CARBON ISOTOPES CONFIRM THE COMPETITIVE ADVANTAGES OF *Prosopis* OVER *Acacia erioloba*

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The landscape of the Kalahari Desert is changing as the indigenous *Acacia erioloba* E.Mey. is being replaced by the invasive *Prosopis* spp. Although both species are phreatophytic, the disproportionately large taproot of *Prosopis* enables it to survive extreme moisture stress. $\delta^{13}C$ values were determined on annually resolved *Prosopis* and *Acacia erioloba* samples to investigate adaptation to changing edaphic conditions. The results confirm that the *Acacia erioloba* sample died during a period of water stress.

Acacia erioloba is extremely well adapted to surviving in arid and semi-arid environments. It is a 'keystone species' upon which a wide variety of plant and animals depend. However, it is being rapidly replaced by *Prosopis*; a species that was originally introduced to South Africa in the late-1880s. *Prosopis* has an extensive lateral root system to obtain water from the unsaturated zone and, depending upon moisture regimes, can develop a large taproot to access ground water.

Ten *Acacia erioloba* and ten *Prosopis* discs were obtained from a bushveld site close to Askham (27°1'S, 20°48'E) in the Northern Cape, South Africa. Precipitation data were obtained from the Police Station at Witdraai, 10 km from the site.

Although *Prosopis* has the potential to be cross-dated [1], asymmetrical growth precluded the establishment of a chronology for *Prosopis* or *Acacia erioloba*. However, marginal parenchyma bands enabled the rings of *Acacia erioloba* to be counted [2] and a high-resolution radiocarbon date (± 1 year) confirmed the *Prosopis* ring count. α-Cellulose was extracted from the annual rings and $\delta^{13}C$ values were determined using standard techniques.

The $\delta^{13}C$ values of *Prosopis* (1970-1999) and *Acacia erioloba* (1977-1994) for two samples typical of the site were determined (Fig. 1). The $\delta^{13}C$ results demonstrate that after a major precipitation event, *Prosopis* and *Acacia erioloba* experience a reduction in water stress. *Acacia erioloba* is almost entirely dependent upon ground water. As a juvenile tree it exhibits water stress (1978-79) as the taproot is extended to reach the water table. In the following relatively dry years, it starts to experience water stress until the major precipitation event in 1987-1988, which replenishes water reserves. The decrease in precipitation and increased extraction of water by *Prosopis* causes eventual death in 1994.

The *Prosopis* $\delta^{13}C$ values for the period after unusually high precipitation in the mid-1970s indicate that this relief from water stress is short-lived as amount of water in the unsaturated zone is reduced. The increase in water stress is more rapid than *Acacia erioloba* and suggests that *Prosopis* initially uses its lateral roots to extract water from the unsaturated zone until the water reserves are exhausted and it switches to the dormant taproot.

Prosopis is replacing *Acacia erioloba* in arid and semi-arid regions of South Africa. In areas where the limiting factor upon growth is water availability, *Prosopis* appears to maintain a competitive advantage by tracking changes in the level of the water table or extracting deeper ground water. *Acacia erioloba* cannot compete with the increased demand for water. Carbon isotopes confirm mortality of *Acacia erioloba* occurs in times of water stress.

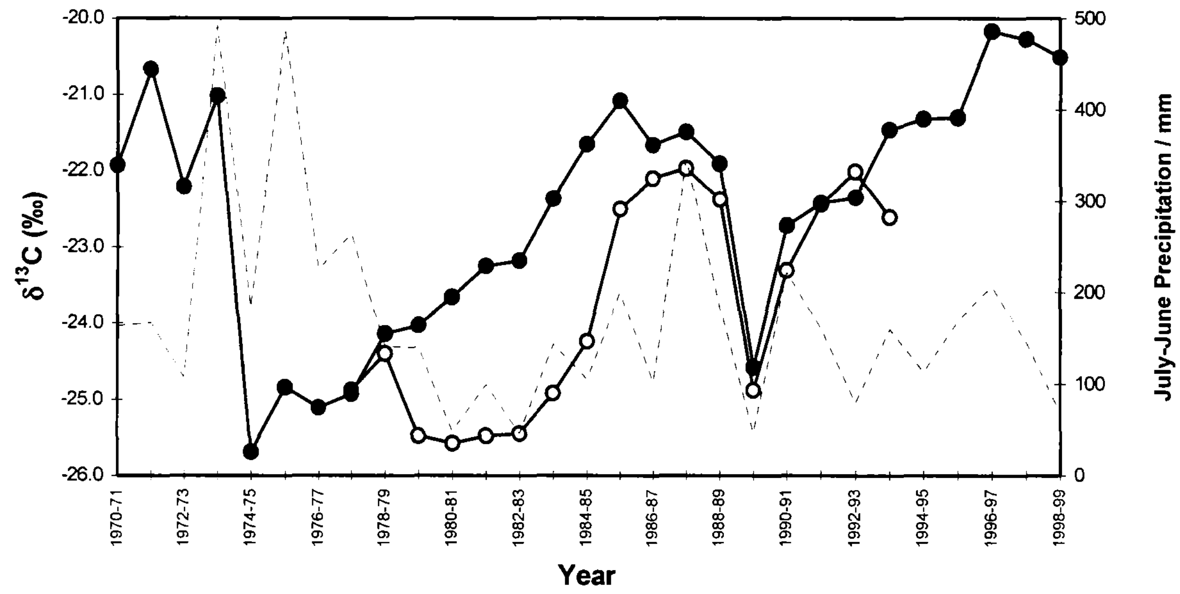

*FIG 1. $\delta^{13}C$ values of **Prosopis** (solid circles) and **Acacia erioloba** (open circles). Annual July-June rainfall is represented by the dotted line. A high resolution radiocarbon date (± 1 year) on the 1974-75 **Prosopis** sample confirmed the ring count.*

REFERENCES

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[2] GOURLAY, I.D., KANOWSKI, P.J., Marginal parenchyma bands and crystalliferous chains as indicators of age in African Acacia species, IAWA Bulletin **12**(2) (1991) 187-194.