time that the characteristically violent storms occur at the beginning of the rainy season and they are relatively resistant to damage which is one reason for *A. erioloba* producing good pod crops compared with other *Acacia* species.

E. Tree to tree variation in pod size and shape in *Acacia erioloba.* The illustration shows five fully ripe pods from each of 25 trees in a single population of *A. erioloba* in Zimbabwe. The pods ripen between April and June and most fall between May and July. Each individual tree can be recognized by its pods; and they ripen and fall at different times. Number of pods produced and their nutritional value also vary from tree to tree. A large proportion of this variation is likely to be under genetic control and therefore open to improvement through selection and breeding.

F. Fully developed green pods of *Acacia erioloba.* Pods reach their full size by the end of December and then fill out with seed development. Green pods have high levels of prussic acid (cyanogenetic glucosides) and, at this stage, can have fatal results if eaten in any quantity by livestock.

G. The transition point between last and the current year's shoot in *Acacia erioloba.* This point is conspicuous because the smooth brown bark of the previous year's growth splits to reveal a whitish chalky under-layer. The thorns soon harden on the current year's growth to provide protection against browsing.

H. The swollen "insect-gall" base of an *Acacia erioloba* spine. A varying proportion of the spines on *A. erioloba* develop swellings at their bases that are inhabited by a sequence of moth larvae, ants and spiders. It is thought that the swellings may be genetically controlled by the tree rather than a gall response to insects.


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Plate 2.

A. *Acacia erioloba* in the Nossob River valley in the Kalahari-Gemsbok National Park in the northern Cape Province of South Africa. The species is an important source of food and shade for most mammals in this arid environment where the mean annual rainfall is less than 150 mm.

B. *Acacia haematoxylon* in the Auob River valley in the Kalahari-Gemsbok National Park in the northern Cape Province of South Africa. This species occurs sympatrically with *A. erioloba* in the south-west of the latter's range where its distribution is restricted to the Kalahari sands of the north-western Cape Province, south-eastern Namibia and south-western Botswana. It also produces a non-dehiscent velvety pod which, although generally narrower and smaller than that of *A. erioloba*, is even more highly relished by the wild herbivores in the area.

C. A hybrid between *Acacia erioloba* and *A. haematoxylon* in the Auob River valley in the Kalahari-Gemsbok National Park in the northern Cape Province of South Africa. This naturally occurring hybrid has only been found in the northern Cape Province. Material of the hybrid was first collected in 1809 by Willdenow when it was unrecognized as a hybrid and given the name of *A. giraffae*. The name *A. giraffae* was widely misapplied to what is now known as *A. erioloba* until the holotype was re-identified as being a hybrid by Ross in 1975 who subsequently resuscitated the name *A. erioloba*, originally assigned by Meyer in 1836.

D. *Acacia haematoxylon* (left), *A. erioloba* (right) and the natural hybrid between them (centre) in the Auob River valley in the Kalahari-Gemsbok National Park in the northern Cape province of South Africa. This is the typical habitat of *A. haematoxylon* on sandy flats between the dunes and along watercourses.

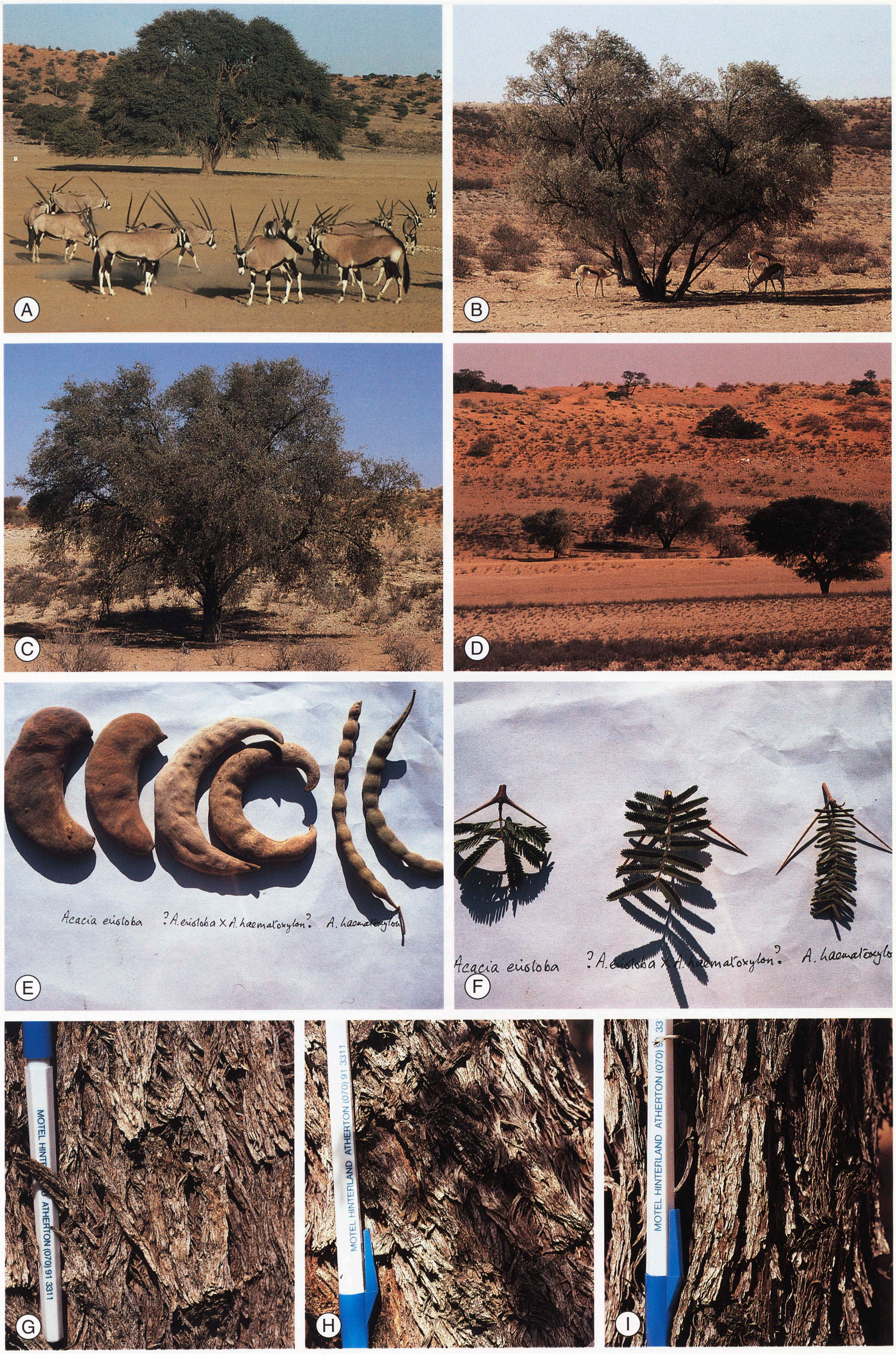
E. Typical pods of *Acacia erioloba* (left), *A. haematoxylon* (right) and the natural hybrid between them collected in the northern Cape Province of South Africa. The hybrid produces well-formed seeds that are viable. The intermediacy of the hybrids, however, suggests that they are all F_1 crosses and therefore that seedlings from hybrid trees may not survive to maturity.

F. Leaves and spines of *Acacia erioloba* (left), *A. haematoxylon* (right) and the natural hybrid between them collected in the northern Cape Province of South Africa. The leaves of the hybrid are intermediate between the minute, compact, densely grey-tomentellous leaves of *A. haematoxylon* and the larger, loosely arranged, generally glabrous leaves of *A. erioloba*. The spines of the hybrid are also intermediate between the thick thorns of *A. erioloba* and the long thin needle-like thorns of *A. haematoxylon*.

G. The bark of *Acacia erioloba* on a tree growing at Twee Rivieren in the Kalahari-Gemsbok National Park on the northern Cape Province of south Africa.

H. The Bark of the hybrid between *Acacia erioloba* and *A. haematoxylon* on a tree growing at Twee Rivieren in the Kalahari-Gemsbok National Park on the northern Cape Province of south Africa.

I. The bark of *Acacia haematoxylon* on a tree growing at Twee Rivieren in the Kalahari-Gemsbok National Park on the northern Cape Province of south Africa.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Acacia erioloba
? A. erioloba x A. haematoxylon ?
A. haematoxylon
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Acacia erioloba
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Plate 3.

A. Gallery forest near the Gobabeb Desert Research Station on the Kuiseb River in Namibia where the annual rainfall is less than 50 mm. The large trees in the riverine vegetation are principally *Faidherbia albida*, nearest the river, and *Acacia erioloba*, on the flats bordering the river. *A. erioloba* can root deeper and is less affected by fluctuating subterranean water levels than *Faidherbia albida*. The sand dunes move up the coast northwards, from left to right in the photograph, but periodic floods from heavy rain upstream carry the sand down to the sea and prevent the dunes from inundating the gravel plain on the north side of the river.

B. *Acacia erioloba* in the Sossus Vlei on the Tsauchab River in Namibia where the average annual rainfall is less than 50 mm and in many years there is no rain at all. This is the only tree species in this environment and the only source of shade and protein-rich pods for the larger herbivores that inhabit the area. The seed passes through the gut of these animals and is ready to germinate immediately after rare floods. The seedlings are capable of very fast root growth and follow the water down to where there is a permanent source.

C. *Acacia erioloba* in the Nossob River valley in the northern Cape Province of South Africa where the annual rainfall is about 270 mm. The species grows in the valleys and along the water courses in this arid area. Copious pod crops are available to the wild herbivores as they fall from April to August and the foliage is an important source of sustenance for them later in the dry season because the trees flush long before there is any green grass.

D. *Acacia erioloba* parkland in the Umguza Valley in Matabeleland, Zimbabwe, where the annual rainfall is about 550 mm. A natural stocking of about 15 mature trees per hectare in this environment can yield an annual pod crop of over 2 t ha^{-1} with a crude protein content that would be likely to exceed the yields that a small farmer might expect from a crop of un-irrigated grain.

E. A 20-year-old stand of *Acacia erioloba* that colonized arable land in the Umguza Valley in Matabeleland, Zimbabwe, when cultivation ceased. A combination of circumstances including cattle droppings rich in *A. erioloba* seeds, high temperatures, minimal perennial grass competition, adequate rainfall at the right time and low populations of predatory insects and rodents ensured this cohort establishment of a forest. This stand is already yielding 226 kg of pods per hectare.

F. Six-month-old seedlings of five provenances of *Acacia erioloba* in the Chesa Forest Research Station in Bulawayo Zimbabwe. From left to right the provenances are:- Makatoolo (Zambia), Shorobe (Botswana), Emhohloweni (Zimbabwe), Twee Rivieren, (South Africa) and Potgietersrus (South Africa). There was significant variation in height and provenance means over all trials ranked inversely to the latitude of the seed origin.

G. *Acacia erioloba* forest near Khwai in the Moremi Wildlife Reserve, Botswana, where the annual rainfall is about 450 mm. This species does not form impenetrable thickets that lock up the productivity of the land as do many other acacias that have invasive tendencies.

H. *Acacia erioloba* growing at Makatoolo in Zambia where the annual rainfall is about 850 mm. This is the northern-most natural provenance of the species and it consistently grew faster than all other provenances at one year from planting in the field. It was also the most frost-resistant provenance.

I. An uneven-aged stand of *Acacia erioloba* in the Umguza Valley in Matabeleland, Zimbabwe. It is unusual to see such a range of ages in a single stand. In this case it probably has been because arable and grazing management of the land provided the ideal set of circumstances fof germination and survival of the seedlings than would be the case under natural conditions. It does indicate that, with proper management, it would be feasible to sustain production of pods and browse indefinitely from a parkland of *A. erioloba*.

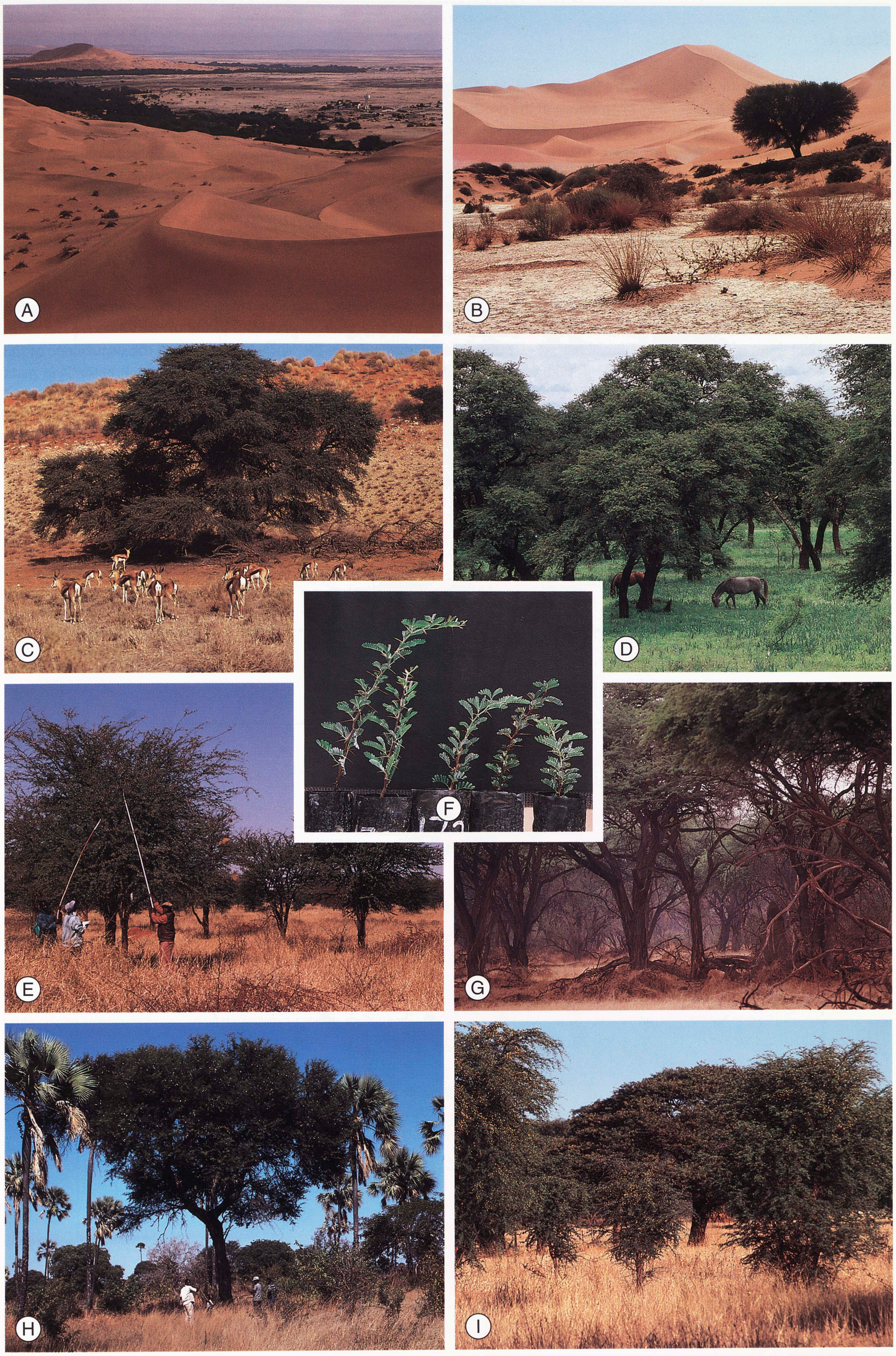
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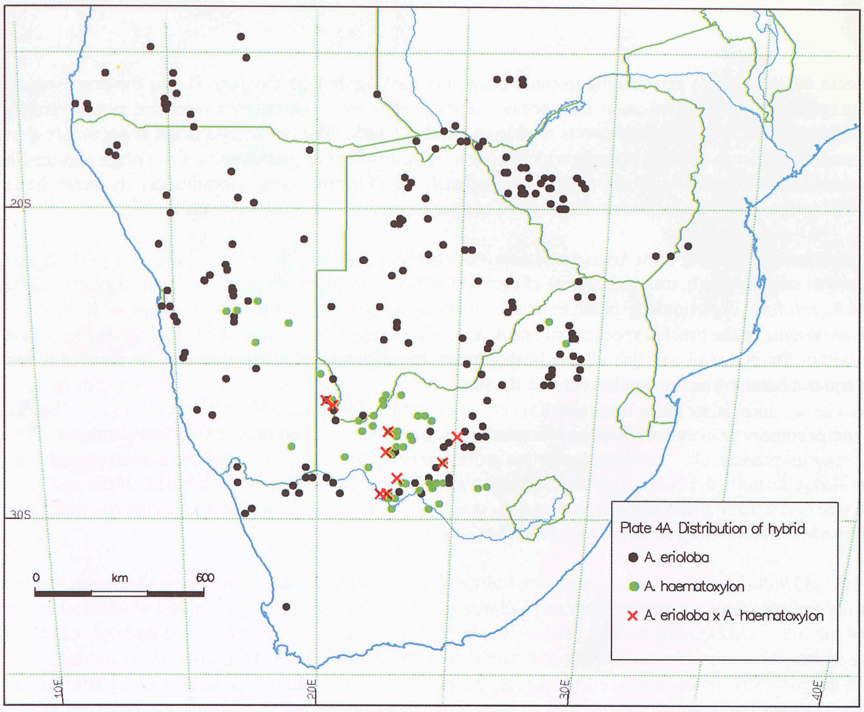
Plate 4.

A. Map of southern Africa showing the distribution of *Acacia erioloba, A. haematoxylon* and the hybrid between them. So far, the hybrids have only been found in the northern Cape Province of South Africa. The hybrids found have been morphologically so precisely intermediate between the parent species that it is suspected that they are all F_1 crosses. The pollen grains of *A. haematoxylon* consist of 16 symmetrical and uniform cells per polyad like those in most southern African acacias whereas *A. erioloba* has reportedly 28 to 48 cells in a different arrangement. The hybrid may be of interest for use in increasing productivity of arid rangelands. Although *A. erioloba* grows in areas of very low rainfall, it is dependent for its survival on reaching a permanent supply of underground water, albeit at great depth. *A. haematoxylon*, on the other hand, appears to be more specifically adapted for survival in areas of very low rainfall with no access to underground water.

B. Map of southern Africa showing the distribution of *Acacia erioloba*, the seed collection sites and the mean annual rainfall isohyets. The distribution of *A. erioloba* coincides almost exactly with the extreme limits of the Kalahari Desert in ancient times of the driest interpluvial period. Its distribution in relation to the isohyets shows that the occurrence of the sands is the critical factor rather than rainfall which varies from <100 mm to >800 mm over its range. It extends in parts at the periphery to even small outliers of windblown sand such as those in Zambia to the north and Zimbabwe and Mozambique in the east. It is able to withstand great extremes of heat and cold but it needs herbivores to scarify and distribute its seed. It then needs periodic heavy rain to germinate and sustain taproot growth for long enough to make contact with a permanent supply of underground water which can be at great depth. The seed collection sites were selected to cover the east-west rainfall gradient of the region.


20S
30S
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20E
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0
km
600
Plate 4A. Distribution of hybrid
A. erioloba
A. haematoxylon
A. erioloba x A. haematoxylon

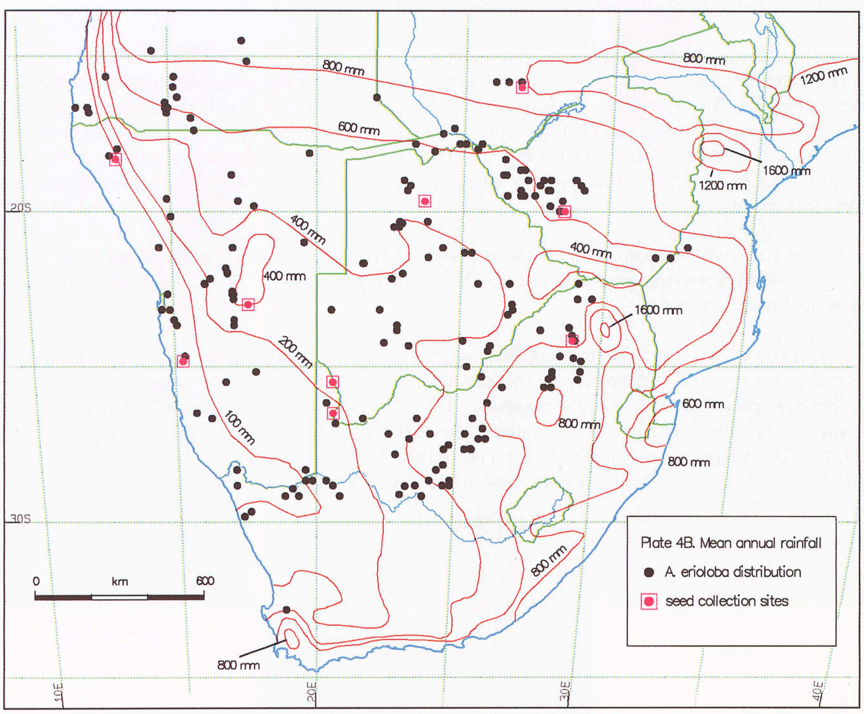
20S
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Plate 4B. Mean annual rainfall
A. erioloba distribution
seed collection sites

Plate 5.

A. *Acacia erioloba* seeds germinating in cattle dung after passing through the gut. This is the prime natural means of propagation and regeneration in the species. Passage through a herbivore's digestive system greatly increases scarification and, it is thought, protects seed from bruchid attack. The percentage of seeds germinating from dung is particularly high in *A. erioloba* and seeds have a higher germination rate, germination percentage and seedling survival compared to seeds that have not passed through an animal. There is often intense termite activity under the cow pats but the *A. erioloba* seedlings appear to be immune to attack.

B. Bruchid larvae emerging from *Acacia erioloba* seeds before pupating. The most conspicuous pests of the species are those that infest the seeds, mainly the larvae of bruchid beetles. The larger bruchids favour the seeds in indehiscent pods and *A. erioloba* is particularly prone to attack. Virtually all seeds on a tree may be colonized by these beetles. The larvae of some of the bruchid species that attack *A. erioloba* are so large that they have to emerge to pupate in the soil or within the pod wall and this allows further attack by medium sized bruchids that lay their eggs inside the old emergence hole; the larvae totally consume the seed.

C. Termites consume *Acacia erioloba* pods soon after they fall to the ground but the seed is undamaged. If there are any herbivores present, all pods that drop to the ground are picked up and consumed in a short period and the seed is scarified in the gut and is ready to germinate as soon as the rains come and water is imbibed. If the pod is not eaten and the seed coat remains undamaged, it may remain in the ground for many years before the coat has weathered enough to allow the seed to take up moisture and germinate.

D. A hayfield with *Acacia erioloba* trees in the Lukwe Valley in Matabeleland, Zimbabwe. Although this field is mown for hay annually, there is a massive bush encroachment problem with *Dichrostachys cinerea* which thickens up with each mowing and would form impenetrable thickets if mowing were to cease, effectively taking the land out of production for many years. The economic justification of bush clearing for grazing is dubious in such circumstances. The *D. cinerea* does not grow beneath the large *A. erioloba* trees. It is not clear whether this is due to allelopathy or to animal or termite activity beneath the crowns of the trees. A solution to the bush encroachment problem may be to encourage a parkland of naturally regenerated *A. erioloba* trees.

E. *Acacia erioloba* trees in the desert near Sesriem in Namibia. The trees are often the only source of food and shade as shown by the animal tracks that go from tree to tree.

F. A young *Acacia erioloba* tree encased in termite earthworks. Periodically when the moisture status of the soil is right, the whole stem and major branches of a young tree may be attacked by termites which remove the dead bark without harming the tree. This kind of termite activity is the scourge of exotic tree planting in the region and expensive and highly toxic chemicals have to be used to avoid a very large percentage failure of individual trees or plantations. It is likely that some symbiotic relationship has evolved between *A. erioloba* and termites, a better understanding of which may provide a lead in resolving the problem with exotics without recourse to the environmentally and economically undesirable chemicals.

G. The larva of a bark beetle that mines in the cambial layers of branches in the crowns of stressed *Acacia erioloba* trees. The flat, fras-filled tunnels are shown with a larva. The tunnels can partially or completely ring-bark the branch causing patchy die-back in the crown.

H. An *Acacia erioloba* tree with a companion *Ziziphus mucronata* in the Umguza Valley, Matabeleland, Zimbabwe. In this part of its range, it is common for almost every old tree to have a single *Z. mucronata*, almost to the exclusion of all other tree species, growing beneath its canopy. The seed of *Z. mucronata* is spread by birds. The *Z. mucronata* eventually replaces the *A. erioloba* as the dominant tree on the spot; but there is no cohort development as there is with the latter. This suggests that *Z. mucronata* is a natural successor to *A. erioloba* but there is often regeneration of *A. erioloba* as well and the latter's place in succession and climax is not well understood.

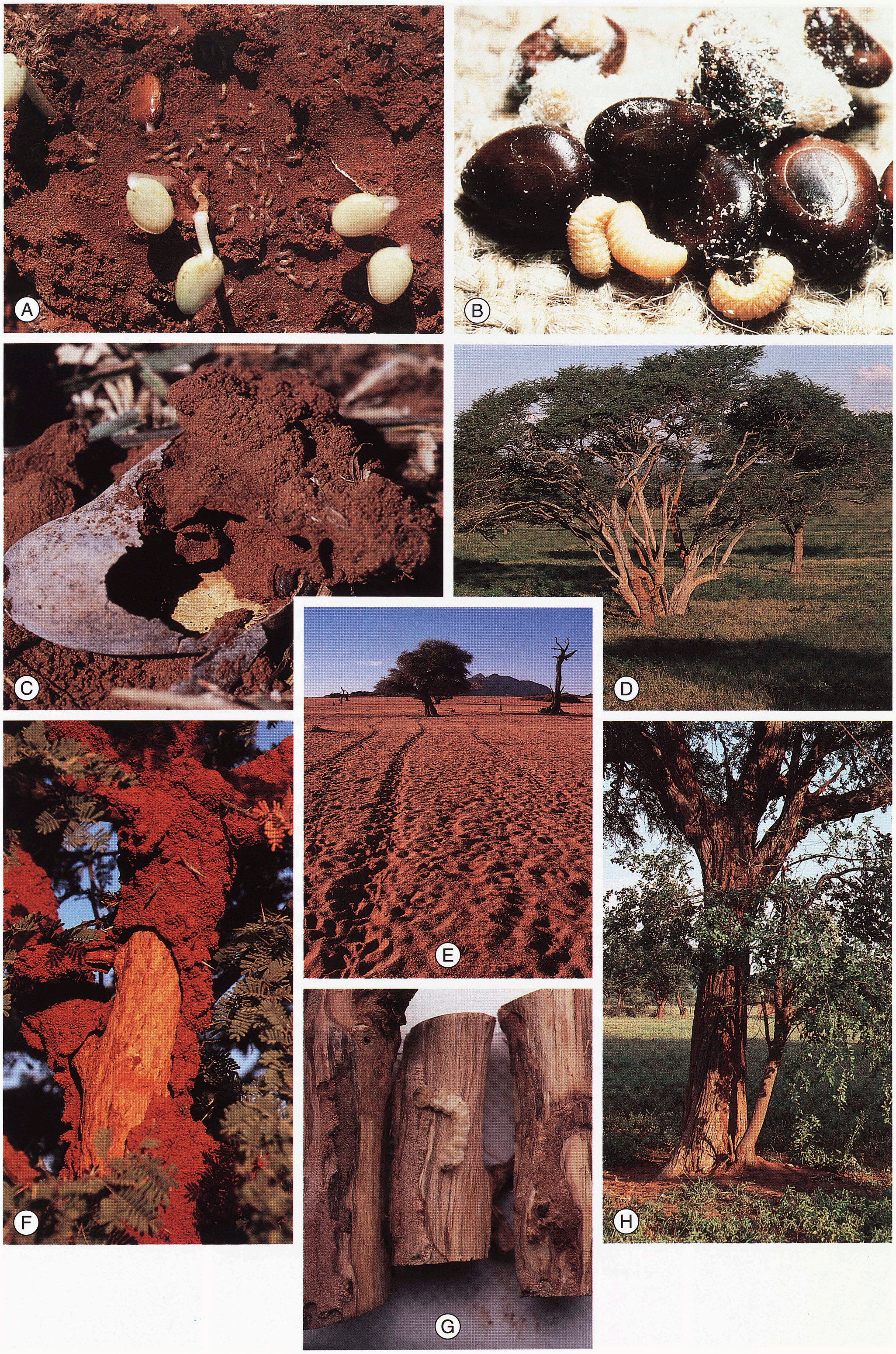
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Plate 6.

A. Seed of *Acacia erioloba* germinating after nicking and soaking. If the seed is unscarified, it is unable to imbibe water and will not germinate. The most reliable means of inducing rapid germination of an unscarified seed is to nick the seed coat at the micropylar end with a pair of nail clippers, soak in water for 12 hours and place the seed in a germination cabinet at a temperature of about 36°C; the radicle will appear within about 8 hours and the seed can then be sown in soil.

B. *Acacia erioloba* seeds germinating in a cow pat. Under natural conditions, the pods are eaten by a herbivore between May and July. The seeds are scarified by passing through the gut but the combination of temperature and moisture after the dung is dropped are not right for germination until after the first rains have fallen between October and December when the seedlings send a taproot deep down into the soil below the dung.

C. An *Acacia erioloba* seedling that could be anywhere between one and four years old. Growth is very slow during this period, rarely more than a metre, when it is putting a maximum amount of its resources into establishing a deep root system that will make it independent of the seasonal and periodic droughts that are characteristic of the environment. Many seedlings fail to establish themselves at the end of the first year. Germination in the cow pat does not guarantee that the seedling will make it through to the second year. Grass competition, fierce grass fires, browsing by herbivores, predation by insects and rodents and severe drought must be absent for it to have a good chance of surviving and there are, no doubt, other subtle factors in the environment that must be absent or present for a good year for the development of a cohort of trees because years when this happens are not frequent in any part of the species' distribution.

D. An 11-year-old *Acacia erioloba* in the Umguza Valley, Matabeleland, Zimbabwe. This tree is known to have put on almost all its height growth in the previous seven years and is now nearly 4 m high. It has been pruned to about 1.5 m; an untended tree would still have a "skirt" of live branches to the ground. There was no flowering to this stage.

E. A 12-year-old *Acacia erioloba* in the Umguza Valley, Matabeleland, Zimbabwe. This is the same tree as in D on the left exactly one year later. It can be seen that growth is rapid at this stage and there has been an increase of about a metre in height and crown width and the tree has started flowering.

F. A 17-year-old *Acacia erioloba* in the Umguza Valley, Matabeleland, Zimbabwe. This is the same tree as in D and E on the left five and six and five years later respectively. All three photographs were taken in September. The tree is now nearly 7 m high and in full flower and will produce up to a useful 15 kg of pods nine months later in the following dry season.

G. A *c.* 40-year-old *Acacia erioloba* in the Umguza Valley, Matabeleland, Zimbabwe. At this stage the trees that will reach a large size and live to a great age become conspicuous by their luxuriance among the individuals of their cohort. Pod production from individual trees varies greatly but this tree already produces on average about 150 kg of pods per annum.

H. A large *Acacia erioloba* in its prime in the Hwange National Park in western Zimbabwe. This tree is probably between 100 and 200 years old and might produce as much as 500 kg of pods in a single good year. The *c.* 6 m browse line in this case is maintained by browsing giraffe and elephant reaching for the pods and smaller branches.

I. A very old *Acacia erioloba* growing in the Umguza Valley in Matabeleland, Zimbabwe. It is estimated that this species may live longer than 300 years. The crown of this tree has started to become moribund in parts and it will die over a long period. Pod production has declined to less than 50 kg per annum. Even after it has died, the dead stem will stand for many years because there will be a high proportion of heartwood and it is very durable, resistant to termites and not attractive to firewood cutters because the wood is so hard that it bluntens tools.

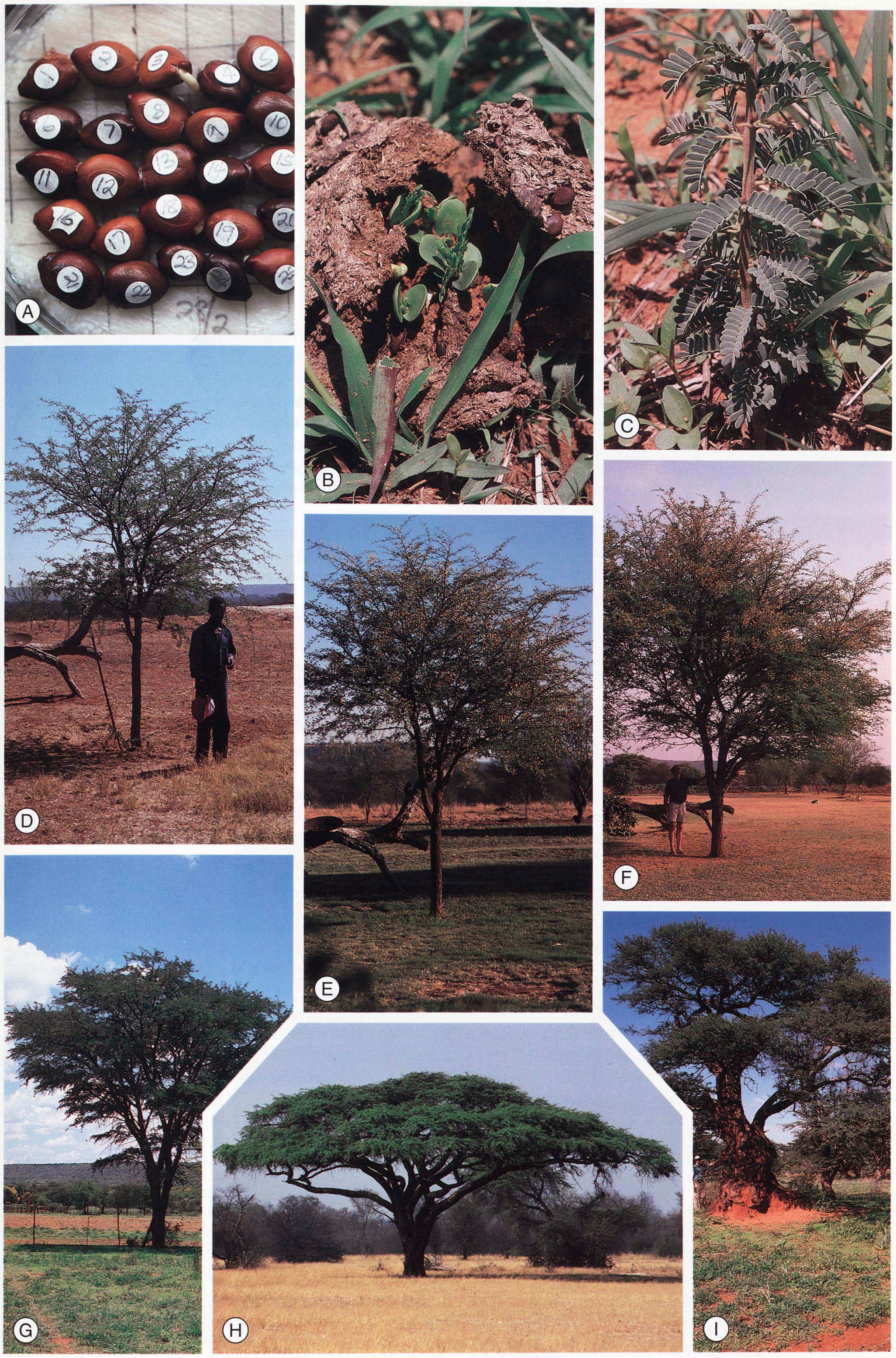
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Plate 7.

A. A *c.* 20-year-old *Acacia erioloba* tree in the Umguza Valley in Matabeleland, Zimbabwe, with sparrow-weavers' nests. The nests are always built on the south-western side of the tree possibly to benefit from the warmth of the setting sun and to avoid the entrances facing into the periodically cold prevailing south-east wind. In drought years when roughage is short for livestock at the end of the dry season, the grass nests of sparrow-weavers are collected from the crowns of *A. erioloba* and fed to domestic animals. It is possible that the bird chick droppings add to the nutritional value of this emergency feed.

B. Huge sociable weaver bird nests in an old *Acacia erioloba* tree in the Kalahari-gemsbok National Park in the northern Cape Province of South Africa. The trees are vital to the birds in providing the sites for their nests but their presence can be fatal to the tree if there is a fire as shown in D below.

C. Young *Acacia erioloba* near Kana in Botswana regenerating by coppice after a fire. At this stage the tree has developed a very deep root system, has a thick bark and can regenerate its aerial parts rapidly after a fire.

D. An *Acacia erioloba* destroyed by fire in the Nossob Valley in the Kalahari-gemsbok National Park in the northern Cape Province of South Africa. Mature trees are very fire resistant except where large sociable weaver nests in the crown, dead branches 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 happened on a large scale in the Nossob River Valley after the 1974-6 floods when there were severe lightning fires set off in the dense grass cover that resulted from the rain.

E. Stem roots on *Acacia erioloba* in the Kalahari-gemsbok National Park in the northern Cape Province of South Africa. *A. erioloba* has the capacity to produce stem roots when it is buried by a moving sand dune and can subsequently survive when the sand dune moves on. This is an unusually flexible response for such a large and long-lived tree but shows the extent of its remarkable adaptability to desert conditions.

F. A large old *Acacia erioloba* tree in the Umguza Valley in Matabeleland, Zimbabwe, bearing a huge pod crop and harbouring palatable grasses beneath its crown. Unlike most of the African acacias, *A. erioloba* does not nodulate freely but obtains a higher proportion of its nitrogen from nitrates in deep ground water. It provides just as useful a service to the plant community by utilizing this source of nitrogen which is inaccessible to all other plants. The shade and improved nitrogen status of the soil and the low demands made by the tree for surface moisture, encourage a rich sward of palatable and nutritious perennial grasses to grow beneath the crown, an added bonus to the pod crop and browse.

G. Annual growth rings in the stem of *Acacia erioloba*. It has recently been discovered that there is a anatomical feature in the stems of some acacias that is annual in its formation; it is particularly distinct in *A. erioloba*. This feature is a band of marginal parenchyma in which the cells are characteristically filled with crystals of calcium oxalate which makes the rings clearly visible. They are seen for the years 1987 and 1988 in this photograph as thin lines quite distinct from the broader bands of aliform parenchyma. (Photo: I.D. Gourlay)

H. *Acacia erioloba* flushing before nearly all other tree species at the end of the dry season in the Umguza Valley in Matabeleland, Zimbabwe. The tree is independent of rainfall over the past few years because of its deep rooting architecture that ensures a supply of moisture from ground water that is out of reach of most of the plant species in the community.

I. Annual shoot growth in the crown of *Acacia erioloba*. Shoot elongation starts just after leaf flush and flowering at the end of September. Up to a metre or more of growth is produced in about a six-week period after which the shoot thickens and no further growth takes place until the next season. The spines are soft when they are first produced but soon stiffen to protect the young shoot and new leaves. Trees vary in the stiffness of the shoots, some being almost upright whereas others have a graceful arcing habit.

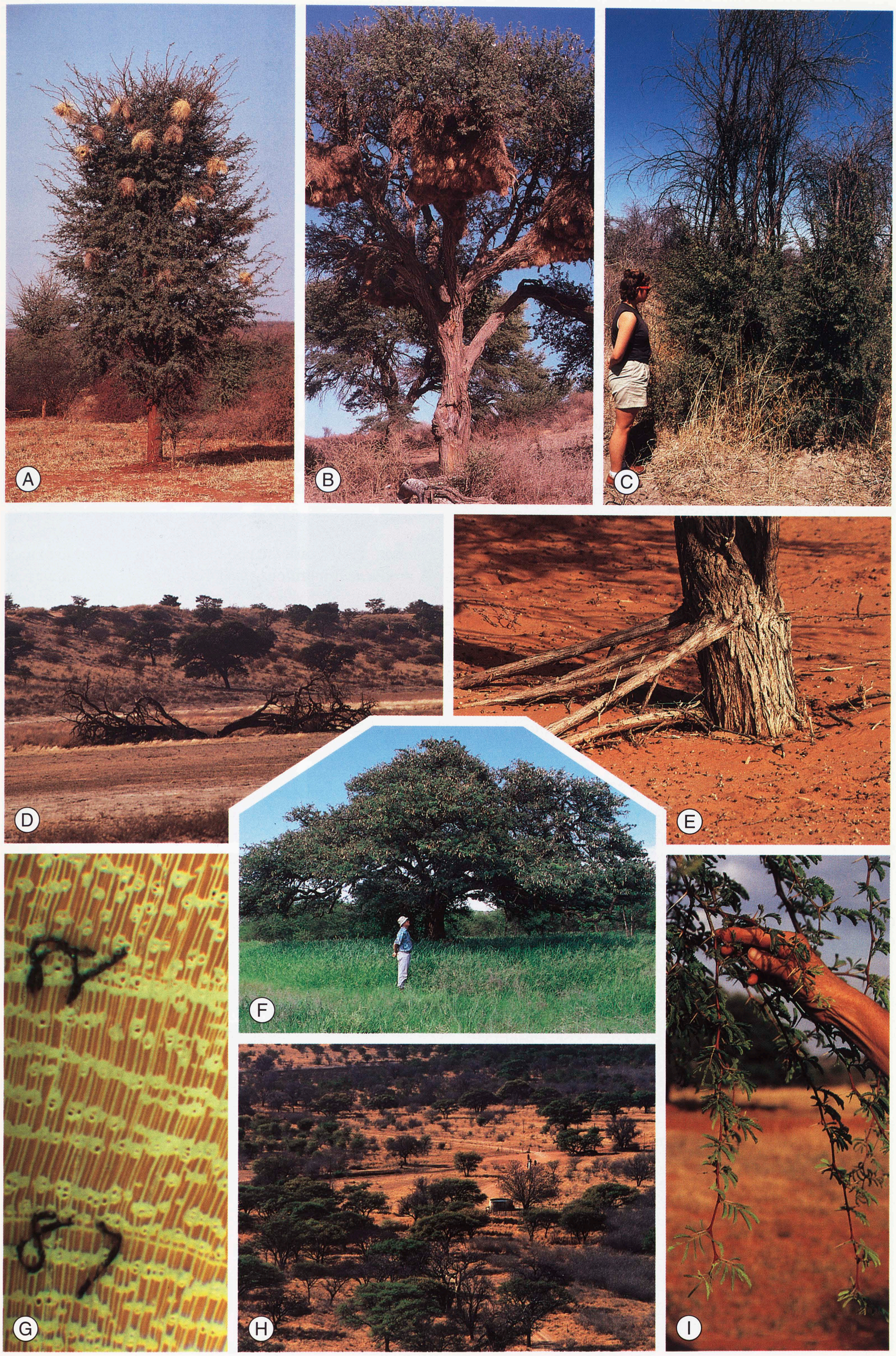


Plate 8.

A. Springbok browsing off a large *Acacia erioloba* tree in the Kalahari-gemsbok National Park in the northern Cape Province of South Africa. *A. erioloba* has evolved with the herbivores of Africa; hence its nutritious indehiscent pod that is relished by a very wide range of animals that disperse the seed so effectively. The prussic acid content of the green pods and foliage prevent damage to unripe seed and limit the browsing of young trees to a tolerable level even when it is the only green forage in the environment.

B. Goats browsing on the foliage of a young *Acacia erioloba* tree. The prussic acid in the foliage and fresh pods can poison stock if too much is eaten at once. The cyanide gas produced is, however, rapidly disposed of by the body and stock can take a large amount of browse provided it is eaten in small quantities at a time.

C. Cattle in the shade of a large *Acacia erioloba* tree at midday. This species is conspicuous in that it provides dense shade at the end of the dry season when temperatures are highest. Over much of its range it is the only tree species present when it is literally a "tree of life" for the majority of insects and animals in the environment. Livestock use energy to keep cool in the heat of the day. Shade increases weight gain and calving rate.

D. Cattle being fed *Acacia erioloba* pods. Farmers appreciate the value of the pods over much of the natural range of the species and they are often collected and stored or sold for feeding to livestock at the end of the dry season when grazing and browse are at their scarcest. Stored pods can make the difference between life and death of the animal in drought years. Demand for the pods puts a high price on the commodity and the tree makes a contribution to the cash economy in some communal areas.

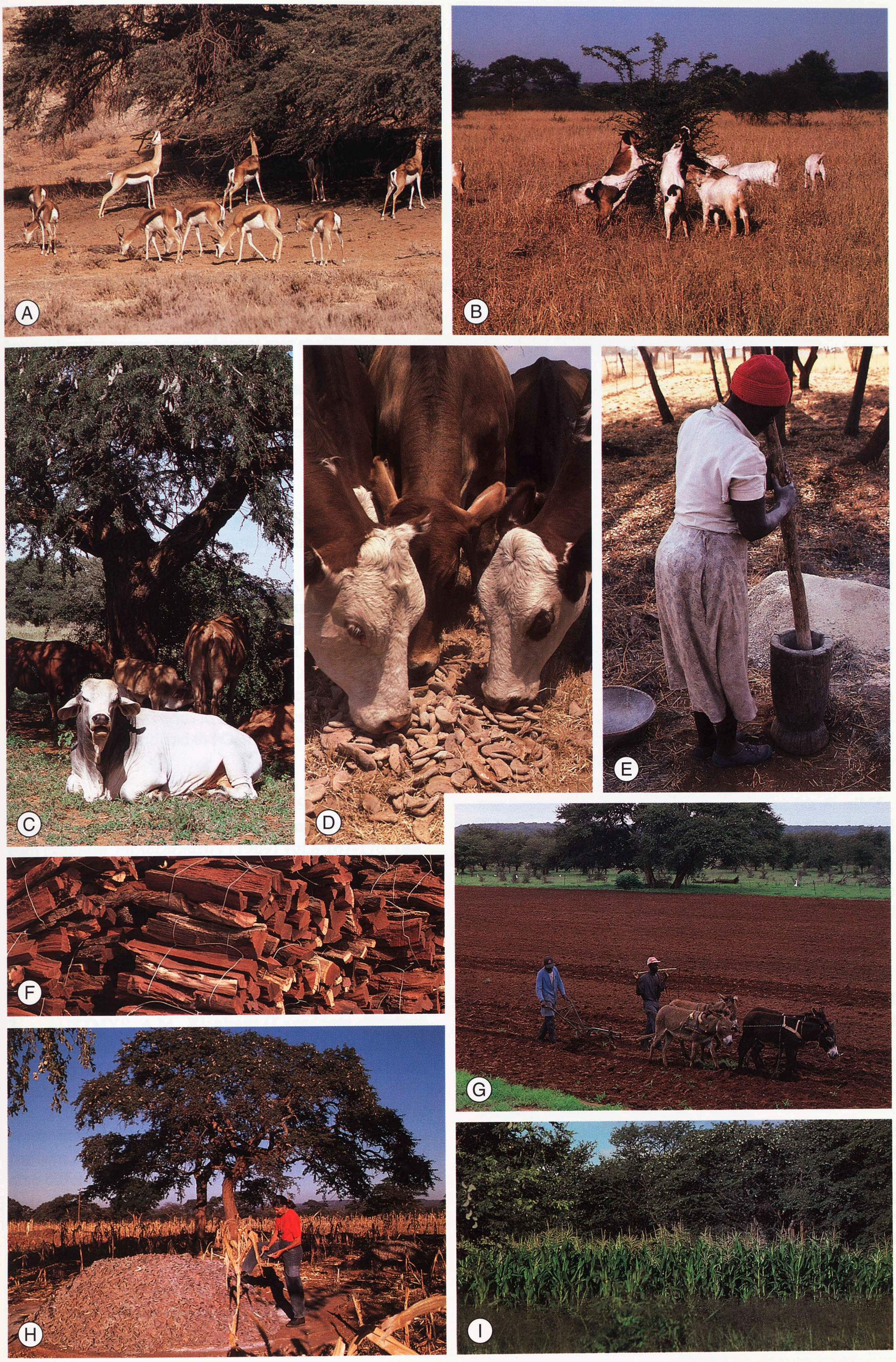
E. Grinding *Acacia erioloba* pods with a wooden pestle and mortar. In this case the pods were being crushed to extract the seed for a provenance collection. Crushing the pods produces a nutritious meal with a crude protein content equivalent to that of maize grain. If the seeds are crushed as well, the protein value of the meal is over 70% higher than that in maize grain. If they are kept dry, the pods will store well for more than a year.

F. *Acacia erioloba* firewood stacked for sale. The species produces a fuel with a high calorific value and it makes excellent coals that generate heat for a long period. It is in very high demand for roasting meat on an open fire (braaifleis or barbecue) and in the southern part of its range, a bundle of wood the size of those shown in the photograph costs more than a litre of diesel fuel. However, the wood burns with an acrid smoke and is not popular for burning in traditional kitchen huts.

G. Ploughing in preparation for planting a grain crop between the trees in an *Acacia erioloba* parkland in the Umguza Valley in Matabeleland, Zimbabwe. In some parts of its range, trees are still cleared to make way for grain crops. The more immediate needs of the community for directly consumable human food obscures the potential of the trees the products of which, if put through properly managed herds of livestock, could make as high a contribution per hectare in the form of meat and milk than the grain - and with far fewer inputs.

H. Pods collected from *Acacia erioloba* trees growing in a maize land in the Umguza Valley in Matabeleland, Zimbabwe. The pods are collected and brought to central purchasing points in June/July and ground and mixed with maize stalks for feed later in the dry season when grass is scarce and meat prices high. Like most acacias, this tree improves the nitrogen status of the soil beneath its crown and crop yields are often higher near the trees, especially if the crowns are high and do not restrict the light. *Acacia erioloba* is very deep rooted and unlikely to compete with the crops for moisture or to mine nutrients from the open spaces as some surface-rooted species are suspected of doing.

I. A crop of irrigated maize grown between young *Acacia erioloba* trees in the Umguza Valley in Matabeleland, Zimbabwe. Commercial farmers often leave the large trees in their irrigated lands but the trees commonly die because they cannot respond to the changes in moisture regimes in the soil. Young trees are more likely to survive, and to thrive, because their root systems can adapt.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ANNOTATED BIBLIOGRAPHY

This bibliography is arranged in alphabetical order of authorship. Subject groupings can be accessed by reference to the publication numbers at the end of each section in the main text of the monograph. There is also an author index at the end of the bibliography in which the publication numbers are given for each author.

Both the published and the grey literature on *Acacia erioloba* have been searched for this bibliography. In some abstracts, information is given on other species where this serves to place *A. erioloba* in context in the subject being discussed.

Not all the publications cited were available to the authors. Where a publication was judged to be of significance from its title but neither the paper nor an abstract was available, it has, nevertheless, been included without annotation.

In the monographic section, reference has been made to a number of works that do not specifically mention *A. erioloba* but which are pertinent to the discussion of the particular topic. For ease of reference, these are included, without annotation, in this bibliography rather than in a separate section. Otherwise, where the title of a paper is given alone without abstract, the work has not been seen.

1 ACOCKS, J.P.H. **Veld Types of South Africa** 2nd edition *Botanical Survey of South Africa Memoirs* no. 40 (1975) 128 pp. [En, 20 refs.]

Comprehensive work on South African forest and other vegetation types with vegetation maps and separate veld type map. *Acacia erioloba* is generally associated with deep sand over limestone in the flat, hot semi-arid to arid country of the Kalahari thornveld which it often dominates because of its large size. It also forms a distinct veld type on light turfy soils and extends as a component into the broken veld of Namaqualand and the Orange River.

2 ANDERSON, D.M.W.; DEA, I.C.M. Review Article **Chemotaxonomic aspects of the chemistry of *Acacia* gum exudates** *Phytochemistry* (1969) vol.8 167-176. [En, 89 refs.]

The results of chemical studies of the gum exudates from thirty *Acacia* species including *A. erioloba* are reviewed, and their taxonomic significance is discussed with respect to Bentham's divisions of the genus.

3 AUSTMYR, A.M. **Elephant (*Loxodonta africana*) seed dispersal in Namibia**. Unpublished M.Sc. thesis at University of Oxford, United Kingdom (1994). [En, 83 refs, 30 tables, 56 figs, 34 plates.]

This is an investigation of the dispersal and survival of seeds ingested by elephants during a drought year in northern Namibia. Elephant dung analysis yielded seed of nine different species of six families. The most prevalent were *Grewia* species (82%). Most seeds were found in dung from elephants in the juvenile to adult cow age range suggesting that they did most of the seed dispersal. Laboratory examination and germination trials were carried out on seed of the three most abundant species (*Grewia* spp., *Acacia erioloba* (13%) and *Faidherbia albida* (4%) collected from dung and pods. Scanning electron microscopy showed that although non-ingested seeds were scarified, passage through the elephant's digestive system greatly increased scarification, particularly in *A. erioloba seeds*. It is also suggested that ingestion by elephant protects *A. erioloba* seed from bruchid attack. The percentage of seeds germinating from dung and pods was greatest in *A. erioloba* and least in *Grewia* spp. Overall, *A. erioloba* seeds had a significantly higher germination percentage and germination rate but lower average plant height than *F. albida*; the latter had a higher death rate and thus a lower survival than *A. erioloba*. Ingestion by elephants significantly increased the germination percentage and establishment rates of *A. erioloba* but not *F. albida*. Statistical analysis of the survival data using the hazard function revealed that, for both species, ingestion by the elephant decreased death rate, hence increased survival. The effect of ingestion and germination on survival of the three plant species are discussed in relation to their seed morphology and their natural environment.

4 BARNES, R.D.; FAGG, C.W. **The potential of African Acacias in agricultural systems in the dryland tropics.** In E. Korpilahti et al. **Caring for the forest: Research in a Changing World** Congress Report Vol 2 IUFRO XX World Congress, 6-12 August 1995, Tampere, Finland. (1996) 381-390.[En, 7 refs.]

Acacia species dominate the dry zones of Africa. The role of six species, including *Acacia erioloba*, is described and discussed. These species provide the rural people of the continent with multiple products including fuelwood, fodder, food, fibre and gums. Their role is becoming more prominent because of their ability to cycle water and nutrients from depth, fix nitrogen and colonize and rehabilitate the increasing amount of degraded land. Genetic variation and their range of ecologies give them the potential

of being more formally used to ameliorate soils and climate and to increase productivity throughout dryland Africa. Their most likely use is in improving animal production by enriching the range in silvopastoral systems, in restoring fertility in bush-fallows, in inter-cropping with grain crops and in woodlots dedicated to fuelwood or gum production. Research into genetic variation is providing the information and materials necessary for breeding. Research is also needed into their ecology to help integrate this superior material into operational agricultural systems. A knowledge of the environmental conditions that are required for the periodic mass regeneration events and an understanding of the competitional and allelopathic relationships must be acquired to provide a basis for the development of management techniques to establish and control the improved germplasm in the new environments.

5 BARNES, R.D.; FILER, D.L.; MILTON, S.J. ***Acacia karroo*: monograph and annotated bibliography.** *Tropical Forestry Papers* No. 32. Oxford Forestry Institute. 1996a. 77 pp. [En, 5 tables, 9 Figs., 2 maps, 44 photos., 258 refs.]

This comprehensive monograph and annotated bibliography on *Acacia karroo* includes mention of *A. erioloba* in a table that presents an analysis of the percentage of leaf nitrogen, the nitrogen 15 ratio and the carbon 15 ratio for six *Acacia* species growing sympatrically in the Umguza Valley in Zimbabwe. The data indicate that *A. erioloba* fixes a lower proportion of its nitrogen from the atmosphere than the other five species.

6 BARNES, R.D.; FAGG, C.W.; MARUNDA, C.T.; STEWART, J.L.; CHIMBALANGA, J. ***Acacia erioloba*: a tree of life in semi-arid lands.** *In* Dieters, M.J., Matheson, A.C., Nikles, D.G., Harwood, C.E., and Walker, S.M. (*eds.*). 1996b. *Tree improvement for sustainable tropical forestry.* Proc. QFRI-IUFRO Conf., Caloundra, Queensland, Australia. 27 October - 1 November 1996. 2 pp. [En, 4 refs, 2 tables, 2 figs.]

Acacia erioloba E. Meyer occurs naturally on the ancient windblown sand formations of southern Africa where the annual rainfall varies from 50 to 600 mm. It thrives under these conditions because of its capacity to root to great depth. The species is valued for its nutritious pods and foliage and the environment it creates for palatable grasses. A parkland of *A. erioloba* trees can yield an annual pod crop with a crude protein equivalent of 372 kg ha^{-1}, higher than the maximum expected from small-holder grain crops in the area. There is substantial tree to tree variation within populations in pod yield and nutritional value; a proportion of this variation is likely to be under genetic control and could be exploited to increase yields.

7 BARNES, R.D.; MARUNDA, C.T.; MAKONI, O.; MARUZANE, D.; CHIMBALANGA, J. African acacias: Genetic evaluation: Phase I. Final Report of ODA Forestry Research Scheme R5653. Oxford Forestry Institute and Zimbabwe Forestry Commission. 1996c. 209 pp. [En, 34 tab., 11 fig., 48 photo.]

This is a report on the establishment and assessment of wide ranging provenance trials of *Faidherbia albida, Acacia erioloba, A. karroo, A. nilotica, A. senegal* and *A. tortilis* in the semi arid south-western part of Zimbabwe. Screening trials of a total of over 70 entries representing provenances of all six species were planted on eight sites and assessed at 12 months old. Provenance composition, trial design, nursery procedures, field planting and maintenance are described. Five provenances of *A. erioloba* were included in the trials, Imhohloweni (Zimbabwe), Makatoolo (Zambia), Potgeitersrus (South Africa), Twee Rivieren (South Africa) and Shorobe (Botswana). All seeds were individually nicked and pre-germinated in an incubator before sowing. *A. erioloba* took 12 hours to imbibe water after nicking, 72-96 hours to produce a radicle in the incubator (at 25-30°C) and a further 72 hours for the hypocotyl to emerge after sowing in the nursery. Recovery of pre-germinated seed was about 95% and average height growth in the nursery was 6.0, 9.7, 12.9 and 16.5 cm at 1, 2, 5 and 7 months respectively. The seedlings were smaller than all the other five species except for *A. senegal* which averaged only 9.3 cm at 7 months; *Faidherbia albida* averaged 25.9 cm at the same age. Average field survival of *A. erioloba* varied from 16% on the harshest to 80% on the best site and was generally below average for all six species and no provenance showed consistent superiority in this trait. Average height of *A. erioloba* at 12 months varied from 0.328 to 0.748 m across sites and was among the lowest-ranked of the six species except on the Kalahari sand site where it was ranked second out of the specific and sub-specific taxa. Among the five *A. erioloba* provenances, Makatoolo from Zambia, the northern-most, consistently ranked highest at all but one site and Twee Rivieren from South Africa, the southern-most provenance was most often lowest ranked. The *A. erioloba* provenances were significantly more frost resistant than all entries of the other species; the Shorobe and Imhohloweni provenances from Zambia and Zimbabwe respectively were most frost resistant within the species which was not unexpected since the frosts in these areas are probably the most severe in the range. The report includes a description of a study in progress in an even-aged (*c.* 20 years) natural stand of *A. erioloba* that resulted from cattle depositing their dung when cultivation ceased on a flat area of alluvial sand. At 20 years, the mean height of the stand was 5.7 m (3.7-7.3 m), mean stem diameter at ankle height 18.4 cm (10.1-35.0 cm), total number of pods per tree 339 (25-1204), pod weight 13.5 g (7.4- 30.2 g), weight of seeds per pod 3.8 g (1.8-9.6 g), crude protein content of pods without seeds 9.9% (6.6-12.8%), crude protein content of seeds per pod 27.4% (23.1-31.4%). The was no correlation between tree size and number or weight of pods produced. Pods started falling in the first half of May, were at their maximum rate of fall from 16 May to 15 June and were almost all fallen by the end of August. The area of the observation plot was 3.8 ha and every one of the 500 trees on it was measured. The total weight of pods produced was 600 kg of pods ha^{-1}.

8 BEN-SHAHAR, R. **Woodland dynamics under the influence of elephants and fire in Northern Botswana** *Vegetatio* (1996) 123: 2, 153-163 [En, 27 ref.]

Sustained elephant browsing and intense burning could result in the loss of woodlands under conditions where elephant densities are high, such as in northern Botswana. Three woodland types dominated by *Acacia erioloba* (acacia), *Baikiaea plurijuga* (baikiaea) and *Colophospermum mopane* (mopane) were monitored in plots, and contemporary recruitment rates of woody plants were compared with the associated local elephant densities and fire occurrences. Woodland types differed with respect to structure, extent of elephant damage and the occurrence of fire. *A. erioloba* woodlands had very low fire damage (24 plants per hectare) compared to the other two (232 & 194). The mean numbers of new seedlings per hectare (109), no of seedlings per hectare (232), no of shrubs per hectare (121) and total number of trees per hectare (165) are recorded from the acacia woodlands during 1991-1993. Elephant-induced mortality was highest for mopane, and low for acacia and baikiaea, whereas fire affected baikiaea recruitment most, and with moderate fire regimes barely affected the acacia and mopane woodlands. Concluded that the acacia woodlands are unlikely to decline under present elephant and fire damage regimes, but that those populations growing in low lying areas which are susceptible to flooding can result in tree and high seedling mortality.

9 BENTHAM, G. **Revision of the suborder Mimoseae.** *Transactions of the Linnaean Society of London* (1875) 30: (3) 335-664.

A comprehensive revision of the suborder Mimoseae, in which 7 tribes are recognised. The genus *Acacia* was divided into 6 series, and *A. giraffae* Willd. placed in the series Gummiferae, subseries Summibracteatae with some American and two other African species, *A. haematoxylon* Willd. and *A. sieberiana* DC.

10 BERRY, C. **Trees and shrubs of the Etosha National Park**. Directorate of Nature Conservation, Windhoek, Namibia (198?) 161 pp. [En]

Illustrated descriptions of a selection of trees that occur in the Etosha National Park. The guide includes a map and brief descriptions of the nine major vegetation types in the park. *Acacia erioloba* occurs in small numbers in the sandveld areas. Many herbivores eat the pods and ostriches eat the flowers. It flowers in August/September and is very slow-growing.

11 BEZUIDENHOUT, H. **An ecological study of the major vegetation communities of the Vaalbos National Park, Northern Cape. 1. The Than-Droogeveld section** *Koedoe* (1994) 37: 2, 19-42; [En, 38 ref.]

A detailed classification, description and mapping of the Than-Droogeveld section of the Vaalbos National Park was undertaken to serve as an ecological basis for the establishment of a wildlife management programme and to develop conservation policies. Using a numerical classification technique (TWINSPAN) as a first approximation, the classification was refined by applying Braun-Blanquet procedures. A hierarchical classification, as well as description, ecological interpretation and a vegetation map are presented. Eleven major plant communities were recognised, and *A. erioloba* was a dominant of three. The *Grewia flava - A. erioloba* woodland was found on deep well drained red sandy soils, with occurrences of surface limestone. This was a closed mixed woodland, with a total tree canopy cover of 7.5% and a height of 7 m. The *Lycium hirsutum - A. erioloba* woodland is associated with deep well drained sandy soil, and the tree is very prominent to 8.5 m tall with a canopy cover of 10%. The third community was an *A. erioloba - A. tortilis* woodland, found on well drained stony alluvium of the watercourses of the Vaal river. Scattered trees of *A. erioloba* reaching 10 m tall were also found in the *Rhus ciliata - Tarchonanthus camphoratus* shrubland with a canopy cover of 1%.

12 BEZUIDENHOUT, H.; BREDENKAMP, G.J.;THERON, G.K. **A classification of the vegetation of the western Transvaal dolomite and chert grassland, South Africa** *South African Journal of Botany* (1994) 60 (3) 152-161 [En, Af]

On shallow soils overlying chert and dolomite rock, *Acacia erioloba* is restricted to sand filled sink holes in bottom lands. Here it is associated with a variety of fleshy fruited shrubs including *Rhus lancea, Maytenus heterophylla, Ehretia rigida, Grewia flava* and *Asparagus* species. In such sinkhole areas, *A. erioloba* reaches 6.5 m in height.

13 BOTHMA, J.D.; DE GRAAFF, G. **A habitat map of the Kalahari Gemsbok National Park** *Koedoe* (1973) 16, 181-188 [En]

Provides a detailed habitat map of the Kalahari Gemsbok National Park, on which is plotted six major habitat categories. Away from the riverbeds the tree savanna is limited to the northern corner of the park, consisting of *Acacia giraffae* woodland and scattered dunes. The Nossob and Auob riverbeds and adjacent areas also harbour *A. giraffae* except in the south where *A. haematoxylon* becomes dominant, and where the Karoo flora increases. The dunes covered with trees and shrubs usually support *Boscia albitrunca, A. mellifera* and an occasional *A. giraffae.*

14 BOTHMA, J.D.; VAN ROOYEN, N.; THERON, G.K.; LE RICHE, E.A.N. **Quantifying woody plants as hunting cover for southern Kalahari leopards** *Journal*

of Arid Environments (1994) 26 273-280

The authors quantified tree and shrub density near Unions End in the Nossob River valley in the northern Kalahari Gemsbok National Park. *Acacia erioloba* saplings occurred at densities of 10-30 individuals/ha and mature trees at densities of 6-10 trees/ha.

15 BRENAN, J.P.M. **Leguminosae (incl. Mimosaceae, Caesalpiniaceae and Papilionaceae.** *Flora Zambesiaca* (1970) 3 (1) 153pp. [En.]

Presents the floral treatment of the Leguminosae for the Flora Zambesiaca region (Botswana, Zambia, Zimbabwe, Malawi, Mozambique). Gives a detailed botanical description of *A. giraffae* Willd., citing representative specimens from the area, and notes on its ecology. It occurs generally on Kalahari sands, in dry woodland, wooded grassland and sometimes in *Baikiaea-Acacia* forest.

16 BROOMBERG, B. **Trees of the Gwaai Valley** *Trees in South Africa* (1973) vol.25, no.2 43-47 [En]

Describes the flora of the Gwaai Valley, a vast area between the Victoria Falls and Bulawayo. Gives a comprehensive list of species found in the region which includes *Acacia giraffae*.

17 BROWNE, C.W. **Sowing Tree Seeds *in Situ*** *Trees in South Africa* (1981) vol.32,no.4 95-98 [En]

Reports on experimental planting at 50 sites with the seeds of various indigenous and exotic trees. The seeds of *Acacia erioloba* were among those that germinated successfully.

18 CARR, J.D. **Mosdene** *Trees in South Africa* (1969) vol.21, no.1 2-14 [En]

Reports on a society outing to the Mosdene farm in the vicinity of Naboomspruit. An overall list of the trees and shrubs that were identified was drawn up and including *Acacia giraffae*.

19 CARR, J.D. **The Richtersveld Visited** *Trees in South Africa* (1972) vol.24, no.2 30-43,56 [En]

Describes a trip made to the Richtersveld, a little frequented corner of the Cape Province bounded in the north by a big bend in the Orange River, immediately before it flows into the Atlantic Ocean. Gives details of the tree species seen including a large specimen of *Acacia giraffae* at the Fish River Canyon.

20 CARR, J.D. **In Search of *Acacia montis-usti*** *Trees in South Africa* (1973) vol.25, no.1 2-10 [En]

Describes a trip made to the Brandberg with the hope of seeing the rare species *Acacia montis-usti*. Also gives details of other species seen, including *Acacia giraffae*, one specimen having unusually slender spines.

21 CARR, J.D. **To South West Africa in search of *Acacias*** *Trees in South Africa* (1974) vol.25, no.4 86-96 [En]

Describes trip made in October 1972 to South West Africa which was made to gather information of acacia species which occur in those parts. Between Sishen and Olifantshoek a number of particularly large specimens of *Acacia giraffae* were noted - a rare sight since most of the larger trees of the species in the area were cut down for fuel for the Kimberley diamond mines, before coal became available in the area. Further groves of *A. giraffae* were seen on the trip.

22 CARR, J.D. **The South African acacias**. Conservation Press (Pty) Ltd. Johannesburg London Manzini. (1976) 323pp. [En, 6 refs.]

This is an illustrated guide to the African acacias giving botanical name, synonyms and common names, habitat description, botanical description and notes on hybridization, wood and cultivation. *Acacia erioloba* is described as occurring almost invariably on the Kalahari sands. Germination can be hastened by filing the seed coat on two edges or boiled briefly in water and allowed to soak for two days. Growth in the nursery is slow and the seedlings should be planted out soon or they become stunted. Under favourable conditions the tree can grow to 1m in a single season.

23 CHURMS, S.C.; STEPHEN, A.M.; STEYN, C.B. **Analytical comparison of gums from *Acacia hebeclada* and other Gummiferae species.** *Phytochemistry* (1986) 25 (12) 2807-2809 [En, 25 ref.]

The paper describes analyses of arabinogalactan-proteins from the gums of *A. hebeclada* and comparisons are made with analyses and published data on *A. tortilis* subsp. *heteracantha*, *A. karroo*, *A. erioloba* and *A. robusta* var. *clavigera*.

24 CLOUDSLEY-THOMPSON, J.L. **Etosha and the Kaokoveld: problems of conservation in Namibia** *Environmental Conservation* (1990) 17 (4) 351-354 [En, 6 refs.]

Etosha National Park in NW Namibia is an area extremely rich in game. Etosha Pan, a 6133 km^2 saltpan, is bordered on the S. by natural springs and artificial waterholes where animals congregate in large numbers and cause overgrazing and browsing pressure. Migration to regions beyond the Park is prevented by an 850-km game proof fence. The main factors affecting animal population are anthrax and poaching. The bushveld around the Park consists mainly of mopane (*Colophospermum mopane*) and shrub. Moringa (*Moringa ovalifolia*), an endemic tree of rocky ledges from Naudluft in the south to the Kaokoveld to the NW of Etosha, forms a dense stand 32 km west of Okaukuejo, a tourist rest camp on the SW of the Pan. Trees are more numerous to the east, where there is mixed woodland consisting of various *Acacia* spp. including *A. kirkii*, *A. mellifera*, *A. nilotica*, *A. senegal*, flame trees (*A. ataxacantha*), camel thorn (*A. erioloba*) and *A. tortilis*, which in Namibia grows luxuriantly with a flat top and masses of fragrant white flowers - its spiral seed pods are a favourite food of many wild ungulates.

25 COATES-PALGRAVE, K. **Trees of Southern Africa**. Struik (1977), Cape Town p. 234 [En]

The book describes and illustrates all the indigenous and many of the naturalised non-indigenous species of trees at present known to occur in South Africa, Rhodesia, South West Africa, Botswana, Lesotho, Swaziland and Mozambique. Gives a brief description, the distribution and some uses for each tree including *Acacia erioloba*. This acacia is a major tree species of the desert regions where it occurs in dry woodland in stony or sandy areas. The pods form an excellent fodder for stock and increase milk yield in cows but at certain times of the year they are poisonous. The wood is dark brown and very strong, resistant to borers and termites and a good firewood. The gum is eaten by humans and animals. It is a valuable shade tree and is a protected plant in South Africa.

26 COE, M.; BEENTJE, H. **A Field guide to the *Acacias* of Kenya** Oxford University Press (1991) 4-5 [En]

Gives species details for 43 different *Acacias* in Kenya. *A. erioloba* does not occur naturally in Kenya but it is noted in the introduction that the large seeds of *Acacia erioloba* are attacked by medium sized bruchids, which lay their eggs inside an old emergence hole or on the surface of broken seeds and a new generation of beetles emerges in almost exactly two months and continues to reinfest the seeds until the contents have been totally consumed. The larvae of one of the bruchid species (*Caryodon multinotatus*) that attack *A. erioloba* seeds is so large that it not only consumes the whole inside of the seed, but the mature larva has to emerge and pupate in the soil or within the pod wall. Bruchid larvae are usually killed during their passage through the gut of a herbivore and, if they have not killed the seed's embryo, their minute entrance holes will allow water to enter the seed and stimulate rapid germination in the dung.

27 COE, M.; COE, C. **Large herbivores, *acacia* trees and bruchid beetles**. *South African Journal of Science* (1987) 83 (10) 624-635 [En, 85 refs.]

The African *acacias* compromise 128, of the 1200 species throughout the world. These are variously defended by spines or hooks. Eleven per cent of the African species develop "pseudo-galls" which are occupied by predatory Crematogaster ant species. *Acacia* pods may be classified into dehiscent and indehiscent forms, the latter being favoured by large browsing herbivores which disperse the seeds. Seeds from indehiscent pods are thick and robust, and resist the shearing forces of the molar teeth of large herbivores much better than dehiscent seeds. *Acacia* pods reach their full size before the seeds swell, thus conserving their nutrients. The activities of ants and the rapid mobilization of chemical defences may explain why specialist browsers feed only in short bursts. The larvae of bruchid beetles are important predators of acacia seeds. The larger bruchids are more likely to attack indehiscent than dehiscent seeds. Virtually all seeds may be colonized by these beetles on occasion, though 10% is more common. X-ray studies show that up to 16% of acacia seeds are digested in their passage through the gut of large herbivores. Consumption by these mammals not only aids in the dispersal of seeds but also reduces bruchid attack. *A. erioloba* has indehiscent seed pods- the pod being greatly enlarged with a thick fawn wall and a white spongy interior containing irregularly scattered seeds. *A. erioloba* has a particularly large seed.

28 COETZEE, J.A. **The morphology of *Acacia* pollen** South African Journal of Science (1955) 52:23-27 [En]

A study of the pollen morphology of 28 South African and 31 Australian species of *Acacia*. All the African species studied had pollen grains of 16 cells except *A. giraffae* which is 32 celled. *A. giraffae* pollen grains have furrows present and a baculate and tegillate sexine, along with all the other South African species with a globose inflorescence except the climbing *Acacia pennata* Willd.. The spicate inflorescence species have no furrows present.

29 COETZEE, J.A. **Comparison of recent and quaternary pollen data** In: Boehm, G. and Leuschner (ed.) *Experimental supplementum (Basel)*, Vol. 51. Advances in Aerobiology; Proceedings of the 3rd International Conference on Aerobiology, Basel, Switzerland, August 6-9, 1986. (1987) 31-36 [En]

A study of recent and quaternary pollen data from 3 areas, the Sahara and Namib deserts and the east African mountains. In the Namib, *A. erioloba* is the dominant woody species along the ephemeral rivers. The pollen spectra from the fossil silt layers of 2000 years ago differed little from present day deposits.

30 CORBY, H.D.L. **Types of rhizobial nodules and their distribution among the Leguminosae** *Kirkia* (1988) 13 (1): 53-123 [En, 92 ref.]

A major survey of nodulation of 362 genera of the Leguminosae, comprising of around 94 % of all species. Nodules were collected by growing plants in pots from innoculated seed. Nodule-forming habit is general in the subfamilies Mimosoideae and Papilionoideae, with only a small minority of genera and species forming nodules in the subfamily Caesalpinioideae. *A. erioloba* is recorded in having a Caesalpinioid type nodule.

31 DAVIDSON, L.; JEPPE, B. **Acacias: A field guide to the acacias of southern Africa** Centaur Publishers, Johannesburg (1981) [En]

This is an illustrated field guide to the identification of the 64 *Acacia* species and sub-species of southern Africa south of the Cunene and Zambezi Rivers including *A. erioloba.*

32 DE GRAAFF, G.; VAN RENSBURG, D.J. (EDITORS) **Proceedings of a symposium on the Kalahari ecosystem** Symposium-verrigtinge oor die Kalahari-ekosisteem *Koedoe* (1984) Supplement 333pp. [En]

This proceedings of a symposium held at Pretoria on 11-12 Oct. 1983 contains 25 contributions on the Kalahari ecosystem; the history, geology, soils and vegetation dynamics of the Kalahari Gemsbok National Park; pans, rivers and artificial waterholes in SW Kalahari; effects of fire on an *Acacia erioloba* community; descriptions of habitat selection, plant digestibility, adaption, food or behaviour ecology, or effects of climate on movement of ungulates, ostriches, herbivorous mammals, coleopterous fauna, invertebrates, amphibians, reptiles, birds, rodents, canids, hyaena, lions, leopards and antelopes. Relevant chapters are abstracted separately.

33 DE WINTER B.; DE WINTER, M.; KILLICK D.J.B. **Sixty Six Transvaal Trees**, Botanical Research Institute and Transvaal Provincial Administration, Republic of South Africa (1966) 48-49 [En]

For *Acacia giraffae* Burch gives a simplified description, distribution map in south Africa, phenology, uses and common names, cultivation and illustrated with photographs and drawings. Specimens seen up to 60 ft with a 3 ft diameter, typical of Kalahari sands. It is a protected tree in the northern Cape and Jacobsdal district of Orange Free State. Includes the National Tree list for South Africa (*A. giraffae* = 168).

34 ELOFF, F.C. **Observations on the migration and habits of the antelopes of the Kalahari Gemsbok Park.** *Koedoe* (1959) 21: 1-51 [En]

Describes the seasonal distribution of antelope in the various habitat types of the Kalahari and, in particular, discusses movements of animals from the river valleys to the dunes after rain when green forage is available. Also presents data on food plant species used by various antelope.

35 ERNST, W.H.O. **Nutritional aspects in the development of *Bruchidius sahlbergi* (Coleoptera: Bruchidae) in the seeds of *Acacia erioloba*.** *Journal of Insect Physiology* (1992) 38 (11): 831-838 [En]

The multivoline bruchid species *B. sahlbergi*, is a common seed preditor of *Acacia erioloba* in the savannas of southern Africa. The development from egg to beetle, and the uptake and turnover of food by the various developmental stages were investigated. Most development of the beetle (from the second instar onwards) takes place within the seed.

36 ERNST, W.H.O. **Food consumption, Life History and Determinants of Host range in the Bruchid beetle *Specularius impressithorax* (Coleoptera: Bruchidae)** *Journal of Stored Products Research* (1993) 29 (1): 53-62 [En]

Bruchid bettles regularly infest seeds of *Acacia erioloba* both in the field and in storage. This multivoline species feeds on the seeds of *Erythrina abyssinicum* (another Legume) affecting them in storage. The beetles have a preference for *Erythrina* as host (due to some smell in the seed coat,) but will eventually attack other associate miombo woodland trees *Acacia erioloba* and *Brachystegia speciformis*, but larval development stops after the first instar in seeds of these non host species.

37 ERNST, W.H.O.; TOLSMA, D.J. **Dispersal of fruits and seeds in woody savanna plants in southern Botswana.** *Beitrage zur Biologie der Pflanzen* (1990) 65: 3, 325-342; [En, 44 ref.]

The dispersal mechanisms of fruits and seeds of shrubs and trees in savanna ecosystems in Botswana were studied from 1982 to 1988. Pods of *Acacia erioloba* are eaten with relish. In a savanna dominated by *A. erioloba* and *A. hebeclada*, seeds of both species are transported at least 2-3 km by cattle and dropped in great amounts around the pans. The mean numbers of seeds per cattle dropping was 41 ± 81 with a range from 0-273. The weight of healthy seeds of *A. erioloba* did not significantly differ from the tree or cattle dropping collections, whereas those collected from *A. hebeclada* were significantly smaller in the cattle droppings compared to those on the tree. Seed of all *Acacia* species collected from cattle droppings were essentially less affected by Bruchid beetle attacks. In *A. erioloba* 64.5% of all seeds from the tree which were stored for 6 months were infested by *Bruchidius sahlbergi,* whereas seeds collected at the same time from cattle droppings and stored for the same time resulted in only 3% infestation.

38 ERNST, W.H.O.; DECELLE, J.E.; TOLSMA, D.J. **Predisposal seed predation in native leguminous shrubs and trees in savannas of Southern Botswana** *African Journal of Ecology* (1990) 28 (1) 45-54 [En]

Seed predation by insects in the seed crop of nine *Acacia* species [*A. burkei, A. erioloba, A. erubescens, A. fleckii, A. hebeclada, A. karroo, A. mellifera, A. nilotica* and *A. tortilis*] *Dichrostachys cinerea*, and *Peltophorum africanum* was examined in various tree savannas in

Botswana. The degree of infestation varied strongly between and within species from 0% (*P. africanum*) to more than 80% (*A. hebeclada, D. cinerea*). Whereas in all *Acacia* species only one phytophagus hymenopteran (*Oedaule* sp.) was present, the number of bruchid species varied between one (*Bruchidius sahlbergi* on *A. hebeclada, B. uberatus* on *A. nilotica*) and eight species (*Bruchidius* div. spec., *Caryedon* sp., *Spermophagus rufonotatus* on *A. tortilis*). The life history of *B. sahlbergi* was studied in detail and lasted at least 100 days from egg to adult beetle. The life-span of adult beetles may extend to a further 57 days.

39 EXELL, A.W.; MENDONCA, F.A. **Balsaminaceae and Leguminosae** In: *Conspectus Florae Angolensis* Volume 2 Ministerio de Ultramar, Lisboa (1956) p 281.

Botanical treatment of these two large families for Angola. For *A. giraffae* Burch. it gives representative specimens from Huila province, and that it is a tree 10-18 m tall in dry forest.

40 FAGG, C.W.; BARNES, R.D. **African acacias: study and assembly of the genetic resources**. Final Report of ODA Forestry Research Scheme R5655. Oxford Forestry Institute. 1995. 173 pp. [En, 12 tables, 10 figs., 10 maps, 57 photos., 89 refs.]

The first of the three-year ODA-funded projects on the study and assembly of the genetic resources of the African acacias at the OFI started in 1987. This report covers the work done in Research Scheme R4583 and its extension, R5655, and includes reference to the achievements of the first of the acacia projects, R4348.

The principal objectives of these projects were, for *Faidherbia (Acacia) albida, A. tortilis, A. nilotica, A. senegal* as well as for *A. erioloba*, to assemble rangewide material for evaluation, domestication and conservation, to investigate selfing levels, breeding systems and genetic variation, to distribute seed for evaluation with recommendations for trial design and management, to produce annotated bibliographies, to describe phenology and morphology, to establish whether it was feasible to date trees by dendrochronology and to collect material to elucidate and resolve the taxonomic problems of the five species and their close relatives. The objectives were accomplished through a combination of project-directed independent and collaborative research.

Rangewide seed collections for all five species were assembled; 141 provenances represent 19 of the 21 taxa that comprise the five species. Investigations into selfing levels, breeding systems and genetic variation were used to improve the precision of sampling the natural range. Of the five *Acacia* species included in these projects, *A. erioloba* was expected to be least variable across its range and therefore molecular work with this species was given lowest priority. Collaboration was initiated early on between institutions involved in complementary *Acacia* research and germplasm collections in Africa. This led to the formation of the African *Acacia* trials network. The intention is to establish four or five main trial centres, one in each principal phytochorium in Africa. The first main trials centre in the network was established at Bulawayo, Zimbabwe in 1994 under an OFI-conducted, ODA-funded Research Scheme (R5653).

A large number of herbaria were visited and detailed information logged into the *Acacia* database, BRAHMS which currently contains detailed information on more than 11,500 specimens. The database can produce nomenclatural summaries, specimen citation lists and species distribution maps; it is also possible to assemble and synthesize altitudinal ranges, vernacular names, and phenological charts. Seedlings of six African *Acacia* species were raised in six nurseries in different environments throughout Zimbabwe and nodules collected for a study on rhizobia technology. Nodules were found in profusion on all species except *A. erioloba*. Analysis of leaf samples collected from *Acacia erioloba* and five other *Acacia* species growing sympatrically with it suggested that *A. erioloba* obtains most of its nitrogen from ground water. Known-age trees of 21 African *Acacia* species were identified and radial and cross-sections wood samples examined at the OFI for anatomical features that could be matched to periods of annual growth. These were apparent in most species, including *A. erioloba*, as narrow bands of marginal parenchyma filled with long crystal chains. The crystals were subsequently identified as calcium oxalate. It was determined that the marginal parenchyma was produced at the onset of the dry season. Material was also collected for the study of a natural hybrid between *A. erioloba* and *A. haematoxylon*.

The most important areas for future research into the African acacias are in the fields of:- evaluation of the genetic potential of the acacias; socio-economic studies to quantify their current and potential value in farming systems; the relationship between seedling physiology and adaptation; selfing studies to determine genetic load; hybrid studies to assess heterosis, to resolve taxonomic inconsistencies and to produce sterile, fast-growing, productive cultivars; rhizobial studies; investigations into the stand dynamics of invasion. These projects have provided the information and materials on which much of this recommended research can be based. The task in the future is to manage this resource efficiently to supply the needs of well-focused research projects.

41 FERGUSON, J.W.H. **Preferred habitat of white-browed sparrow-weavers *Plocepasser mahali*** *South African Journal of Zoology* (1989) 24 (1) 1-10 [En]

Habitat use by white browed sparrow-weavers *Plocepasser mahali* was studied in the Bloemhof area South Africa. The habitat of nine sparrow-weaver groups consisted of three vegetation communities: *Acacia erioloba* community, *Nidorella resedifolia* community and *Conyza bonariensis* community. The latter community comprised disturbed, ecotonal areas along the edges of roads and maize lands and had a lower basal cover and higher terrestrial arthropod availability than the other two plant communities. The *Conyza bonariensis* community, together with areas with little vegetation cover was well used by sparrow-weavers. Seeds eaten by sparrow-weavers also reflect the open character of feeding areas. Termites are an important sparrow-weaver food taxon and large similarities exist between the geographical distributions of *Trinervitermes trinervoides* and sparrow-weavers.

42 FOURIE, M.P. **Chemical bush control with ethidimuron.** *Proceedings of the 1st International Weed Control Congress* (1992) 2: 166-168 [En, 14 ref.]

Aerial spraying of ethidimuron at 0-70 kg/ha was found to control many bush and tree species during trials in 1984 in Northern Cape province, South Africa. These included *Grewia flava, Rhigozum trichotomum, Boscia albitrunca* and, in particular, *Acacia mellifera* and *A. erioloba.* As a result, grass production increased, more grass tufts were produced and the grazing capacity increased. Increases were particularly dramatic in the dry season.

43 FREEMAN, B.H.; STEPHEN, A.M.; WOOLARD, G.R. **The G.L.C. (gas-liquid chromatographic) analysis of methylated polysaccharides using derivatives of alditol methyl ethers** *Journal of South African Chemistry Institute* (1973) vol.26 (3) 106-110 [En]

44 FRIEDE, H.M **Tress of the Kalahari and the South-West African Highlands** ***Trees in South Africa*** (1960) vol.12, no.3 50-54 [En]

Reports on a study of the flora of the thornveld at the Kalahari Gemsbok National Park. The camelthorn thorn (*Acacia giraffae*) was found to be the most characteristic tree of the area growing in large numbers along the roads leading through the riverbeds. The tree grows up to 30 feet high, with stout whitish spines and velvety flat pods, a rough grey bark and dark green foliage. The pods and young shoots of the tree are relished by stock and game, it is also a useful timber tree.

45 FURGUSON, J.W.H.; SIEGFRIED, W.R. **Environmental factors influencing nest-site preference in white-browed sparrow-weavers** (*Plocepasser mahali*) *The Condor* (1989) 91 100-107.

White-browed sparrow-weavers in the southern Freestate area of South Africa built their nests mainly on the southwest sides of *Acacia erioloba* trees, selecting trees that were over 3 m in height.

46 GAMMON, D.W.; STEPHEN, A.M. **Glycosylated hydroxyproline derivatives from *Acacia erioloba* exudate** *Carbohydrate Research* (1986) 154 (0) 289-295 [En, 13 ref.]

The general structural features of the glycoproteins found in the gum exudate of *A. erioloba* are described in Gammon et al. (1987 - following abstract). This note shows the isolation and characterisation of some of the hydroxyproline glycosides released on alkaline hydrolysis of the gum.

47 GAMMON, D.W.; STEPHEN, A.M.; CHURMS, S.C. **The glycoproteins of *Acacia erioloba* exudates** *Carbohydrate Research* (1987) 158 (0) 157-172 [En]

The gum exudate from *Acacia erioloba* contains protein (53%-56%) and carbohydrate as a mixture of glycoproteins that are relatively resistant to proteases and not readily separable. The protein components have high contents of hydroxyproline and serine, and the carbohydrate is composed mainly of L-arabinose, D-galactose, and 4-0-methyl-D-glucuronic acid residues. Methylation, partial acid hydrolysis, and alkaline hydrolysis studies revealed units of the aldobiouronic acids .alpha.-4MeHlcpA-(l .fwdarw. 4)-Gal, and .beta.-4MeGlcpA-(l .fwdarw. 6)-Gal, and that the carbohydrate, mainly in the form of short, linear oligosaccharides, is attached to Hyp residues in the peptide chains. This gum exudate differs markedly from other *Acacia* species in the same taxonomic group (series Gummiferae).

48 GÖHL, B. (1981). **Tropical feeds: feed information summaries and nutritive values.** FAO Animal Production and Health Series No. 12. FAO, Rome, Italy. 529 pp.

49 GOLDSMITH, B.; CARTER, D.T. **The indigenous timbers of Zimbabwe** The Zimbabwe Bulletin of Forest Research (1981) Zimbabwe Forestry Commission No. 9. 406 pp. [En]

Acacia erioloba is briefly described. The sapwood is wide and pale pinkish while the heartwood is uniformly deep red or purple-red. It is a medium to finely textured wood but it has large vessels that form coarse conspicuous lines both in tangential and radial section. Rays are few and narrow, parenchyma aliform-confluent and shiny dark gum deposits are visible in the vessels. The wood is very heavy (1,230 kg m^{-3}) and difficult to saw although it planes to a lustrous finish. The sapwood has good and the heartwood excellent durability; the heartwood is almost immune to borer, termite and fungal attack. It must be pre-bored to nail and although it has poor paint-holding properties, it glues well. It is unstable in seasoning and tends to be brittle. The main uses are for fence posts and firewood.

50 GOURLAY, I.D.; KANOWSKI, P.J. **Marginal parenchyma bands and crystalliferous chains as indicators of age in African acacia species** *IAWA Bulletin* n.s., (1991) Vol.12 (2) 187-194 [En, 28 refs.]

The radial cross sections of wood samples from individuals of known age in six African Acacia species were examined for growth rings, which were apparent in most species as narrow bands of marginal parenchyma filled with long crystal chains. The number of bands formed annually corresponded to the number of peaks in rainfall distribution. The results suggested that marginal parenchyma bands and crystalliferous chains define growth phases in African Acacia species, and may therefore be useful for age determination.

51 GUBB, A.A. **The relationship between *Acacia erioloba* spines and insects in the Kalahari Thornveld.** *The Naturalist* (1988) 32 (1) 22-28.

Some of the stout, paired spines of *Acacia erioloba* are swollen, and it is possible that the swelling is genetically controlled rather than a gall response to insects. The ratio of swollen to normal thorns varies from year to year. In years of below average rainfall only 5% of spines swell but the proportion is greater in wet years. Of the few thousand spines investigated, 60-95% of swollen spines were occupied by insects as compared with 2-5% of normal spines. Insect occupants appear to follow a succession, starting with a moth larva that hollows out the spine interior and followed by any one of four species of spine-dwelling ants. The ants feed on nectar produced by the extra-floral nectaries on the *A. erioloba* leaves; these also attact folivorous insects. The hollow spines may also be occupied by spiders.

52 GUINET, P.; VASSAL, J. **Hypothesis on the differentiation of the major groups in the genus *Acacia* (Leguminosae)** *Kew Bulletin* (1978) 32 (3): 509-527. [En, 64 refs.]

Based on evidence from pollen, chromosome numbers, seed characters, vegetative characters, inflorescence and fruit, they propose three subgenera (which are still currently accepted) in the genus *Acacia*. These subgenera correspond to the Bentham series as follows: subgenus *Acacia* (=series *Gummiferae* Benth.); subgenus *Aculeiferum* Vassal (=series *Vulgares* Benth. and *Filicinae* Benth.); and subgenus *Heterophyllum* Vassal (=series *Phyllodineae, Botrycephalae & Pulchellae* Benth.).

53 GWAZE, D.P.; STEWART, H.T.L.; SNEIZKO, R.A. **Variation in height growth and nodulation of *Acacia albida* and *A. erioloba* seedlings from Zimbabwe seed sources** *Nitrogen Fixing Tree Research Reports* (1988) 6, 34-36 [En, 5 refs.]

Seeds were collected from 16 open pollinated parent trees of *Acacia erioloba* in Matabeleland North, and from 10 parent trees each of 2 provenances of *A. albida* (Mana pools and Hwange). Seeds were scarified for 30 min with concentrated sulphuric acid before sowing 2 seeds per pot in August at the Matapos nursery, in a soil mixture made from soil collected from nearby termite mounds in an area with indigenous acacias (not *A. albida* or *A. erioloba*), mixed with coarse sand in the ratio 3:1; this in turn was mixed in the ratio 10:1 with soil from around the roots of a nearby *A. sieberiana* to provide the Rhizobium inoculum. Germinants were thinned to one per pot when 4-5 cm tall. Height and nodule numbers were recorded 11 week after sowing. There were significant differences in height between families: the range for *A. albida* was 16.3-23.7 cm and for *A. erioloba* 7.1-12.7 cm. The 2 *A. albida* provenances were significantly different in height growth. Sixty four percent of *A. albida* seedlings nodulated while only 2 out of 240 seedlings of *A. erioloba* had nodules. Despite this, seedlings of *A. erioloba* were more vigorous. For *A. albida*, mean nodules per seedling were 1.1-4.7, with mean nodule weight per seedling 5.7-38.0mg; there were no significant differences among families; seedling height and nodulation characteristics were not related.

54 HAMANT, C.; LESCANNE, N.; VASSAL, J. Sur quelques nombres chromosomiques nouveaux dans le genre *Acacia* (1975) Taxon 24 (5/6): 667-670.

Lists new chromosome determinations for 51 species of *Acacia*, and for *A. giraffae* Burch. the number recorded was 2n = 52. The voucher specimen was Kennan TCD MRSH 4307, Redbank, Nyamandhlovu, Zimbabwe.

55 HARRISON, G.S.; HAWKE, F. Studies of the fats from indigenous south African plants. III. $\Delta^{9,12}$ Hexadecadienoic acid: Its constitution and occurrence in the seed fat and seed pod fat of *Acacia giraffae* (Kameeldoorn). *Journal of the South African Chemical Institute* (1952) 5 (1): 23-30 [En, af]

The presence of the above acid in the mixed fatty acids of the seed fat and seed pod fat of *Acacia giraffae* is shown.

56 HARVEY, P.H. **Tree Families in England and in South Africa** *Trees in South Africa* (1962) vol.14, no.3 62-66 [En]

Notes that the following trees grow in the Witwatersrand vicinity: *Acacia karroo*, *A. robusta*, *A. tortilis*, *A. caffra*, *A. woodii*, *A. hebeclada*, and *A. giraffae*.

57 HARVEY, P.H. **Some Trees of the Semi-Desert** ***Trees in South Africa*** (1971) Vol.23, no.2 42-50 [En]

Describes a journey made from Johannesburg through semi-desert type country via Kuruman, Sishen, the Kalahari Gemsbok National Park, Keetmanshoop, The Fish River Canyon, Little Namaqualand, the Augrabies Falls area, Koegas and back to Johannesburg via Kimberley; describing the vegetation seen. Many specimens of *Acacia giraffae* were recorded; the tree being predominant in the Kuruman River area. In many of the *A. giraffae* social weaver birds had built their nests. *Acacia giraffae* were also seen in the Gemsbok National Park, becoming less evident at Matamata until the koppies between Koes and Keetmanshoop where *Aloe dichotoma* stands out.

58 HARVEY, W.H.; SONDER, O.W. **Leguminosae to**

Loranthaceae *Flora Capensis* (1862) 2: 621 pp.

Botanical treatment of the families Leguminosae to Loranthaceae for the flora Capensis, including Cape Colony, Caffraria and Port Natal. For *A. giraffae* Burch. and *A. erioloba* E. Mey. gives a short botanical description and notes on habitat and uses. Notes that *A. erioloba* from Namaqualand is probably *A. giraffae*. The Bichuanas use the hard dense wood for spoons and knife handles.

59 HEDBERG, I.; STAUGARD, F. **Traditional Medical Plants, Traditional Medicine in Botswana.** Ipelegeng Publishers, PO Box 40097, Broadhurst, Gaborone, Botswana. (1989) 324 pp.

Describes 314 medicinal plants collected in Botswana, giving their latin and vernacular names, their habitat and medicinal use, dose and regimen as prescribed by Tswana herbalists. *A. erioloba* whose common name is Mogotho, is used for nose bleeding, the powdered roots being boiled with water, and three to four cups taken daily.

60 HEINZ, H.J., MAGUIRE, B. **The ethnobotany of the *!ko* Bushmen,. Their ethno-botanical knowledge and plant lore.** *Occasional Paper No.1, Botswana Society*, Government Printer, Gaborone (1974), 53 pp.

Discusses uses of plant species including bulbs and trees for food, artifact manufacture and firewood. *Acacia erioloba* (called *//ah*) is a preferred firewood species, and the exuded gum is eaten. Local names for plant species are listed.

61 HENKEL, J.S. **The camelthorn (*Acacia giraffae* Burch.)** *The Rhodesia Agricultural Journal* (1931) 28 (1) 71-73 [En]

Reports that the Camelthorn occurs in Bechuanaland (Botswana) and Southern Rhodesia (Zimbabwe) on deep alluvial soil along rivers and on the edges of vleis in Kalahari sand areas. Pods collected in the Wankie Game Reserve were constituted as follows:- moisture 9.4%, acid soluable ash 3.3%, either extract 1.6%, fibre 31.0%, crude protein 11.4%, calcium 0.9%, phosphoric oxide 0.24% and potassium 1.3%. The tree can be introduced to farms by feeding ripe pods to cattle just before the summer rains. The tap roots of this tree can reach to 80 feet (25 m)deep.

62 HOFFMAN, M.T.; COWLING, R.M.; DOUIE, C.; PIERCE, S.M. **Seed predation and germination of *Acacia erioloba* in the Kuiseb River Valley, Namib Desert** *South African Journal of Botany* (1989) 55 (1) 103-106 [En, Af, 18 ref.]

The interactions were investigated between mammalian herbivores, bruchid seed predators and *A. erioloba* seeds in Namibia. Predation by bruchids was significantly less in canopy-held pods than in pods on the ground. Germination success was higher for ingested seeds than for an untreated control and was almost zero for predated seed. Acid treatment and scarification of seed resulted in high rates of germination. The study supports the theory of a mutualistic relationship between mammalian herbivores and acacias; for example, the indehiscent pods of *A. erioloba* are eaten and the seed dispersed over large areas in the dung.

63 HOFFMAN, M.T.; SONNENBURG, D; HURFORD, J.L.; JAGGER, B.W. **The ecology and managment of Riemvasmaak's natural resources.** *National Botanical Institute*, Private Bag X7, Claremont 7735 South Africa (1995) approx 200 pp [En, maps, photos]

Camelthorn is a valuable forage and firewood species in Riemvasmaak communal grazing area in the north-western Cape Province of South Africa. The authors assessed the size class distributions of six widely-dispersed populations in this area. Patterns varied considerably between populations, but all showed healthy recruitment of saplings and young trees. The absence of very small individuals and.the mortality of individuals in the smaller size classes suggested that recruitment conditions had not been favourable during the years immediately prior to this study. Very high rainfall conditions that prevailed in the region during the early to mid 1970s as well as the absence of grazing during that period may have been responsible for the recruitment of the younger trees recorded. Saplings of *A.erioloba* were frequent in the vicinity of old kraals. Discussion about the sustainable use of this species so that a favourable population structure can be maintained was initiated within the Riemvasmaak community so as to make descisions about harvesting and grazing immature *A.erioloba* saplings.

64 JAROSZEWSKI, J.W. **Heterodendrin in *Acacia* ssp.** *Journal of Natural Products (Lloydia)* (1986) 49 (5) 927-928 [En]

Describes the occurrence and synthesis of the glucoside Heterodendrin, from the leaves of *A. hebeclada* DC and *A. giraffae* Willd.. These are the first records in the genus and family, and it has previously been found in the families Sapindaceae, Rosaceae and Poaceae.

65 JELTSCH, F.; MILTON, S.J.; DEAN, W.R.J.; VAN ROOYEN, N. **Untersuchung der Auswirkung verschiedener Umwelteinflüsse auf das Verbreitunsmuster von Savannenpflanzen - ein Modellierungsansatz** *Verhanlungen der Gesellschaft für Ökologie* (1995) 24 45-53 [German, En]

A spatial simulation model is used to investigate the factors and processes influencing the population parameters of *Acacia erioloba* in arid Kalahari savanna. The model indicates that fire, rainfall and grazing are inadequate to explain the scattered distribution of these savanna trees in the landscape. Small-scale heterogeneities in soil, seed and water distribution could possibly explain the observed pattern.

66 JELTSCH, F.; MILTON, S.J.; DEAN, W.R.J.; VAN ROOYEN, N. **Tree spacing and co-existence in semi-arid savannas** *Journal of Ecology* (1996) 84: 583-595 [En]

A spatial simulation model is used to investigate the factors and processes influencing the population parameters of *Acacia erioloba* in arid Kalahari savanna. The model indicates that fire, rainfall and grazing are inadequate to explain the scattered distribution of these savanna trees in the landscape. Small-scale heterogeneities in soil, seed and water distribution could possibly explain the observed pattern.

67 KAKES, P.; HAKVOORT, H. **Is there rhodanese activity in plants ?** *Phytochemistry.* (1992) 31: 5, 1501-1505; [En, 16 ref.]

Rhodanese is an enzyme that detoxifies cyanide in animals, and since many plant species (including *A. erioloba*) are cyanogenic producing HCN when damaged, the authors tried to measure low rhodanese activity in plants to test whether this enzyme operates. In all tested plants rhodanese activity was very low, and no relation was found between cyanogenesis and rhodanese activity.

68 KARSCHON, R. **Tree plantings and afforestation by the Palestine Railways** *La-Yaaran* (1984) 34 (1-4) 14-17, 46-50 [En, Hebrew].

In 1975-82, a survey was made of plantings made by the Palestine Railways in the 1930s at 46 stations. Brief descriptions are given of amenity plantings in railway stations, of trees planted in sections between stations, and of the Isdud sand dune plantation. Fifty-four tree and shrub species were recorded. The value of *Acacia erioloba* is emphasized for planting on sandy soils in arid areas.

69 KOLBERG, H. **Acacias of SWA/Namibia** *SWA Herbarium, Windhoek, Namibia* (1989) 30pp.

Gives a key to 23 species of *Acacia* indigenous to Namibia, and general notes on their distribution in the country, and a more detailed notes on 4 of the more widespread species including *A. erioloba*. Gives a dot distribution map of *A. erioloba* in Namibia, and notes it is probably the most well known and widespread tree in the country. Lists some uses and notes that because it was heavily exploited for firewood, it is now protected by law in Namibia.

70 LEISTNER, O.A. **On the dispersal of Acacia giraffae by game** *Koedoe* (1961) 4 101-104 [En]

Acacia erioloba seeds are commonly found in the fecal pellets of Eland in the Kalahari Gemsbok National Park. Eland feed on the fallen pods.

71 LEISTNER, O.A. **The Plant Ecology of the Southern Kalahari** *Botanical Survey of South Africa Memoirs* no. 38 (1967).

Reports on the plant ecology of the Southern Kalahari, the research project had four main aims: 1. The compilation of a vegetation map of the region; 2. The description of the vegetation of the main habitats; 3. the study of plants in relation to climate, soil and animals; 4. the compilation of a check list. It was noted that *Acacia giraffae* along with the majority of trees and shrubs in the area flowers in the spring. In the Southern Kalahari tall specimens of trees are largely confined to river beds; the commonest species is *A. giraffae* which is found throughout the region usually occurring singly or in very open stands. *A. giraffae* is also a plant of economic importance in the region; the following uses being noted: the best firewood in the region; used extensively for timber and as a building material; leaves, flowers and pods are eaten by many herbivores; crushed pods are excellent stock feed; Seeds constitute the staple diet of some rodents. Leaves, seeds and pods may contain prussic acid but cases of poisoning are very rare. Porcupines occasionally cause the trees to die by ring-barking them.

72 MACDONALD, I.A.W. **A description of the vegetation of the Kathubos, an isolated *Acacia erioloba* "forest" and its surrounds**. Unpublished Report (1976). Cape Department of Nature and Environmental Conservation. 3pp.

73 MACDONALD, I.A.W. **Report on a visit to the Kathubos *Acacia erioloba* "forest".** Unpublished Report (1977). Cape Department of Nature and Environmental Conservation. 8pp.

74 MACLEAN, G.L. **An analysis of the avifauna of the southern Kalahari Gemsbok Nation Park**. *Zoologica Africana* (1970) 5: 249-273 [En]

The bird species of the area are listed together with information on their seasonal occurrence, and use of habitats and resources.

75 MACLEAN, G.L. **The sociable weaver part 1: description, distribution, dispersion and populations** *Ostrich* (1973) 44 (314) 176-190[En]

A study of the social weaver bird *Philetairus socius* living in the semi arid to arid region of southwestern Africa. Its range coincides with that of stout trees like *Acacia giraffae* and the stiff dry grasses like *Aristida ciliata*; these plants providing nest sites and building materials respectively.

76 MACLEAN, G.L. **The sociable weaver part 2: nest architecture and social organization** *Ostrich* (1973) 44 (314) 191-218 [En]

The sociable weaver usually constructs its large nests on horizonal branches of *Acacia erioloba.* Details of tree and nest frequencies in the Kalahari Gemsbok National Park are tabulated. There were 1 to 10 large trees per kilometer road transect.

77 MALAN, E.; ROUX, D.G. **Flavonoids and tannins of *Acacia* spp.** *Phytochemistry* (1975) 14 (8) 1835-1842 [En]

In heartwoods of the South African species *A. giraffae* and *A. galpinii*, respectively represent species with very high and very low tannin contents.

78 MILLER, O.B. **Southern Kalahari** *Emp. For. Rev.* (1946) 25 (2), 225-9 + plate [En]

Notes on a journey from Kanye to Kokong via Khakea, through that part of the Kalahari sand sheet which has not been invaded by the more diverse woody flora to the east and north. Subjects dealt with are climate, rainfall, geology, vegetation, and the degradation of the Kalahari. The larger trees belong to only 4 species, *Acacia giraffae*, *A. gillettiae*, *A. detinens* and *Boscia albitrunca*. *A. giraffae* (Camel Thorn) is the largest of these, up to 2 ft. d.b.h. and a total height of 30 ft., well distributed over the whole area. Large areas are treeless and from savanna woodland have become grass steppe which is very vulnerable to wind erosion. It is uncertain whether the small number of woody plants is to be ascribed to the comparatively recent stabilization of the sand sheet or to the greater aridity and lower temperature (compared with the country to the east and north) which would admit only drought and frost-hardy plants as colonizers, or to a combination of these two factors.

79 MILLER, O.B. **The Woody Plants of the Bechuanaland Protectorate** *The Journal of South African Botany* (1952) Vol. XVIII p.21 [En]

Gives brief description of the area before listing the woody plants, with a brief description of each, recorded in the area and classified by family; gives 44 different *Acacias* including *A. giraffae*.

80 MILTON, S.J. **Plant spinescence in arid southern Africa: does moisture mediate selection by mammals?** *Oecologia* (1991) 87: 279-287 [En, 73 refs.]

The prediction that spinescence in plants increases with aridity, soil fertility and mammalian herbivory was examined at regional and local scales in southern Africa. Spinescence tended to increase with aridity. Within arid areas, vegetation of moist, nutrient-rich habitats was more spinescent than that of the surrounding dry plains. Spinescence in plants of drainage lines and pans in arid southern Africa occurs in a wide range of genera and appears to have been selected by the effect of large mammals which concentrate on these moist patches. It is concluded that spinescence may be selected by breakage as well as herbivory, and that in arid areas moisture may be important in mediating mammalian selection of spinescence. *Acacia erioloba* was recorded as a spinescent plant species with drainage line habitat; stipular spines and outgrowths from stem; 3.5m high; life form deciduous, phanaerophyte life form.

81 MILTON, S.J.; DEAN, W.R.J. **How useful is the keystone species concept, and can it be applied to *Acacia erioloba* in the Kalahari Desert** *Zeitschrift für Ökologie und Naturschutz* (1995) 4 147-156 [En, German]

The authors suggest that the functions performed by a keystone species, through performance or facilitation of keystone processes, may be modified by its population structure, density and distribution. As an illustration of this idea they show that the "goods and services" provided by large *Acacia erioloba* trees in the Kalahari desert differ considerably from those provided by saplings of the same species. Fleshy-fruited shrubs were significantly more frequent beneath scattered *A. erioloba* trees than in the intervening desert grassland. Soils beneath large living *A. erioloba* trees contained higher concentrations of carbon, nitrogen and phosphorous than soils away from trees. Concentrations of these nutrients gradually decreased following the death of a tree. Large *A. erioloba* trees provided shade for herds of antelope (wildebeest, gemsbok, eland, springbok) and the only suitable nest sites for the huge communal nests of the endemic Sociable Weaver bird. The trees are also perch sites for vultures and large raptors and shelter hole-nesting birds and mammals. Animal activities focussed around large *A. erioloba* trees and served to enrich the soil beneath them, improving conditions for certain annual plants and fleshy-fruited shrubs.

82 MITCHELL WATT, J. **An ABC of Trees in South Africa** *Trees in South Africa* (1957) vol. 9, no.3 50-61 [En, 29 refs.]

Acacias represent the letter A. Notes that *A. giraffae* Willd., the Transvaal kameeldoring, is under suspicion of causing poisoning and even death in stock.

83 MOORE, A.; VAN NIEKERK, J.P.; KNIGHT, I.W.; WESSELS, H. **The effect of Tebuthiuron on the vegetation of the Thorn Bushveld of the Northern Cape - A Preliminary Report** *Journal of the Grassland Society of Southern Africa* (1985) 2 (4) 7-10 [En, 9 refs.]

Two formulations of tebuthiuron i.e. Graslan 20P and Graslan 40P are currently being evaluated in the Molopo area. Tebuthiuron was applied aerially at ten application rates, in combination with two application dates. After only two seasons, the chemical has already shown a reasonable selectivity for the woody species. Of these, *Acacia mellifera*, *A. reficiens* and *Grewia flava* are very sensitive while *A. erioloba* and *Dichrosatchys cinerea* are less sensitive and *Boscia albitrunca* seems almost resistant to the lower application rates (<1,0 kg a.i./h.a.). The standing crop of grass on the treated plots increased by between 220 and 740 per cent. Changes in the total grass density and botanical composition can be ascribed to an increased density of *Eragrostis lehmanniana*. At this stage of the trial, its selectivity in favour of the more desirable woody species, suggests that tebuthiuron shows great promise for controlling bush encroachment in the Northern Cape, although a final conclusion would only be possible 5 years after its application.

84 MULLER, T. **Acacia species cultivated in the National Botanic Garden, Salisbury, Rhodesia** *International Group for the study of Mimosoideae Bulletin* no. 7 (1979) 36-39 [En]

Gives a brief description of the layout of the Harare National Botanic gardens. Acacias, prominent in many vegetation types in southern Africa, have a systematic section devoted to the genus. Species cultivated include *Acacia erioloba* E. Mey.

85 NEL, P.S. **Monitering van die beskikbaarheid, gehalte en benutting van voer op die gruisvlaktes van die Kuiseb-studiegebied**. *Msc (Agric) thesis* (1983) University of the Orange Freestate, South Africa. [Af, 189 pp + appendices]

The monthly availability of *Acacia erioloba* shoots, leaves and pods for game were monitored from March 1979 to June 1981 in the Kuiseb River Valley, Namibia. Availability of fallen pods peaked in April in all three years. In most years a reserve of fallen pods was available to game during the dry winter, but during drought years game consumed the pods as they fell, leaving no winter reserve. The trees began to flower in September and there was considerable loss of young pods caused by strong winds in September and October. Digestible organic matter averaged 48% in pods and 40% in stems and leaves of *A. erioloba*. Crude protein content of the pods varied from 10 to 16%.

86 NEL, P.S.; OPPERMAN, D.P.J.; KOK, O.B. **Forage availability and utilization and large herbivore distribution on the gravel plains**. In Huntley, B.J. (ed) The Kuiseb Environment: the development of a monitoring baseline *South African National Scientific Programmes Report* 106 (1985) 126-134.

Acacia erioloba pods were available from April to September, but the quantity of pods produced varied with rainfall.

87 ORMOND, B. **Indigenous Bonsai - A Plea for Experiment** *Trees in South Africa* (1968) vol.20 no.3 71-74 [En]

Reports on the interest in growing South African miniature trees. Many acacias have been successfully cultivated in this fashion including *Acacia karroo*, *A. burkei*, *A. nigrescens* and *A. giraffae*; as well as other species for example: *Brachylaena rotundata* and *Dichrostachys cinerea*.

88 PALMER, E.; PITMAN, N. **Trees of Southern Africa** A.A. Balkema, Cape Town (1972) 2, 741-743 [En]

Gives a general description, illustrated with photography, of Anaboom (*Acacia albida*) in Southern Africa, and lists its vernacular names. This species with camelthorn (*A. erioloba*) play a vital role in local economy of the Topnaar Hottentots, who live in the margins of the Kuiseb river in the Namib desert. Their bark is used for building huts, and their pods as a food supplement. Anaboom can grow relatively fast under good growing conditions, reaching 7 m in 3 years, but is slightly frost tender.

89 PARDY, A.A. **Notes on indigenous trees and shrubs of S. Rhodesia** *Rhod. Agric. J.* (1953) 50 (1), 4-6 + 4 plates [En]

The note on *Acacia giraffae* (*A. erioloba*) is one of a series on selected indigenous trees of S. Rhodesia (Zimbabwe). There is a botanical description of the tree and it is said to sucker freely. Its distribution in the country is described as being limited to the Kalahari sand, forest sandstone and deep alluvial soils of western Matabeleland. The wood is hard, heavy and durable and used for bearings, piles and posts and is an excellent firewood. The pods are eaten by many animals and the seeds are frequently destroyed by insects.

90 PEDLEY, L. **Derivation and dispersal of *Acacia* (Leguminosae), with particular reference to Australia, and the recognition of *Senegalia* and *Racosperma*** *Botanical Journal of the Linnean Society* (1986) 92: 219-254 [En, 143 ref.]

Describes a range of character states and their evolutionary polarity, the evolutionary trends and biogeography of the genus *Acacia* and proposes that the genus should be split into three genera, *Acacia* Miller, *Senegalia* Raf. and *Racosperma* Martius. These correspond to the currently accepted subgenera of *Acacia*. *Acacia* and *Senegalia* arose independently from the *Ingeae*, with *Racosperma* being derived from *Senegalia*.

91 PETERS, C.R.; O'BRIEN, E.M.; DRUMMOND, R.B. **Edible wild plants of Sub-Saharan Africa: an annotated checklist, emphasizing the woodland and savanna floras of eastern and southern Africa, including the plants utilized for food by Chimpanzees and Baboons.** Royal Botanic Gardens Kew, Richmond, Surrey. (1992) 239 pp. [En,5 pp. of ref.]

Gives a checklist of edible plants and the reference where it was cited. The gum of *Acacia erioloba* is listed as being eaten by Bushman and Kwanyama Ovambos, and the fruit and seed by baboons.

92 POYTON, R.J. **Characteristics and uses of selected trees and shrubs cultivated in South Africa** *Directorate*

of Forestry: Department of Environment Affairs Bulletin no.39. (1984) pp.22,66,93. [En]

Includes tables on characteristics and uses of species and recommended silvicultural zones for each. Includes *Acacia erioloba* the characteristics which are summarized in the table as being: tolerance of brackish water; resistance to termites; grows to an average height of 8m and a maximum height of 14m; main flowering period is in the spring but can start in winter and end in summer; fruits ripen in autumn and winter; height growth is 0.3m per year or less; it is hardy to drought and frost; it has useful pods, nectar and pollen and excellent fuelwood.

93 ROBBERTSE, P.J. **A scanning electron microscopic investigation of the pollen of South African *Acacia* species** *Journal of South Africa Botany* (1974) 40 (2) 91-99 [En, af, 13 refs.]

Uses SEM and light microscopic techniques to gain further details on the surface structures of pollen of South African *Acacia* species, and briefly discusses the taxonomic position of *A. albida* and *A. giraffae* (*A. erioloba*). In the polyads of *A. giraffae* the monads are not clearly arranged in centrally and peripherally-placed cells as in other species of the Gummiferae. The number of monads vary from 26-48, and are irregular in shape. *A. albida* is distinct in that (1) unlike all S. African *Acacias* it has no glandular appendages on its anthers, (2) it has polyads with ungrooved monads like the *Acacias* in the series *Vulgares*, which all have 16 cell polyads but (3) it has up to 32 cells in the polyad (4) 2 peripheral monads on each lateral side of the polyad undergo a single division to form a double layer (unlike all others except *A. giraffae*). Concludes that *A. giraffae* and *A. albida* must be relicts of the parental stock of the African *Acacia* species, and *A. albida* should not be separated into *Faidherbia*.

94 ROBBERTSE, P.J. **The genus *Acacia* Miller in South Africa. I. Stipules and spines** *Bothalia* (1975a) 11,4: 473-479 [En]

A large number of seedlings and young twigs of South African Acacia species was sectioned and the vascularization of the nodes and internodes studied. The nodes of all the species examined are trilacunate and the vascular tissue of the stipules originates from the lateral leaf traces. The Gummiferae species all have spinescent stipules, while the stipules of the Vulgares are membranous. Prickles containing no vascular tissue are found on the nodes and in some species also on the internodes of the Vulgares species. These prickles always occur on the ridges formed on the stem by leaf traces.

95 ROBBERTSE, P.J. **The genus *Acacia* in South Africa. IV. The morphology of mature pods.** *Bothalia* (1975b) 11 (4) 481-489.

The external morphology and the anatomy of the pods of all the South African Acacia species are discussed. It was found that the South African *Acacia* species can be grouped into a number of distinct categories on the basis of the anatomy of their pods. There is quite a marked difference in the anatomy of the pod of the series Vulgares and that of the series Gummiferae. *Acacia erioloba* is in Gummiferae according to classifications based on pod anatomy, having a fibre stratum with longitudinal fibres only; *A. erioloba* has a continuous stone cell stratum outside vascular bundles.

96 ROBBERTSE, P.J. **The genus *Acacia* Miller in South Africa- VI. The morphology of the leaf** *Boissiera* (1975c) 24: 263-270

The author has studied the morphology anatomy of the heterophyllous (proximal and distal) leaves of South African *Acacia* species. According to classifications made based on the anatomy of the petiole *A. giraffae* (*A. erioloba*) belongs to the Gummiferae grouping. *A. albida* resembles *A. giraffae* most closely although the anatomy of the pinnules of *A. albida* corresponds to that of the Vulgares series. *A. albida* is therefore given a separate classification.

97 ROBBERTSE, P.J.; VAN DER SCHIJFF, H.P. **The genus *Acacia* Miller in South Africa - 5; with special reference to the seedling structure as a taxonomic characteristic** Mitteilungen der Botanishen Staatssammlung Munchen (1971) X:170-177 [En, 10 ref.]

Observed the germination and growth of seedlings of 43 taxa of *Acacia* over a year, recording their seedling characteristics. From these observations grouped the species into 10 groups, and with evidence from previous papers suggested possible phylogenetic lines for the genus in South Africa. *A. giraffae* is included in group 10 having petiolated cotyledons, and its first and second leaves of seedlings are pinnate (and often the third also). This group also includes *A. grandicornuta, A. haematoxylon, A. robusta* and *A. stuhlmannii* from the Gummiferae and *A. mellifera* and *A. modesta* from the Vulgares group. Also records a chromosome no of 2n = 26 for *A. giraffae*.

98 ROBBERTSE, P.J.; VENTER, G.; VAN RENSBURG, D.J. **The wood anatomy of the South African *acacias*** *IAWA-Bulletin* (1980) 1 (3) 93-103 [En, 19 ref., 2 pl.]

Wood specimens of 37 different *Acacia* species were studied. Of the many wood characters investigated, only 9 were found useful for principal component analysis to differentiate between the different species. Width and, to a lesser extent, height of the rays gave the best results. The rays in the wood of the subgenus *Acacia* are 1-3 seriate, while those of the subgenus *Aculeiferum* are multiseriate. A significant negative correlation was found between latitude and ray height. of *A. karroo* wood specimens collected in different parts of South Africa. The rays of *A. erioloba* are among the narrowest found in the subgenus *Acacia*. *A. erioloba*, with *A. nilotica* and *A. haematoxylon*, are exceptions in the subgenus *Acacia* in having distinct heartwood; heartwood is better developed in the species of the subgenus *Aculeiferum*.

99 ROSS, J.H. **A note on the *Acacia giraffae* x *A. haematoxylon* hybrid** *Bothalia* (1971) 10 (2) 359-362 [En]

Over 20 years ago the first specimens of a hybrid between *Acacia giraffae* Willd. and *A. haematoxylon* Willd. were collected in the Hay district of the Cape Province. From an examination of all available herbarium specimens the characteristics of *A. giraffae*, *A. haematoxylon*, and the hybrid are tabulated. Some characteristics displayed by the hybrid, for example number of pinna pairs, are found to be intermediate between the values recorded for the parent species, while other characters, for example the degree of pubescence and the presence of glands, tend to be inherited from one parent species only. It appears, therefore, that there is a marked tendency for certain characters associated together in a parent to be associated in the hybrid. [From the author's summary].

100 ROSS, J.H. **Notes on *Acacia* species in southern Africa Part 2** *Bothalia* (1972) 10 (4) 547-553 [En]

The typification of *A. galpinii* is discussed and attention is drawn to an unusual specimen of *A. giraffae* and to the seedling development of *A. haematoxylon*. *A. inermis* is shown by Marloth's type to be *Albizia anthelmintica*. The continued confusion about the identity of *A. heteracantha* (i.e. *A. tortilis* subsp. *heteracantha*) is considered, and the misapplication of this name in the literature is traced.

101 ROSS, J.H. **Notes on African *Acacia* species** *Bothalia* (1975a) 11 (4) 443-447 [En, many ref. in text].

Presents taxonomic notes on miscellaneous African species. *A. dekindtiana* and *A. hirtella* var. *inermis* are reduced to synonymy under *A. karroo*. The holotype of *A. giraffae* appears to be a *A. erioloba* x *A. haematoxylon*, and the name *A. giraffae* has been widely misapplied to the species which should now be called *A. erioloba* E. Mey. He selected as a neotype JW Morris 1042 at Kew herbarium, from Transvaal between Kommandodrift and Mahwassie. Notes are also included on some taxa of *Acacia* originally described under the genus *Mimosa*.

102 ROSS, J.H. **Fabaceae** *Flora of Southern Africa* (1975b) 16 (1) 159 pp. [En]

Presents the floral treatment of the Leguminosae for south Africa and south west Africa (now Namibia). For *A. erioloba* E. Mey gives a detailed botanical description, with synonyms, citing representative specimens from the area, and notes on their ecology (similar details in Ross 1979). It occurs frequently on Kalahari sands, often dominating the Kalahari thornveld. In very dry areas it occurs along watercourses or where underground water is available. Notes that it was much more frequent in parts of South Africa, but has been heavily exploited for fuel, particularly within several hundred kilometres of the Kimberley mines, where up to 10,000 tons of wood per year were collected. The species is now protected in the northern Cape and in the Jacobsdal district of the Orange Free State.

103 ROSS, J.H. **A conspectus of the African *Acacia* species.** *Botanical Survey of South Africa Memoirs* (1979) No. 44, 93 pp. [En]

A conspectus is presented of the *Acacia* species (Fabaceae) which occur indigenously in the continent of Africa west of Suez. The characters traditionally employed to divide the African species into two main groups are reviewed and the advantages of using these characters are discussed. The findings of workers in a number of diverse field such as pollen, seedling and chromosome morphology, phytochemistry and amino acid content of seeds is correlated with general morphology to provide a more comprehensive overall picture, and the infrageneric classification of the African species down to rank of section is provided. Brief notes are given on pollen morphology and pollination, seed production, predation and dispersal, hybridization, and the origin and distribution of the African species. The morphological characters employed in the keys to the identification are outlined and keys to the identification of the African species are provided. A brief description of each species is given together with synonymy, bibliographic references and a selection of representative specimens, and most species are illustrated with a simple line drawing. Attention is drawn specifically to deficiencies in our knowledge and to species where taxonomic problems exist.

For *Acacia erioloba*, the distribution is described as southern Angola, South West Africa (Namibia), Botswana, south-western Zambia and Rhodesia (Zimbabwe), the Transvaal, western Orange Free State and northern Cape Province. It occurs frequently on the Kalahari sands and in dry woodland. It is often the dominant species in Kalahari thornveld and in very dry areas it occurs along water courses and in other areas where there is underground water. The comnbination of stout spines, often enlarged into "ant-galls", leaflets wth prominant venation, bright yellow flowers, glabrous peduncles, apical involucels and densely grey velutinous pods distinguish this from all otther species of African *Acacia*. Pollen grains are anomalous in having 32 (26-48) cells as opposed to 16 in all other south African species studied. The polyads themselves have a different arrangement and the furrows in the monds are different from those with capitate inflorescences and stipular spines. In the south-western part of its range, *A. erioloba* is often the only tree of any size in the landscape and sociable weavers build their nests in them. *A. erioloba* hybridizes with *A. haematoxylon*. The hybrid is also described.

104 ROSS, J.H. **An analysis of the African *Acacia* species: their distribution, possible origins and relationships** *Bothalia* (1981) 13, 3 & 4 389-413 [En, 92 refs.]

The 3 subgenera recognized within the genus *Acacia* are outlined and the global distribution of each is indicated. The differences between the subgenera and the degree of relationship and levels of specialization are discussed briefly. It is suggested that the ancestral members of the genus were climbers or lianes. Past geological events considered likely to have influenced the distribution of the *Acacia* species in Africa are outlined. The number of species recorded from each African country is tabulated and the distribution and concentration of species within the genus Acacia as a whole and within each subgenus in Africa are illustrated. The highest concentrations of species within each subgenus occur in tropical east and south-east Africa. The distribution of species within some of the individual African countries and possible affinities are discussed and attention is drawn to the main centres of endemism. The distribution of the African species is correlated with the major phytogeographical regions recognized on the continent. The relationships between the African and the American, Madagascan, Indian and Australian *Acacia* species are discussed briefly. The *A. erioloba* x *A. haematoxylon* hybrid is confined to the northern Cape. *A. karroo*, *A. erioloba*, *A. hereroensis* Engl., *A.tortilis* and *A. mellifera* are characteristic of the Karroo-Namib Region, which consists of the interior of the Cape Province, the western portion of South West African and extends into south western Angola.

105 SECOR, J.B.; CONN, E.E.; DUNN, J.E.; SEIGLER, D.S. **Detection and identification of cyanogenic glucosides in 6 species of *Acacia*** ***Phytochemistry*** (1976) 15 (11) 1703-1706 [En]

The presence of prunasin in *A. deanei* ssp. *paucijuga*, sambunigrin in *A. cunninghami* and acacipetalin in *A. giraffae* was established by chromatographic and NMR spectral evidence. Mandelonitrile glucosides of unknown configuration in *A. parramattensis* and *A. pulchella* and as yet unidentified glycoside in *A. farnesiana* are reported.

106 SEELY, M.K.; BUSKIRK, W.H.; HAMILTON, W.J.; DIXON, J.E.W. **Lower Kuiseb River, South-West Africa. Perennial vegetation Survey** *Journal SWA (South West Africa) Scientific Society* (1979-81) 34-35, 57-86 [En]

The Kuiseb River, located in central South-West Africa, is one of several seasonal rivers flowing through the Namib Desert towards the southern Atlantic Ocean. As a linear oasis, it supports an extensive growth of trees and other vegetation which, in turn, allows many non-desertic or partially adapted animal species to extend their range into the true desert. Today, extensive plans to develop this water source for human use threaten the Kuiseb River ecosystem, particularly in its desert reaches. At least 10 spp. of perennial plants occur in the Kuiseb River system in the Namib Desert: *Acacia albida*, *A. erioloba*, *Tamarix usneoides*, *Euclea pseudebenus*, *Salvadora persica*, *Phoenix dactylifera*, *Ficus sycomorus*, *F. cordata*, *Maerua schinzii* and *Acanthosicyos horrida*. Their number and canopy width were measured to allow comparison between transects surveyed from Rooibank to Homeb. Relatively little variation between transects occurred along this lower portion of the Kuiseb River. Differences within the transects, on the flood plane perpendicular to the water course, were greater. Above Homeb, in the narrow Kuiseb Canyon, the relative composition of plant species altered. Measurement of fruit production by *A. albida*, *A. erioloba* and *F. sycomorus* indicates an acyclic production. Long-term studies are recommended to provide an insight into this ecosystem.

107 SEIGLER, D.S; CONN, E.E. **Cyanogenesis and Systematics of the Genus *Acacia*** *International Group for the study of Mimosoideae Bulletin* no. 10 (1982) 32-43 [En, 48 refs.]

Under a listing of cyanogenic compounds of *Acacia* species, *A. giraffae* contained the compound proacacipetalin.

108 SIM, T.R. **Native Timbers of South Africa** Department of Mines and Industries Memoir, Pretoria, Union of South Africa Memoir (1921) No. 3, 33-34 [En]

A. giraffae Burch. is described, its distribution, uses and common names given, and its status as a reserved (conserved) tree. It is a large spreading tree of Orange river, Bechuanaland and western Transvaal, being formerly abundant but excessively cut for firewood for Kimberley [mines]. It coppices from root suckers, and can commonly have stem diameters of 24 inches. From a large range of uses for native timbers, its wood is listed only for fuel.

109 SKARPE, C. **Observations on two bushfires in the western Kalahari, Botswana** *Acta-Phytogeographica-Suecica* (1980) No. 68, 131 [En, 20 ref., 4 pl].

Data are presented on % crown cover and numbers of major shrub species before and 5-6 months after the fires. No persistent effect was noted on the shrub layer although the size of the shrubs was reduced. Grazing value of the field layer did not deteriorate. One third of the tree species (*Acacia erioloba*, *A. luederizii* [*luederitzii*] and *Boscia albitrunca*, found in only one of the areas) was killed.

110 SKARPE, C. **Spatial patterns and dynamics of woody vegetation in an arid savanna** *Journal of Vegetation Science* (1991) 2 565-572 [En]

The spatial distribution of woody plants was studied in an arid savanna in Botswana. The study included stands of mixed species as well as monospecific even-sized stands of different size-classes of the tree *Acacia erioloba* and the shrub *A. mellifera*. In *A. erioloba*, saplings were aggregated, small trees were randomly or regularly distributed and large trees were randomly spaced. In open stands of *A.mellifera*, aggregation increased with the size of shrubs, while in dense stands with overgrazing, aggregation decreased with increasing size. The different patterns are discussed in relation to the relative importance in inter- and intra-specific competition fòr water, and of disturbance by fire as a regulatory mechanisms for total amount and spatial distribution of woody plants in this savanna.

111 SKARPE, C.; BERGSTRÖM, R. **Nutrient content and digestibility of forage plants in relation to plant phenology and rainfall in the Kalahari, Botswana.** *Journal of Arid Environments* (1986) 11(2) 147-164 [En]

The authors monitored *in vitro* digestibility, crude protein, phosphorous and calcium levels in the foliage of grasses, shrubs and trees in souther Botswana. *Acacia erioloba, A. leuderitzii* and *A. mellifera* were among the tree species sampled.

112 SMALL, J.G.C.; BURGER, A.L.; BOTHA, F.C. **Alcohol dehydrogenase in seeds and seedlings of *Acacia erioloba*** From Proceedings of XIVTH International Botanical Congress, Berlin, West Germany, July 24-August 1, 1987. *Int. Bot. Congr. Abstr.* 17 (0). (1987) 60. [En]

Same results as detailed in the following abstract (Small *et al.* 1990).

113 SMALL, J.G.C.; BURGER, A.L.; BOTHA, F.C. **Alcohol dehydrogenase in the desert species *Acacia erioloba* - ontogeny during germination and induction in seedling roots** *South African Journal of Botany* (1990) 56 (3) 403-408 [En]

Dry seeds of *Acacia erioloba*, a southern African desert tree species, contain high levels of alcohol dehydrogenase (ADH) which separate into six electrophoretic (PAGE) bands in axes and five bands in cotyledons. It is proposed that ADH in this species is coded for by three genes and that the isoenzymes arise from intergenic and intragenic dimerization of protomers. The number of ADH isoenzymes and activity decreases after germination, this change being more rapid in axes than in cotyledons. Decline in activity appears to require active protein synthesis. Cycloheximide and nitrogen prevent, but oxygen enhances loss of ADH activity. An ADH inactivator was shown to be present in developing axes and may be involved in the regulation of ADH activity. Anoxia, in contrast to hypoxia and 2,4-D is largely ineffective in inducing ADH activity in seedling roots. Roots of well aerated plants show one ADH electrophoretic band. Induction causes increase in activity in five ADH isoenzymes with most activity occurring in two isoenzymes.

114 SOUTH AFRICA, PLANT PROTECTION RESEARCH INSTITUTE. **Checklist of insects on forest trees and shrubs in South Africa** *Entomology memoir, Department of Agricultural Technical Services, Pretoria, Republic of South Africa* (1970) No.21, 81 pp. [En, 17 refs.]

A checklist of insects, mainly from the orders *Coleoptera* and *Lepidoptera*, found attacking trees and shrubs growing in South Africa. Many insect species are listed for the genus *Acacia*. The following insects are listed as attacking *A. giraffae* Willd. (Mimosaceae) Camel thorn-Kameeldoring [*A. erioloba*]:

ORDER COLEOPTERA
 Family Bruchidae
  Bruchus albosparsus - beetle destroys seeds
  Bruchus sp.
ORDER LEPIDOPTERA
 Family Lasiocampidae
  Gonometa postica - larval defoliator

115 SOUTHGATE, B.J. **Variation in the susceptibility of African *Acacia* (Leguminosae) to seed beetle attack** *Kew Bulletin* (1978) *32* (3) 541-544 [En]

Many species of the family Bruchidae parasitize seeds of members of the Leguminosae. The female beetle lays an egg on a ripening or, more rarely, a dehisced ripened pod. The larva bores through the pod wall and burrows into a ripening seed within which it creates a chamber. In its final stages the larva eats away the outer layers of the seed until only a thin circular 'window' of testa remains. After pupation, the beetle emerges through the 'window'. In a few species the larva leaves the seed and pod, drops to the ground on a silk thread, and pupates in the soil beneath the tree. Fourteen of the 61 *Acacia* species recorded in East Africa are known to be the hosts of one or more species of bruchid. Examples of the very high rates of seed infestation that can occur in markedly different habitats are given by data relating to *A. tortilis*: ssp. *spirocarpa* (Tanzania) 90-95%; ssp. *raddiana* (Israel) 72%; and ssp. *tortilis* (Israel) 99%. Moreover, species with very different seed pods may be parasitized by the same bruchid, e.g. that which parasitizes the *A. tortilis* complex also infests seed of *A. malacocephala* and probably *A. abyssinica* ssp. *calophylla* in Tanzania, *A. erioloba* in Botswana, *A. karroo* in Natal and *A. hockii* in Ethiopia. Early indications from phytochemical investigations indicate that the concentrations of certain amino acids (pipecolic acid and some heteropoly-saccharides) determine if a bruchid larva can survive in a seed. A method for collecting and storing seed pods to preserve beetles emerging from them is described, and attention is drawn to the importance of international cooperation to gain further knowledge of the bruchid/host relationship.

116 STEYN, D.G. **The Camel-thorn tree and other *Acacia* species as stockfeed** *Farming in South Africa* 9 (1934) 89-90,106 [En]

Pods of the Transvaal *Acacia giraffae* (*A. erioloba,*) have a high nutritional value but the fresh green foliage, the green pods and the ripe pods all can contain dangerous quantities of prussic acid (cyanogenetic glucosides); the foliage contains the most and the ripe pods the least. Very high concentrations were found in the foliage and flowers of *A. lasiopetala Oliv.* (*A. sieberana*) and in the fresh and dried green foliage and green pods of *A. stolonifera* Burch. (*A. hebeclada*). Very small amounts of prussic acid were found in the ripe pods of *A. litakunensis* Burch. (*A. tortilis* ssp. *heteracantha*) and in the foliage and green pods of *A. robusta*). No prussic acid was found in the leaves of *A. karroo*. There may be great variation in the amount of prussic acid contained in different trees and at different times of the year. The toxicity of any plant containing prussic acid depends upon the rate at which it is consumed because it is a gas and rapidly eliminated by the lungs. Moistened plants are more dangerous than dry plants, especially if they are eaten some time after moistening. *A. giraffae* pods can be fed safely to stock provided small dry quantities are fed at a time. Their toxicity can also be reduced by boiling the pod or meal before feeding or mixing it with sulphur or molasses.

117 STEYN, D.G. **Camel-thorn pods as stockfeed** *Farming in South Africa* 18 (1943) 313-8 [En]

Tests have shown that the pods and foliage of certain species of *Acacia*, particularly *A. giraffae*, *A. lasiopetala* and *A. stolonifera*, may contain large quantities of prussic acid which under certain conditions would be dangerous to feeding stock. Mature *Acacia* pods have a high protein content (12 per cent.) and are an excellent feed. Methods by which they can be fed to animals without harmful results are indicated.

118 STORY, R. **A botanical survey of the Keiskammahoek district** *Memoires of the Botanical Survey of South Africa, Republic of South Africa.* (1952) 184 pp. [En, 6 pages of refs.]

Describes the area, climate and ecological succession of the Keiskammahoek district. Refers to a letter which reports roots of *A. giraffae* Burch. were found at 150 ft deep in a borehole in South West Africa.

119 STORY, R. **Some plants used by bushman in obtaining food and water** *Memoires of the Botanical Survey of South Africa, Republic of South Africa.* (1958) 23 [En]

A description of plants used by the Kalahari bushman. For *A. giraffae* Burch. gives a general description of the tree, which was found scattered all along the route between Molepolole and Gautscha Pan, but it becomes dominant forming woodlands along the border of the Okavango swamp from Lake Ngami to Tsau, where it can reach 30 ft high. On heavier sands from Molepolole to Ghanzi it is only a shrub to 6 ft high. Gum is edible, and good to eat when fresh and clear, but can become discoloured at times and then is less palatable. It has a stong unpleasent smell when roots are cut.

120 STOURS, A.E.G. **More about Trees: interesting facts and uses of some common Zambian trees** *Forest Department, Ndola, Zambia* (1982) 127 pp.

Gives general data on the Zambian trees and their uses principly for farmers, and is derived from Forest Department species records and various publications. The pods of *Acacia erioloba* is described as being a valuable cattle feed having a high phosphorus content. Its food value is reckoned to be equivalent to leguminous hay, but care is needed not to feed unripe pods (could liberate prussic acid and poison stock. To avoid risk feed ground up pods with molasses or sulphur. String can be made from its inner bark. Its heartwood is termite proof, and is suitable for flooring, building poles, fence posts, tool handles and wagon bodies.

121 TANNER, J.C.; REED, J.D.; OWEN, E. **The nutritive value of fruits (pods with seeds) from four *Acacia* species compared with extracted noug (*Guizotia abyssinica*) meal as supplements to maize stover for Ethiopian highland sheep**. *Animal Production* (1990) **51**:127-133.

122 THERON, G.K.; VAN ROOYEN, N.; VAN ROOYEN, M.W. **Vegetation of the Lower Kuiseb River South West Africa** *Madoqua* (1980) 11 (4) 327-346 [En]

The withdrawal of water from the lower Kuiseb River for mining and industrial purposes may influence the vegetation along the river [*Acacia albida*, *A. erioloba*, *Tamarix usneoides*, *Salvadora persica*, *Euclea pseudebenus*, *Suaeda plumosa*, *Eragrostis spinosa*, *Pechuel-loeschea leubnitziae*, *Acanthosicyos horrida*, *Psilocaulon* sp. cf. *salicornioides*, *Zygophyllum simplex*, *Z. stapfii* and *Odyssea paucinervis*]. The maintenance of this vegetation is essential to the Kuiseb River ecosystem as a whole and the vegetation acts as a barrier checking the northwards movement of the Namib dune-sea. Physiognomic structural areas were distinguished on aerial photographs and these areas were investigated in the field for homogeneity and woody species composition. A vegetation map of the area between Nareb and Rooibank was compiled and 14 different communities were distinguished. Some communities were subdivided into variations and 40 variations were distinguished. Four additional units, consisting mainly of dead herbaceous species, were mapped between Gobabeb and Rooibank.

123 THERON, G.K.; VAN ROOYEN, N.; VAN ROOYEN, M.W. **Vegetation structure and vitality in the lower Kuiseb** In Huntley, B.J. (ed) The Kuiseb Environment: the development of a monitoring baseline *South African National Scientific Programmes Report* 106 (1985) 81-91 [En]

Acacia erioloba and *A. albida* densities and population structures were sampled in the Kuiseb River valley in 1978 and 1981 to determine whether extraction of underground water was influencing their recruitment and survival. Both species decreased in density between 1978 and 1981, with greatest losses occurring in the 1-50 cm stem circumference class. Losses were attributed to dry conditions rather than water extraction. Size class histograms are presented for *A. erioloba* populations from three sites in the Kuiseb valley.

124 TIETEMA, T.; MERKESDAL, E. **An establishment trial with *Acacia tortilis*, *A. karroo*, *A. erubescens* and *A. erioloba* at Morwa Forestry. The situation after one year** *Journal, Forestry Association of Botswana* (1986) 47-52; [En, 5 ref.].

Eucalypt plantations in Botswana have not proven to produce more wood than indigenous natural woodland. Four indigenous *Acacia* species were established at Morwa Forestry, Kgatleng District, Botswana. A year after planting, *A. tortilis* had the highest survival at 85%; survival of the other three species ranged from 25.6% to 41%; There were high failure rates in the early summer. Watering is recommended to improve survival of the three poorly-performing species.

125 TIETEMA, T.; MERKESDAL, E.; SCHROTEN, J. **Seed germination of Indigenous trees in Botswana** *Acts Press, African Centre for Technology Studies, Nairobi, Kenya* (1992) 106 pp.

Gives practical details on seed collection and storage of trees indigenous to Botswana, and their germination and raising seedlings in a nursery. For *A. erioloba* seeds the recommended seed pretreatment was 1 minute in hot sulphuric acid or 10 minutes in cold sulphuric acid which gave 95-100 % germination within 12 days. Hot water treatment gave 65 % germination in 3 weeks.

126 TIETEMA, T.; TOLSMA, D.J.; VEENENDAAL, E.M.; SCHROTEN, J. **Plant responses to human activities in the tropical savanna ecosystem of Botswana.** In Rozema, J. & Verkleij, J.A.C. (eds) *Ecological responses to environmental stresses (1990).* Kluwer Academic Press 262-276.

Reduction in indigenous browsing mammals and the introduction of cattle is leading to bush encroachment by acacias and *Dichrostachys cinerea* in Botswana. Cattle are thought to facilitate bush encroachment by removing the grass as well as by passing large quantities of viable acacia seeds in their dung. Indehiscent acacia pods contain more seeds than dehiscent pods, and are also hard seeded and more accessible to cattle. For this reason *Acacia* species with indehiscent pods (*A. tortilis, A. nilotica, A. erioloba, A. hebeclada*) were more likely than other species to encroach on rangeland grazed by cattle in Botswana. Recorded a mean of 52 (SD 98) *A. erioloba* seeds per cattle dropping.

127 TIMBERLAKE, J. **Handbook of Botswana acacias** Division of Land Utilization, Ministry of Agriculture, Botswana. (1980) 120pp. [En, 48 refs]

The book gives illustrated descriptions of all the acacias of Botswana with a distribution map for each. The work is prefaced by a short introduction on the importance of the acacias and a dichotomous key. *Acacia erioloba* occurs over almost the whole of Botswana on Kalahari sands, often on better quality or alluvial soils. It is an indicator of underground water where the annual rainfall is less than 250mm. It is drought and frost resistant but slow-growing. It is said to root to depths of 46m and live to 300 years. The pods and leaves are valuable browse. Leaves contain up to 17% protein in February with 35% digestibility. The pods are high in protein with 6% in the pod and 33% in the seeds. The seeds are reputed to contain prussic acid and can cause poisoning in cattle. Crushed pods are mixed with maize meal for livestock food; sulphur is added to prevent poisoning. Elephants eat the nutritious bark. The wood is hard, durable and insect-resistant. The gum is clear and edible. *A. erioloba* hybridizes naturally with *A. haematoxylon.*

128 TINLEY, K.L. **An ecological reconnaissance of the Moremi Wildlife Reserve, Botswana** Okovango Wildlife Society (1973) 146 pp [En]

Acacia giraffae wooland occurs on sandy alluvium in the northern part of the Okovango Swamps, where these trees reach heights of 7-15 m. The understory is dominated by *Panicum* sp. or thickets of shrubs. Where the understory is heavily grazed near water, it is dominated by *Aristida* sp. and *Cynodon dactylon.* Elephant feed on the foliage, bark and pods of *A. giraffae* and disperse viable seeds of this tree in their dung.

129 VAN DEN EYNDEN, V.; VERNEMMEN, P.; VAN DAMME, P. **The ethnobotany of the Topnaar** University of Gent (1992) European Community. 154 pp [En]

Known to the Topnaar of the Namib Desert as ganab, *Acacia erioloba*, the most common tree of the Kuiseb River valley, is used as fuelwood, for making charcoal and for fencing. Leaves and pods are browsed by goats and other domestic livestock. The pulp in the pods is eaten by the Topnaar in times of scarcity. Gum exuded from the branches is dissolved in hot water and drunk as a remedy for coughs and colds. Powder from beneath the bark is used to scent the body and the home. The Ovambo people use a decoction of the bark to cure diarrhoea and a root decoction to treat coughs. The seeds are used as a substitute for coffee.

130 VAN DER WALT, P.T. **Camel thorn: symbol of the Kalahari.** *Custos* (1993) 21 (12) 47.

131 VAN DER WALT, P.T.; LE RICHE, E.A.N. **The influence of fire on an *Acacia erioloba* community in the Kalahari Gemsbok National Park** *Koedoe* (1984) 27 (Suppl.) 103-106 [En]

A fire in the Kalahari Gemsbok National Park in 1976 killed approximately one third of the *Acacia erioloba* trees in the Nossob River valley. The fire killed 5-12% of the small trees, 28-39% of medium-sized trees and 56-66% of large *A. erioloba* trees. The worst fire damage occurred in fully grown trees that contained dead material and rat's nests and those that had a dense understory fuel load of tall dead grass.

132 VAN JAARSVELD, E. **A Preliminary report on the vegetation of the Richtersveld with specific reference to the trees and shrubs of the area** *Trees in South Africa* vol.33, no.3 58-84 [En]

Comprehensive study of the vegetation of the Richtersveld. *Acacia erioloba* is included in the listing of non-succulent trees and shrubs and is classified as suitable for cultivation from seed and has yellow flowers in June.

133 VAN ROOYEN, N.; VAN RENSBURG, D.J.; THERON, G.K.; BOTHMA, J. DU P. **A preliminary report on the dynamics of the vegetation of the Kalahari Gemsbok National Park**. *Koedoe* (1984) 27 (Suppl.) 83-102.

Changes in the floristic composition, basal cover and density of herbaceous and woody vegetation were monitored over a seven year period in the Kalahari Gemsbok National Park, South Africa. The composition and density of woody plants were not much affected by periods of drought and rainfall variability during this time. In an experimental plot 50 m from an artificial water point, the density of *Acacia erioloba* varied between years as a result of differences in the numbers of seedlings present. During a long dry period (1980-1983) the total numbers of young *A. erioloba* plants declined.

134 VAN ROOYEN, N.; VAN RENSBURG, D.J.; THERON, G.K.; BOTHMA, J. DU P. **Monitoring of the vegetation around artificial watering points (windmills) in the Kalahari Gemsbok National Park** *Koedoe* (1990) 33 (1) 63-88.

Vegetation was monitored from 1978 to 1989.

135 VAN TONDER, S.J. **Annotated records of southern African Bruchidae (Coleoptera) associated with Acacias, with a description of a new species.** *Phytophylactica* (1985) 17: 143-148.

Seeds of 41 southern African Acacia species were collected, 37 of which yielded one or more bruchid species. Two species were found associated with *A. erioloba*, *Bruchidius senegalensis* (Pic) and *Caryedon multinotatus* (Pic), the latter (which has a two year life cycle) was only found on *A. erioloba*.

136 VAN WYK, A.J.; OPPERMAN, D.P.J.; KOK, O.B. **Availability, quality and utilization of riverine vegetation of the lower Kuiseb and canyon area.** In Huntley, B.J. (ed) The Kuiseb Environment: the development of a monitoring baseline *South African National Scientific Programmes Report* 106 (1985) 107-112.

Acacia erioloba pods in the Kuiseb area of the Namib Desert, Namibia, ripened and fell to the ground between May and August. Large trees with spreading canopies produced 0-290 kg ha^{-1} yr^{1} of pods, and younger trees (upright canopy) produced 0-145 $kgha^{-1}$ yr^{-1} of pods. Trees less than 3 m tall did not bear pods. Gemsbok and goats fed on the foliage and fallen pods of *A. erioloba*, and the rodents *Thallomys* and *Rhabdomys* consumed the seeds.

137 VASSAL, J. **Enumeration des nombres chromosomiques dans le genre *Acacia*** (1974) Groupe International pour l'etude des *Mimosoideae.* Bulletin No. 2:21-29 [Fr,27 ref.]

Compiled list of chromosome numbers published in the genus Acacia, with its reference source. *A. giraffae* Burch. is listed as a diploid and a polyploid (2n = 26 and 52).

138 VILJOEN, P.J.; BOTHMA J. DU P. **The influence of desert-dwelling elephants on vegetation in the northern Namib Desert, South West Africa/Namibia** *Journal of Arid Environments* (1990) 18 (1) 85-96 [En, 24 ref.].

The effects of elephants (*Loxodonta africana*) are discussed based on a survey of 3 sets of aerial photographs covering a 20-yr period from 1963. The 70 elephants representing the desert population in 1983 had no known detrimental effect on the desert vegetation. Monitoring the relative age structure of large trees in river courses (recorded species > 4 m tall were: *Acacia albida*, *A. erioloba*, *A. tortilis*, and a few *Colophospermum mopane* and *Combretum imberbe*) also suggested that for at least the last 20 yr these elephants have had no marked detrimental effect on the large-tree population. It is concluded that the present number of elephants is well below the region's elephant-carrying capacity.

139 VON BREITENBACH, F. **The Indigenous Trees of Southern Africa** Department of Forestry, the Government Printer, Pretoria, Republic of South Africa. (1965) vol.2, part.1 292-295 [En]

Acacia giraffae Burch. is one of 39 South African Acacia species that are described. Gives a general botanical description, common names, drawing of fruiting branch, ecology and distribution, wood properties and other uses, diseases, and propogation. The dark red brown heartwood is hard and heavy (76 lbs./cu.ft. air dry) and is mainly used for fuelwood although the Sotho tribes also make household implements (spoons, knife handles). A widespread fodder for giraffe that browse the flowers and foliage, and cattle and antelope eat the pods that fall. A useful honey tree for nectar and pollen. Often reproduces by suckers, it is a slow growing tree. Bark is attacked by Black spot (*Hysterographium acaciae* Doidge) and tree parasitised by species of *Loranthus* and *Viscum*.

140 VON BREITENBACH, F. **A List of tree names** (II) *Trees in South Africa* (1975) vol.26, no.4 92-103 [En]

Lists 143 species including *Acacia giraffae* [with native names].

141 WALTER, H. **Grundlagen der Weidewirtschaft in Südwestafrika** *Verlag für Landwirtschaft, Gartenbau, Naturwissenschaften* (1954) 100-107 Eugen Ulmer, Stuttgart [German].

The author discusses bush encroachment by acacias (*Acacia giraffae, A. maras, A. uncinata, A. detinens*) and *Dichrostachys glomerata* in response to fire and cattle grazing in South West Africa (Namibia). He also records the dispersal of viable *Acacia giraffae* seeds in the dung of elephant (78% germinable) and cattle (52% germinable).

142 WARD, J.D.; BREEN, C.M. **Drought stress and the demise of *Acacia albida* along the Lower Kuiseb River Central Namib Desert South West Africa preliminary findings** *South African Journal of Science* (1983) 79 (11) 444-447 [En]

The xylem pressure potential in non-flowering shoots of *Acacia albida* and *A. erioloba* in the Kuiseb River valley, Namibia, was measured over full day periods in July and January. Maximum plant water deficit was recorded for both species in mid summer (January). Water potential values were generally higher in winter (July). The retention of leaves by both species during the winter of 1976 suggested that the trees had access to water at that time. The lowering of the Kuiseb water table by water abstraction for industrial purposes apparently lead to the death of large numbers of large *A.albida* in the river bed, not did not affect the more drought tolerant *A. erioloba*. Younger trees of both species were thought to be able to track the falling water table better than large trees that had established when the water table was higher.

143 WATT, J.M. **Magic and trees** *Trees in South Africa* (1956) vol.13, no.1 3-15 [En, 18 refs.]

Gives traditional uses for a number of species. *Acacia giraffae* roots are used to make flutes, the pods are a valuable fodder but at times have caused fatalities through the development of hydrocyanic acid. Among the Thlaping the tree is reserved for the use of the Chief and other prominent people. It is thought also that a person taking refuge in one of these trees during war time will be protected from his enemies. The tree is also thought to attract lightning and the tribal doctor mixes charred portions of the wood from such a tree with goat's fat to make a protective charm when public affairs are attended to.

144 WELLS, M.J.; BALSINHAS, A.A; JOFFE, A.; ENGELBRECHT,V.M.; HARDING, G.; STIRTON, C.H. **A catalogue of problem plants in Southern Africa** *Memoirs of the Botanical Survey of South Africa* (1986) No. 53. 39 [En, af]

Information listed on 1653 taxa, including 711 naturalised exotics, which have been shown to be weedy in certain situations in southern Africa. 45 *Acacia* taxa (mostly indigenous) are described, including *A. erioloba* E. Mey. (= *A. giraffae* Burch.). It is included in the National Weed List having the undesirable characteristics of being competitive (for space, light, nutriment), replacing preferred vegetation (grass), poisonous (sometimes), thorny (plant), and obstructive (access). It is cultivated as a ornamental crop and is the subject of herbicide registration.

145 WEST, O. **Indigenous tree crops for Southern Rhodesia** *Rhod. Agric. J.* (1950) 47 (3) 204-17 + 5 plates [En, 11 refs.]

Describes *Dichrostachys glomerata*, *Piliostigma thonningii* and 5 species of *Acacia*, all producers of large crops of edible pods suitable for fodder, and presents notes on their characteristics and distribution, and data on the chemical composition and feed value of the pods. It is thought that the larger trees, such as *Acacia albida*, *A. giraffae* and *A. woodii* could be grown on perennial grassland at 4-8 trees/acre, and the smaller trees at 10-20/acre, without damage to the grass yield. At a conservative estimate of one crop every 2 years, the average annual yield of pods would be 1,000-2,000 lb./acre for the large trees, and 250-500 lb./acre for the smaller trees. They should be grown in the habitats to which they are naturally adapted, e.g. *A. albida* on deep alluvial flood-plains in the low veld, *A. giraffae* on deep alluvium and sand in the Gush areas, *A. woodii* on granite sands and other soil types under a fairly high rainfall, *A. litakunensis* on fairly deep soils in valley bottoms in the dry, low veld, *A. subalata* and *P. thonningii* on red soils in medium-rainfall areas, and *D. glomerata* in comparatively frost-free localities in the medium- and low-rainfall areas. Stocking may often be easily effected by selective clearings and thinning of too dense bush. All the species produce good seed which may be planted in situ after notching or abrasion, or else germinated in small compost pots which are afterwards planted entire. [Cf. For. Abstr. 12 (No. 1876).]

146 WEST, O. **Progress report of the standing sub-committee on bush control** [Paper] 9th Meeting, South African Regional Conference on the Conservation and Utilisation of Soil, Salisbury 1964. pp. 15. From abstr. in *Weed Abstr.* 14 (3), (1964) 772 [En]

Describes the use of goats, the use of grass and chemical controls in controlling and preventing bush encroachment. In a 6-year trial in S.W. Africa, goats failed to reduce a stand of *Acacia* spp. But in Southern Rhodesia, goats were very effective against *Colophospermum mopane*, *Commiphora* spp., *Acacia* spp. and *Grewia* spp. at Tuli, and against several species, including *Acacia* spp., at Matopos, but were disappointing in veld composed of *Brachystegia* spp. and *Julbernardia* spp. at Battlefields and Makoholi. In S.W. Africa, on deep, sandy soil, after rain, grasses surrounding the boles of the trees and shrubs choked and killed *Acacia mellifera*, *A. giraffae* and *Dichrostachys cinerea*. In the case of *D. cinerea*, the larger bushes were the most susceptible to competition from grasses. In S. Rhodesia, As compounds proved the best herbicides tested, although 2,4,5-T gave effective control of several species. The butyl ester formulation of 2,4,5-T appeared more effective than other formulations tested. In trials made at the end of the rainy season near MacKinnon Road in Kenya, at locations where soil moisture was adequate, satisfactory control of brush was obtained with aerial applications of 2,4-D at 2 lb./acre or 2,4-D at 1 lb./acre or 2,4,5-T at 0.5 lb./acre.

147 WHITE, F. **Forest flora of Northern Rhodesia** Oxford University Press (1962) 76-85 [En]

Comprehensive account of the woody plants of Northern Rhodesia; gives brief description of each tree classified by family. *Acacia erioloba* is locally dominant or subdominant on transitional Kalahari sands in Namwala district and south Barotseland, but very rare in north Barotseland (Balovale district) in Zambia.

148 WILLIAMSON, B.R. **The condition and nutrition of elephant in Wankie National Park Rhodesia** *Arnoldia* (1975) 7 (12) 1-20 [En]

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