SUMMARY

AGE DETERMINATION OF *ACACIA ERIOLOBA* IN THE
KALAHARI GEMSBOK NATIONAL PARK

by
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Trees are an integral component of African savannas. The function of savanna trees may however vary greatly with their population structure, density and distribution. The structure and function of arid and semi-arid savannas are largely governed by soil moisture, soil nutrients, fire and herbivory. To manage and sustainably utilize the trees in semi-arid regions an understanding of their population dynamics is needed. In this regard knowledge of their age and growth rates is essential.

Acacia erioloba plays a pivotal role as keystone species in this environment and is of special ecological importance. To manage the Kalahari Gemsbok National Park in a sustainable manner it is therefore of vital importance to study this important species.

Population structure of *Acacia erioloba* in the Kalahari Gemsbok National Park has been based on size-structure derived from size-class data i.e. stem circumference and height. In order to have a more complete understanding of the population dynamics and their sustained management accurate age-structure is needed. The aim of this study was therefore to develop age-size relationships for *Acacia erioloba* on the basis of ring-counts and carbon dating. Such relationships enable determination of the age-class distribution of the population and consequently the dating of successful regeneration events.

An effective non-destructive sampling method was developed and high quality cores were obtained. Cores were used to determine age by means of carbon dating and anatomical investigation. Seasonal growth changes were reflected in the wood anatomy as bands of marginal parenchyma on the polished surfaces of discs or cores. A strong relationship was found between ring count and estimated carbon age which enabled the determination of age and subsequent growth rates for *Acacia erioloba* in the Kalahari Gemsbok National Park. Age-size relationships for *Acacia erioloba* on the basis of ring-counts and carbon dating lead to the analysis of age-structure for the population of *Acacia erioloba* in the interior dune area and the northern Nossob Riverbed.

Successive above-average rainfall and the occurrence of sporadic flooding play a major role in the dynamics of the vegetation. Floods are rare but they are important in that they sustain the relatively low watertable, lead to tree seed accumulations and favourable conditions for germination and establishment.

OPSOMMING

OUDERDOMSBEPALING VAN *ACACIA ERIOLOBA* IN DIE KALAHARI GEMSBOK NASIONALE PARK

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Bome is 'n integrale komponent van Afrika savannas. Die rol wat bome in savannas speel, verskil grootliks as gevolg van die populasie struktuur, digtheid en verspreiding van die bome. Die struktuur en funksie van ariede en semi-ariede savannas word grootliks bepaal deur die beskikbaarheid van grondvog, die beskikbaarheid van voedingstowwe, vure en beweiding. Ten einde bome in ariede en semi-ariede streke volhoubaar te bestuur, is dit nodig om die populasie dinamika daarvan te verstaan. In die verband is kennis rakende die ouderdom en groeitempo van die bome noodsaaklik.

Acacia erioloba speel 'n sleutelrol in die savanna omgewing en is van besondere ekologiese belang. Ten einde die Kalahari Gemsbok Nasionale Park op 'n volhoubare wyse te bestuur is dit gevolglik noodsaaklik om hierdie belangrike spesie te bestudeer.

Die populasie struktuur van *Acacia erioloba* in die Kalahari Gemsbok Nasionale Park is tot dusver beskryf in terme van die grootte van die bome en afgelei van grootte-klas data, dit wil sê stamomtrek en hoogte. Ten einde 'n vollediger begrip van die populasie dinamika en die volhoubare bestuur daarvan te verkry, is dit noodsaaklik om betroubare data rakende die ouderdom van die bome te bekom. Die doel van hierdie navorsing was derhalwe om die ouderdomstruktuur van *Acacia erioloba* te bepaal gebaseer op die tel van jaarringe en koolstofdatering.

Hierdie verwantskap stel ons in staat om die ouderdomklas verspreiding van die populasie akkuraat vas te stel en gevolglik om die voorwaardes vir regenerasie te beskryf.

'n Effektiewe metode om eksemplare van 'n hoë gehalte vir ouderdomsbepaling te neem sonder om die bome permanent te beskadig, is ontwikkel. Ouderdomme is bepaal deur gebruik te maak van koolstofdatering en 'n anatomiese studie. Seisoenale veranderinge in die groei is gereflekteer in die houtanatomie as marginale parenchiem ringe op die oppervlak van gepoleerde skywe en boorsels. 'n Duidelike verband is gevind tussen die jaarringe en die koolstof gedateerde ouderdom wat dit moontlik gemaak het om die ouderdom en groeitempo van *Acacia erioloba* in die Kalahari Gemsbok Nasionale Park akkuraat te bepaal. Die bepaling van die ouderdomgrootte verwantskap van *Acacia erioloba* gebaseer op jaarringe en koolstofdatering het gelei tot die analise van die ouderdomstruktuur van die populasies in die binneveld en noordelike Nossob rivierbed.

Opeenvolgende bogemiddelde reënval en die voorkoms van sporadiese vloede speel 'n belangrike rol in die dinamika van die plantegroei. Vloede is skaars maar belangrik in die sin dat dit die relatiewe lae watertafel onderhou, lei tot saadakkumulasie en gunstige toestande vir ontkieming en vestiging.

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APPENDIX A

A non-destructive sampling method for dendrochronology in hardwood species

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ABSTRACT

Core sampling in indigenous hardwood species is not a common practise. A field method was developed to obtain a large enough sample without permanently damaging the trees. A Milwaukee Dymo 2,3 kW electric drill fitted with a 2-speed gearbox and powered by a generator was used. A core drill bit (100 mm x 350 mm) fitted with tungsten tips was designed to fit the electric drill. Core samples of mature trees of unknown age were collected according to height and diameter classes in the Kalahari Gemsbok National Park. This non-destructive method was found to be suitable for collecting large core samples of hardwood species.

INTRODUCTION

Acacia erioloba is classified as a keystone species in the Kalahari (Dean and Milton, 1995). A keystone species being defined as one upon which a diversity of other plant and animal species depend.

In a study to determine the population structure of *Acacia erioloba* in the Kalahari Gemsbok National Park it became essential to determine the exact age of the trees. For dendrochronological studies as well as carbon dating, large samples are needed that include all growth-rings from pith to cambium. However, because of the importance of individual trees in this semi-arid region a non-destructive method of sampling had to be developed.

EARLIER ATTEMPTS AT CORE SAMPLING AND RELATED PROBLEMS

Generations of foresters used the increment borer developed by the German forester, Pressler, to obtain samples from living trees, mainly to determine age and to study growth rates at different ages (Sulc, 1967). The Pressler borer, however, was designed to be used on softwoods and the core obtained is too small for a detailed study of wood characteristics. The process is also rather slow and the position of the pith difficult to locate (Echols and Mergen, 1955; Brown, 1958; Sulc, 1967).

Early attempts at mechanization of large increment borers were only partially successful. All of these power sources were rather massive and, therefore, difficult to transport (Stonecypher and Cech, 1960; Nicholls and Santer, 1961; Forest Biology Subcommittee 1963; Echols, 1969).

Furthermore both the electric drills and the gasoline engines turned the borers too fast and caused "burning" of the cutting edges. Moreover the electric drills and the gasoline engines used, were usually not reversible and could not be used to turn the increment borers out of trees (Echols, 1969). The diameter of the cores obtained by this method was small and subject to degradation by temperature and compression due to increasing frictional forces (Nicholls and Santer, 1961; Sulc, 1967).

Johansen (1987) describes a power system used on pine trees which is much more portable, comfortable and produces smooth cores. Unfortunately it has not been used to extract cores from hardwood species.

Many manufacturers of increment borers do not recommend using borers with electric drills, since the borer may break due to the high friction and torque (Lussier, pers. com. 1998).

REQUIREMENTS FOR CORE SAMPLING

The wood of *A. erioloba* is dense and very hard and can therefore not be sampled with conventional hand-driven increment corers (Gourlay; 1995). According to Kromhout (1975) the density of *Acacia erioloba* is 1,07 g/cm^3.

In studies carried out on African *Acacia* species it was not unusual for the tempered steel borer to break due to excessive torque (Gourlay 1995). The researcher may, therefore, miss or fail to reach the pith in some cases. In such cases the length of missing core and number of missing growth-rings has to be estimated.

Small-diameter samples pose a difficulty in obtaining material from the pith and adjacent growth-rings, which are essential for carbon dating. Because of the frequent eccentricity of the pith it is necessary to use a drill bit with a large diameter.

Taking the requirements for increment borers suggested by Echols (1969) into account and noting the problems experienced by earlier researchers a drill bit was then designed to fit a commercially available electric drill.

MATERIALS AND METHOD

The method adopted may be of interest to other researchers and is therefore described in some detail.

In the present study a Milwaukee Dymo 2,3 kW electric drill was fitted with a 2-speed gearbox and powered by a generator.

A core drill bit, fitted with tungsten tips, was designed to fit the electric drill. The drill bit used was 100 mm in diameter and 350 mm long. The tungsten tips were attached to the outside of the cylinder to ensure that the core could be removed easily (Figure 2).

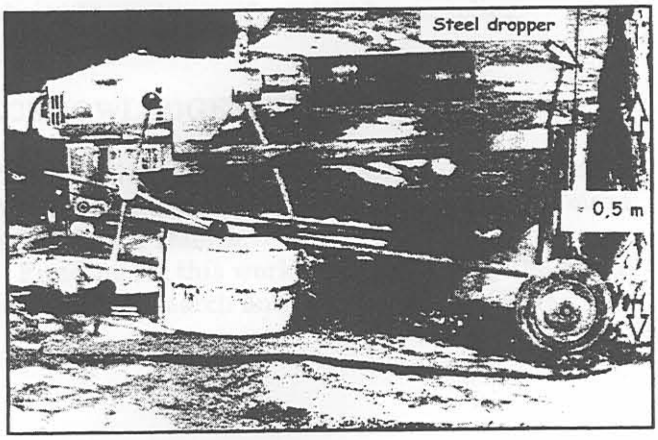

FIGURE 1. Equipment used in sampling Acacia erioloba.

The electric drill was fitted on a lightweight pipe stand with wheels for easy mobility and was powered by a portable generator. Conventionally this drill is used for extracting cores for soil sampling , and drills in a vertical position. The stand was set up in a horizontal position and secured in position by steel droppers (Figure 1).

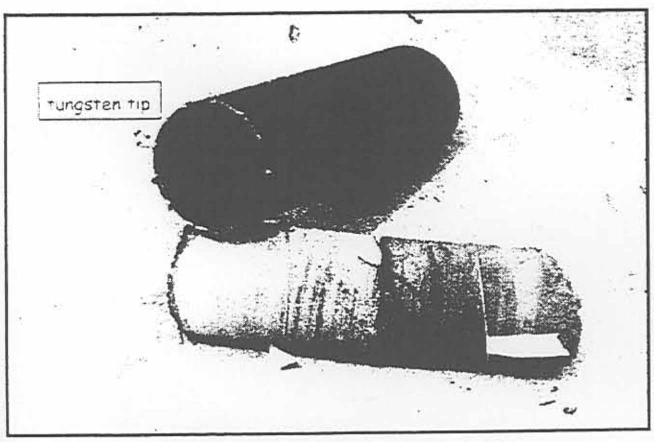

FIGURE 2. Customised drill bit and core sample.

Samples of mature trees of unknown age were collected according to height and diameter classes in both the Nossob River and duneveld areas of the Kalahari Gemsbok National Park. Samples were collected at a height of .0,5 m above the ground (Figure 2) .

Once revolving, the bit was slowly driven into the tree by simply applying pressure to the handle. The drill bit was water cooled while drilling at a low speed, 450 rpm, to prevent burning and compression of the core.

The bit was frequently reversed out of the tree by hand, using the handle which regulates the depth of the drill. Because of this feature it was possible to remove bark and sawdust that tended to clog the drill bit.

The increment borer could easily be driven completely through a tree in cases where the shank was longer than the tree diameter, thereby extracting a core from bark to bark. Trees with a stem diameter of more than 350 mm were carefully measured and then drilled from both sides of the trunk.

The holes that remained after sampling were plugged with wooden dowels to lessen insect and fungal attack.

The time required for the operation varied according to tree size, but on average was in the order of one hour for a core of 100 x 350 mm.

RESULTS AND DISCUSSION

The quality of the cores taken by making use of the described method, was excellent. Samples were large enough to include both the pith and adjacent growth-rings. Samples were smooth, not burned and outer rings did not "corkscrew" (Figure 3).

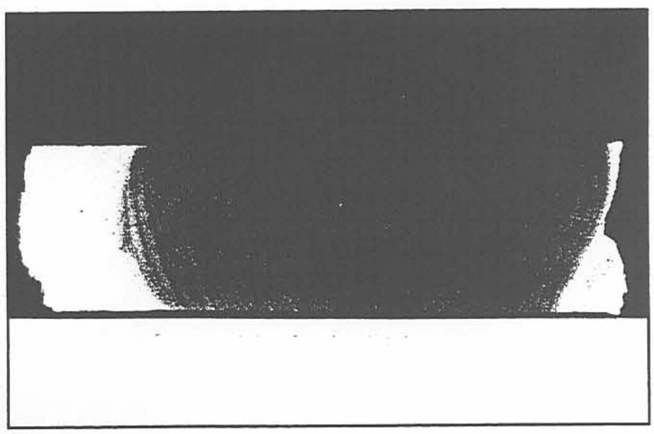

FIGURE 3. Core sample

Trees with a large diameter had to be carefull measured and then drilled from both sides of the trunk. This was problematic and in future studie longer drill bits should be used in order to extrac cores from bark to bark in large trees. For trees wit a smaller circumference bits with a smaller diamete can be used.

The drill bit used in this research can be wate cooled and drills at a low speed therefore preventin burning and compression of the cores. The fact tha the bit could be reversed frequently also contribute to high quality samples.

CONCLUSION

The equipment used is a definite improvement over conventional, hand-turned borers and other described powered equipment and can readily be used where a large number of cores must be taken from hardwood species in a fairly accessible area.

Using this method of sampling enabled the researcher to obtain high quality material suitable for carbon dating and dendrochronological studies without permanently damaging the trees.

The equipment used in this research can also be adapted to suit specific needs for sampling.

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