THE ECOLOGY AND MANAGEMENT OF THE KAAPSEHOOP CYCAD (*ENCEPHALARTOS LAEVIFOLIUS* STAPF AND BURTT DAVY)

by

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Frontispiece 1

This is dedicated to my wife, Natalie, and my daughter, Tamaryn, for all the evenings they sacrificed to allow me the time I needed to complete this work, as well as giving me all their support, love and understanding.

Frontispiece 2

Frontispiece 3

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Although the acknowledgments listed below begin with those persons or institutions that contributed the most to this study, this is not to say that those listed at the end contributed the least. At the outset, therefore, I would like to say that all contributions were equally appreciated . I would also like to apologise if there are any omissions.

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ABSTRACT

The Kaapsehoop Cycad (*Encephalartos laevifolius* Stapf and Burtt Davy) has the international, national, and provincial status of "endangered" by virtue of a number of factors which threaten it with extinction. It occurs in only three disjunct populations in southern Africa, of which two are very small and have only adult plants. This situation suggested the need for specific action to ensure the conservation of the plant within its natural habitat. This study was initiated in an attempt to respond to this call for action. The aims of the study were set at gaining an understanding of the ecology of the cycad, establishing the exact nature and extent of the factors threatening it with extinction, and presenting management guidelines as to how the plant and its habitat may be managed to ensure their conservation.

Chapter One includes a background to the botanical significance of cycads in general, the reasons for the endangered status of *E. laevifolius* and a list of aims and objectives. The latter are briefly; to develop an understanding of the ecology of this cycad, determine the nature and extent of the threats which have placed it in the "endangered" category, and establish means of managing the plants and their habitat so as to mitigate these threats . The methodology followed to achieve the latter is presented in Chapter Two. The results achieved from work carried out by the author are presented In Chapter Three, and they are

then discussed in Chapter Four, together with those obtained from other researchers and experts in the field of cycad ecology and management. From this it becomes apparent that the major factor threatening the plants continued existence in nature, is its illegal removal by unscrupulous collectors. The use of fire as a management tool may cause the loss of sexually propagated off-spring if not based on ecological principals. This would be tragic as the percentage of fertile seed being produced at present is extremely low. Besides the latter two abiotic threats, there are two biotic threats which are also cause for concern. They are the rotting of the female cones and seed by a pathogenic infection, and the destruction of newly growing tissue by the caterpillars of the Leopard Moth. The insights gained from the study are drawn together as conclusions in Chapter Five. Where these indicate specific management measures or directions for further research, recommendations are made.

It must be emphasized that although this study has been used for the enhancement of the author's academic qualification, it is vitally important that the recommendations made be seriously reviewed by those responsible for the conservation of this cycad. If this study is simply put on the shelf after it has achieved its academic goal, the possibility of *E. laevifolius* becoming extinct is very real.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

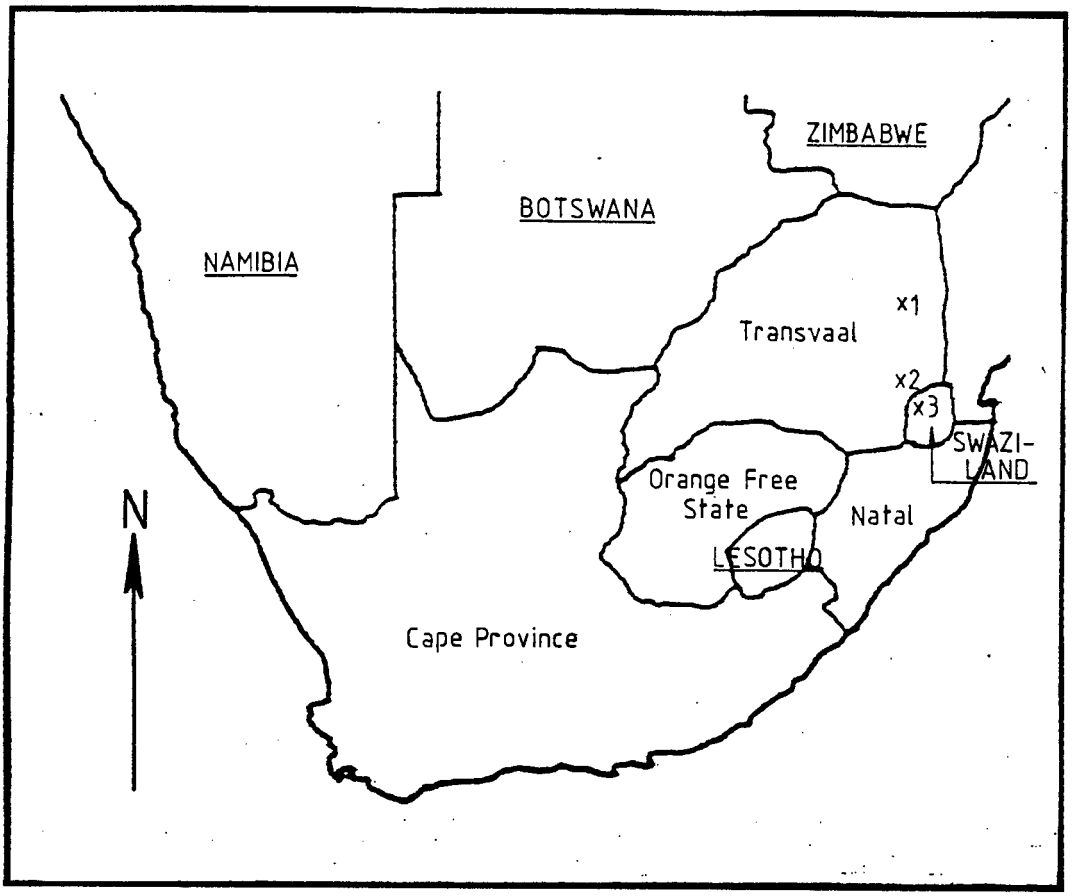
South Africa is host to two of the genera which belong to the order Cycadales, *Encephalartos* and *Stangeria*. These are a group of plants commonly known as cycads. The genus *Encephalartos* is one of eight genera in the family Zamiaceae and the monotypic genus *Stangeria* is of the family Stangeriaceae. *Encephalartos laevifolius* Stapf and Burtt Davy is one of the 32 species of this genus that occur in South Africa.

It is believed that cycads are the most primitive seed bearing plants known (Giddy, 1984). They apparently flourished during the Mesozoic period, from approximately 200 million years ago, and have changed little in their basic character. Giddy (1984) suggests that they could be described as the Coelacanths of the plant world. Sporne (1965) states that the Cycadales first appeared in the Upper Triassic times and are the only group out of all the Cycadopsida to have survived until the present day.

Although the South African cycads are restricted in distribution mainly to the eastern half of the country, they occur in a variety of habitats (Kluge, 1981). *Encephalartos ghellinckii* is found on the cool slopes of the Natal Drakensberg, *E. ferox* in the humid coastal forests of Zululand, and *E. lehmannii* in the dry and rocky areas of the Little Karoo (Giddy, 1984).

During initial investigations the author established that *Encephalartos laevifolius* has a very restricted distribution and is found in three disjunct populations in the mountains of the eastern Transvaal and Swaziland. The largest of these populations is found in the Kaapsehoop mountains to the west of Nelspruit, hence the common name, "The Kaapsehoop Cycad". This population is divided into three sub-populations with individual plants occurring at intervals between them. This would perhaps suggest that this population covered a larger area in the past (Kluge, pers comm.)

The other two populations are considerably smaller than the Kaapsehoop population and are found in the Mariepskop mountains above the Blydepoort dam, and in the mountains south of Piggs Peak on the Malolotja Nature Reserve in Swaziland. Figure 1 is a map which depicts the approximate localities of these three populations. It is unfortunate that the exact localities can not be divulged. The demand placed on these plants by unscrupulous collectors necessitates a degree of secrecy in this regard.



LEGEND: x1 - The Mariepskop population

x2 - The Kaapsehoop population

x3 - The Swaziland Population

Figure 1. A map of Southern Africa depicting the approximate localities of the *E. laevifolius* populations in the Transvaal and Swaziland.

The size of the *E. laevifolius* populations is rapidly diminishing, hence the international, national, and provincial conservation status "endangered" (Hall, *et al*, 1980; Gilbert, 1984). Gilbert (1984) states that many cycad habitats have been converted to human use, so that the distribution of many populations is now limited to small isolated areas such as mountainsides and gorges, rocky terrain, dense jungle or arid savannas - land that cannot be cultivated or is otherwise inhospitable to humans. This is definitely the case with most of the South African cycads.

At the risk of being philosophical, it is necessary to enlarge on the significance of the status into which *E. laevifolius* has been categorized. The public, who are generally uninformed with regard to biological and ecological matters, have recently been made aware of, and are responding to the plight of the black rhino. Large companies are donating massive sums of money to "save the rhino", and there are probably few South Africans that have not made their own personal donations. All this is very laudable, but the lack of awareness as to the plight of threatened plants, and in particular, cycads, is disheartening.

The role that plants play in any ecosystem is extremely important, and although many involved in the conservation of endangered mammals may energetically debate the issue, it is

probably more important than that of the mammals. However, the real issue is that money, time and energy is being concentrated on a few obviously important species, whereas others such as *E. laevifolius*, which is far more endangered, are not receiving the attention they should. Raven *ex* Thomas (1987) recalls a remark by Aldo Leopold, "the first rule in intelligent tinkering is to save all the cogs and wheels. If we ignore the individual importance of a species, we may consider it dispensable and ignore it to act on demands of the moment. We could lose the cogs and wheels which might prove to be of greater importance to our descendants.".

Hall, *et al* (1980) define the term "endangered", according to the standards of the International Union for the Conservation of Nature and Natural Resources (I.U.C.N.), as follows: "In immediate danger of extinction if the causal factors continue operating. Included are taxa whose populations are so critically reduced, that a breeding collapse due to a lack of genetic diversity becomes possible, whether or not they are threatened by human activity.".

A census of the *E. laevifolius* populations revealed that they are alarmingly small and disjunct (see Table 1 and section 3.1.). Solbrig (1980) states, "to avoid extinction, populations must maintain the ability to generate new genetic combinations or otherwise they must be able to migrate and successfully establish

in a new territory.". It is essential that those involved in the conservation of endangered plants and small populations, be aware of this and manage to mitigate the genetical implications.

Disjunct populations are genetically isolated and their evolutionary future is dependent on the size of their gene pool (Roberts, 1976). If it should happen that none of the individuals, in a small population, which carry a particular gene, reproduce successfully, it could lead to a total loss of that gene. This is known as genetic drift and it will generally increase in significance as the population size decreases (Roberts, 1976). Wilcox and Murphy (1985) state that habitat fragmentation negatively affects population survival and thus biological diversity, and therefore, should be a prime consideration in conservation strategy. This reflects Frankel (1970), who discusses the importance of genetic variation for the adaptability and long-term stability of ecosystems.

The above perhaps suggests the need for habitat conservation as opposed to species conservation. Although this is debatable, both have their merits. On discussing this issue, Thompson (1975) states that individuals introduce the genetic variability on which depends the communities resilience to changing circumstances and to natural or man-imposed hazards of their

environment. He continues to say that this genetic heterogeneity represents a resource that is of vital significance in the maintenance of natural communities.

A final thought on the genetic implications of small populations of endangered species; the amount and distribution of genetic diversity has important implications for species conservation (Ledig, 1987). This is in species of both high levels of diversity as well as genetically depauperate species. An inbreeding depression in the former could be a major problem if the populations are drastically reduced in size. Although the latter can be managed in small populations, they are at greater risk. New stresses, such as insects or disease pests or environmental pollution can quickly decimate genetically uniform populations (Ledig, 1987). The actual genetic status of the *E. laevifolius* populations is not known, but they all face the stresses mentioned here.

Although the present populations of *E. laevifolius* are relatively safe with regard to habitat destruction through activities such as agriculture and forestry, there are other threats which exist. Habitat mismanagement in terms of the injudicious use of fire as a management tool could be detrimental to successful sexual propagation. An annual or bi-annual burning frequency can destroy seedlings before they have a chance to establish themselves sufficiently to survive fire. Cycads have become

status symbols and according to South Africa's cycad artist Douglas Goode, they could be referred to as the "rhino's horn" of the plant kingdom (Potgieter and Cresswell, 1989). *Encephalartos laevifolius* is no exception and there is abundant evidence of the poaching of this species.

In addition to the above there are two problem organisms which are thought to be influencing *E. laevifolius* populations (Kluge, 1981; Giddy, 1984). One is an, as yet, unidentified pathogen which causes the rotting of the female cone and seed. The second is the Leopard Moth (*Zeronopsis leopardina)* which lays its eggs on actively growing tissue which is soft enough for the hatching caterpillars to feed on. Entire whorls of new foliage may be consumed by these caterpillars.

It is not certain whether the pathogen is an old or new occurrence (Oosthuizen, pers. comm.; Giddy, pers. comm.; Kluge, pers. comm.), but the Leopard Moth is definitely alien to the Transvaal cycads. Giddy (1984) states that the natural distribution of the moth is from the eastern Cape coast to the Natal coast and as far inland as Eshowe. It may be presumed that the moth's distribution has been spread by the injudicious introduction of Natal and eastern Cape cycads into the Transvaal by collectors (Giddy, pers. comm.).

The Forestry Branch of the Department of Environment Affairs has been responsible for the conservation of *E. laevifolius* in their Starvation Creek Nature Reserve on the Berlin State Forest. The reserve was declared as such in 1962 and the plants have continued to flourish since then. A number of people have done surveys in the reserve on the influence of the management of the plants. Gilliland (1967), Jacobsen (1973) and Oosthuizen (1978) all indicate that the present management on the reserve is having good results. They do, however, express concern at the evidence of damage caused by the two organisms discussed above and suggest further research in this direction.

Kluge (1975; 1976) makes a number of suggestions of research directions with regard to *E. laevifolius* and they are as follows:

i) determine the requirements and growth characteristics of the plants to ensure the implementation of a sound management plan;

ii) determine the habitat requirements so that threatened plants may be relocated into their correct habitat;

iii) determine the growth tempo and sexual viability of the plants and

iv) determine the feasibility of growing seedlings for re-

establishment into their natural habitat.

He also mentions that the population in the Starvation Creek Nature Reserve looks healthy and is flourishing, but expresses concern with regard to the apparent fungal infection of the female cones (Kluge, 1981). He goes on to state that it is not known if this is a new or old occurrence, but that further research in this direction is necessary.

A project to investigate the population dynamics of *E. laevifolius* in the above mentioned reserve was initiated in the early 1980's and was registered with the South African Forest Research Institute (S.A.F.R.I.). The official responsible for the carrying out of this project resigned shortly after it was registered and no further work has been done on this cycad until the initiation of this study.

A preliminary review of the project mentioned above revealed that an investigation into the population dynamics of *E. laevifolius* would require at least thirty years of regular monitoring and research. This is because of the tremendously slow growth rate of these plants. Plants with stems of between three to four meters in length are said to be up to five hundred years old. It was felt that it would, therefore, be impractical to continue with the project as it was originally envisaged.

Considering the above, the conservation status of the plant and all the suggested avenues of research, it was deemed necessary to initiate a new project. One which would investigate the pertinent avenues of suggested research and provide a document that could be used to direct management decisions, so as to enhance the conservation of *E. laevifolius* and its habitat.

To ensure that this document would be a working document (i.e. as suggested above) it was necessary to avoid a purely botanical or biogeographical study, but to concentrate on those aspects relevant to the management of the plants and their habitat. In order to achieve this, the study was set to investigate those aspects of the plant's ecology that could be, or need to be, manipulated by management of some kind. This includes those aspects that may be directly threatening the plants continued existence in nature; for example, the Leopard Moth's caterpillars, the pathogenic infection of the female cones and the illegal removal of habitat plants.

Although Gilliland (1967), Jacobsen (1973), Oosthuizen (1978) and Kluge (1981) all express confidence in the present management being applied in the Starvation Creek Nature Reserve, there is a lack of an ecological basis to the management. The reserve is presently burnt on a tri-annual rotational basis any time from

November to February and there is no record of how this decision was made. Wilson (n.d.) states that the frequency and time of burn needs further study.

During preliminary discussions with officials responsible for the management of the above reserve it became evident that there is the potential for a conflict of interest, that is between the conservation of an endangered species and the protection of timber plantations. It so happens that the tri-annual burning regime that is presently being applied falls within Forestry's primary objective of fire protection. If this study should indicate that the regime be altered in any way, Forestry currently appears likely to accept it only if it falls within the limits set by their primary objective of fire protection.

This attitude is reflected in correspondence between the Regional Director of the Southern Transvaal Forest Region and the Director General of the Department of Water Affairs, Forestry and Environmental Conservation (known today as the Department of Environment Affairs). Harris (1981) states in this letter that special protection cannot be afforded to rare or even endangered species, if by doing so, thousands of hectares of plantation are endangered.

The aims of this study and thesis are, therefore, to gain an understanding of the ecology of *E. laevifolius*, establish the exact nature and extent of the threats which face the plant, and determine ways in which the plant and its habitat may be managed to ensure its continued existence in nature. In order to achieve these aims, the following objectives were set:

i) carry out a population census to determine the distribution and structure of each of the populations;

ii) establish basic habitat requirements;

iii) investigate interactions with specific organisms, i.e. both positive and negative interactions;

iv) determine the role which fire plays in the ecology of the cycad and how it may be used as a management tool taking both ecological and social considerations into account;

v) establish the seriousness of the threat of poaching and the effectiveness of the relevant legislation; and finally

vi) investigate the feasibility of the *ex situ* propagation of plants for re-establishment into their natural habitat and for the enhancement of existing populations.

Until recently, any work or surveys carried out on this plant have been restricted to the Starvation Creek population, possibly because it is the largest and most flourishing of the populations. A few exceptions do, however, exist. Voster (pers. comm.) surveyed the Mariepskop population in 1971 and made his findings available for use in this study. All of this work has, unfortunately, been superficial.

Generally there is very little published work which deals directly with the aspects investigated by this study. Osborne (1987) in his introduction to a bibliography on South African cycads, states that literature on cycad work is fairly thinly spread in a large number of books and journals - many of which may seem obscure and difficult to obtain. In addition to this only a limited number of the publications listed in this bibliography are relevant to this study, i.e. 23 out of 126. Osborne, *et al* (1988) state that, in a recent bibliography of cycad literature, only 103 out of a total of 1713 publications mention the genus, *Encephalartos*. They go on to say that although increasing attention is now being paid to various aspects of cycad research, in most cases this work is at a fairly preliminary stage, is yet unpublished, and many avenues need yet to be explored.

The problem of the lack of relevant publications is exacerbated by the limited number of plants in habitat, their restricted distribution, the large distances between populations, their relative inaccessibility and their extremely slow growth rate. It was, therefore, not possible to carry out any experiments that could have provided valuable data for the study. Unlike a study, for example, on the effect of different burning regimes on grassveld. Such a study over a period of about four years could provide fairly precise conclusions, whereas the four years spent on this study leave a number of specific avenues to be researched and findings that need to be verified by continued monitoring. The fact that the five different populations all experience a different management or no management at all has, however, provided valuable data on which the conclusions in this study have been based.

Now that the necessity of this study has been highlighted through the above discussion on the ecological importance of the cycad and the threats that face it, the methods followed in an attempt to achieve the aims and objectives are described.

CHAPTER 2

METHODS

2. METHODS

2.1. INTRODUCTION

Upon reviewing the avenues of suggested research together with the limited amount of published work on *E. laevifolius*, it was felt that this study should endeavour to achieve a basic understanding of the plants' ecology. In doing so, management principles could be determined against which present management could be compared and appropriate recommendations made. In addition, it was also necessary to investigate the specific aspects threatening the plants continued existence in its habitat. It would be most unfortunate if special effort ensured the application of ecologically based management, while nothing was being done to stop the illegal removal of habitat plants for example. Finally, the *ex situ* propagation of the plant for re-establishment into its habitat was also deemed necessary. That is to either enhance existing populations or to re-establish populations in areas where they occurred in the past.

The methods used to gather the information necessary to achieve the aims and objectives of this study will be discussed as per aspect of investigation. Generally they consisted of field observations and consultations with relevant specialists and officials. Where an observation in the field gave rise to a specific theory or hypothesis, it was tested or verified by

consulting with the relevant expert/s. On the other hand, theories or hypotheses expressed during consultations were tested, as far as possible, in the field.

2.2 POPULATION CENSUS

If any meaningful recommendations are to be made with regard to the management of *E. laevifolius* it is first necessary to determine the exact status of the cycad in its natural habitat. In other words a "stock taking" exercise is necessary to determine the population structure in terms of exact numbers, age class distribution and sex ratio. In order to achieve this, a thorough survey of each of the populations is essential and the locality of each population first needs to be determined.

2.2.1. POPULATION LOCALITIES

The Starvation Creek population was easily located as it is within the reserve of the same name, proclaimed specifically for the conservation of the cycads. The existence of the population in Compartment J on the Berlin State Forest became evident through consultations with the curator of the Lowveld Botanic Gardens, Mr. J. Kluge. He also assisted in the locating of the plots which he set out during his research on the Starvation Creek population (Kluge, 1981). The Belmont population was located by the Flora Section of the Transvaal Provincial

Administrations' Directorate of Nature and Environmental Conservation (T.P.A.N.E.C.). It was discovered during aerial surveys of the Kaapsehoop Mountains and the approximate position of the plants were marked on a 1:50 000 topographical map. This data was then made available for use in this study, courtesy of the T.P.A.N.E.C..

Fourie (1983) describes another population in "an isolated area on the Mariepskop Mountains and on an isolated peak in the Drakensberg Escarpment near the Olifants River Gorge area". Personal observations during an aerial survey of this area, courtesy of the South African Air Force (S.A.A.F.), confirmed the existence of this population. Its locality was then marked on a 1:50 000 map. The plants above the Olifants River Gorge were, unfortunately, not located during the same survey.

The existence of *E. laevifolius* in Swaziland is suggested by both Fourie (n.d.) and Giddy (1984). Donaldson (pers. comm.) indicated that plants may be found on the Malolotja Nature Reserve of the Swaziland Trust Commission. The Senior Warden of the reserve was approached in this regard and confirmed their existence. He also agreed to assist the author in the survey of the population. The survey was carried out on foot and all the known localities were visited.

2.2.2. POPULATION SURVEYS

Once the general localities of the populations were established, each was visited on foot. The surveys were first attempted either alone or with the assistance of one other person. This proved to be a waste of time and energy. The rugged terrain and associated vegetation is such that the plants were easily overlooked. The Flora Section of the T.P.A.N.E.C. were requested to assist in the survey of the four Transvaal populations and agreed to do so. Four officials from this institution assisted in this survey. Their familiarity with the plant enhanced the value of their assistance.

As the approximate location of each population was approached by the survey party, a line was formed perpendicular to the direction of movement. Each person was spaced at a distance of approximately fifty to one hundred meters depending on the topography and vegetation through which the line moved. It was important to maintain visual contact with the adjacent members of the survey line. Two of the people in the line were appointed as scribes and walked in positions two and four. When a member of the party found a plant the line would wait until the details of the plant were related to the closest scribe.

The above method was applied to all the populations except Starvation Creek. This population was surveyed from the air by helicopter by the flora section of the T.P.A.N.E.C. and by the use of two monitor plots, one on either side of the valley. The position of each plot was selected to encompass a concentration of plants in the hope that the survey results would reflect the age class distribution and occurrence of sexual propagation within the population as a whole. It is for this reason that no age classes have been recorded for the 500 plants listed against Starvation Creek in Table 1. However, the occurrence of adults, juveniles and seedlings is recorded for the entire population in Table 3 by virtue of the survey results from plots A and B. The findings from these two survey methods are discussed in section 4.1.(i).

Personal experience has shown that many plant distribution patterns are unreliable. Most distributions are determined from the localities recorded on herbarium specimens, which gives no guarantee that all possible localities have been surveyed. Contrary to this trend, the distribution of *E. laevifolius*, as recorded in this report, is accurate. Besides the fact that one soon develops a "search image" of the cycad, in other words, the ability to actually find the plants, the mature specimens are very obvious and hard to miss. It is possible, however, that the

small juveniles and seedlings were overlooked from time to time. Considering the method of survey as discussed above, it is safe to assume that this was the exception rather than the rule.

The following is a list and a brief discussion of the information that was recorded during the surveys:

i) Plant number

It is seldom that plants are found with single stems as cycads propagate vegetatively by basal suckers. Plants were encountered with up to twelve stems and the question arose as to whether each stem should be counted as an individual plant. In answering the question of whether asexual reproduction should be considered as a form of reproduction, Solbrig (1980) states that "where vegetatively produced plants are capable of independent life and, upon the death of the parent plant, propagate the maternal genes in time and space, this is a function of reproduction.". Therefore, each vegetatively produced stem was considered as a single individual. A multi-stemmed plant was recorded as a group of stems and each stem's details were recorded individually. The plant number was, therefore, recorded as follows: 1.1, 1.2, 1.3,..., 1.n, where n = the number of stems in the group. The next group to be found were recorded as follows: 2.1, 2.2, 2.3,...,

2.n., and so on. In this way, a clear indication is given as to the distribution of the plants within each population, i.e. a random, scattered or clumped distribution. Plate 1 illustrates this phenomenon.

The total number of plants was recorded to determine how the population was made up in terms of groups and individuals, and to assist in determining the sexual viability of the population.

ii) Sex

Cycads are dioecious, i.e. with sexes separate in separate cones on different trees and it is important to determine the sex ratio of the populations as this, in part, indicates their sexual viability. Sexual propagation is only possible if male and female plants produce cones simultaneously. In this way pollen should be available when the female cones are ready for pollination.

Plate 1. A plant with a number of mature root suckers where each sucker is classified as an individual plant.

Sexual viability is a debatable aspect of cycad ecology and demography and there are two trains of thought. Giddy (pers. comm.) suggests that it is generally accepted by botanists that a population of cycads needs at least twenty

individuals to be classed as being sexually viable. Kluge (pers. comm.), however, suggests that the tremendous life span of these plants could make a population of just two individuals of the opposite sex sexually viable. It would seem, therefore, that sexual viability is firstly influenced by the sex ratio of the population and is then enhanced by an increased number of individuals.

It is unfortunately not known what the ideal ratio is but Giddy (pers. comm.) has observed that there are generally more male than female plants within most of the different *Encephalartos* populations in South Africa. Work presently being carried out by a number of entomologists suggests that the ultimate factor in determining sexual viability is the presence of specific insects which fulfil the role of pollen vectors (Herthog, pers. comm.; Donaldson, pers. comms.; and Oberprieler, pers. comm.). This aspect is discussed in detail in sections 2.3. and 3.2., where the reasoning behind the suggestion that insects are the ultimate determining factor in sexual viability, should become clear.

Where plants were found without cones, every effort was made to find remains of old cones or seeds in the immediate vicinity. On occasions, past records provided the information on sex. This was especially true for those

plants which were previously marked by Kluge during his research in the Starvation Creek Nature Reserve. Where cone material was found in the vicinity of a multi-stemmed plant, or where only one or two of the stems carried cones, the relevant sex was recorded for all the stems. Stems which are propagated vegetatively are genetically identical (Solbrig, 1980).

Plates 2 and 3 depict the differences between the male and female cones. The major differences are in the size of the cones and the cone scales. The male cone is thinner and more elongated, and its scales are much thinner and are loose on the axis of the cone. The female cone is much thicker than the male, and the cone scales are tightly packed together on the axis, as well as being much bigger. Typically the male cones are 30 to 40cm long and 10cm in diameter, while the female cones are 20 to 30cm long and 12 to 15cm in diameter.

Plate 2. A plant bearing male cones.

Plate 3. A plant bearing female cones.

iii) The number of cones per plant.

This information was obtained simply by counting the number of cones per plant. It was recorded against the actual stem which carried the cones. In the case of multi-stemmed

plants it was often found that only one or two of the stems actually carried cones. The fact that the plants were carrying cones was more important than the actual number of cones, because cone number differs from plant to plant and from season to season. It is, therefore, to fickle a parameter to use to determine sex ratio, but to ensure that as much information as possible was gathered the cones were counted.

iv) Length of stem.

The length of each stem was measured in meters from the base of the stem to the edge of the crown. Stem length was used as opposed to height as the stems are often found to be growing along the ground or at an angle to the ground with only the crown turned upwards. This parameter was recorded for two reasons. Firstly to provide an idea of the age of mature plants, and secondly to facilitate follow-up surveys. Due to the tremendously slow growth rate of the cycads, stem length serves as a description of the individual plants and in this way will assist future monitoring operations. Although this is beyond the scope of this thesis it is, never the less, desirable to allow for continuity.

v) Age class.

The placing of each plant recorded into an age class is necessary to determine the age class distribution of each population and sub-population. Three age classes are identified by Fourie (1983) and are as follows:

a) Seedlings: those plants with one to six immature leaves protruding above the ground without a developed stem. (The leaflets of immature leaves have small serrations towards the distal end of the leaflet). These plants are estimated at being between one to five years of age.

b) Juveniles: those plants with a well developed leaf crown and a stem length of less than 0.3m. The leaflets lose the above mentioned serrations at this stage and the margin is entire. These plants are estimated to be between five and twenty years of age.

c) Adult: those plants which have reached sexual maturity, i.e. they have the ability to develop cones. These plants are greater than twenty years of age and may reach the age of three hundred and fifty years or more.

Together with the total number of plants, the age class distribution within a population provides a clear indication of the sexual viability of the individual populations. If seedlings and juveniles are present in the population, it may be seen as an indication that successful sexual propagation has occurred. However, the presence of only adult plants in a population places a question mark behind that specific populations sexual viability. The emphasis of the need for an indication of the occurrence of sexual propagation lead to the decision that root suckers resembling the seedling stage would not be recorded as being in a specific age class. The total number of these suckers was recorded in the comments column. The reason for this being that it is often difficult to establish the exact number of suckers when they occur in mass at the base of the parent plant, and that they fluctuate in number from year to year.

vi) Vigour

Although the vigour of the plants does not have any direct bearing on the population structure, it was recorded to reflect the number of senescing and/or senescent plants in each population. Vigour was recorded with one of the following symbols:

"+" referred to the plants in a good condition. The absence of leaves or the presence of senescing foliage were not signs of a lack of vigor. It was the firmness of the crown that indicates the vigour of such plants. It was necessary to use this parameter as cycads are deciduous and it would be incorrect to record a plant without leaves as being unhealthy. Any softness of the crown would indicate senescence.

"0" was used to indicate that the plant was probably senescing but there was a chance that it could recover.

"-" referred to those plants that were obviously senescent. A soft crown is indicative of this state.

In addition to the above any other observations that were made were recorded in a "comments" column. Examples of the observations recorded include the position of the plant in the land- scape, evidence of any biological or mechanical damage and evidence of the pathological infection of the female cones.

It was not possible to complete one hundred percent enumerations in all of the populations. The Starvation Creek population is too large, so two monitor plots were marked out within the reserve. They were specifically located so as to include as many plants as possible within an area large enough to be surveyed

thoroughly. (Examples of some of the surveys are included as Appendix A.) The plots were also located so as to correspond with two of the three plots set out by Kluge (1981) in an attempt to add to and utilize the data collected by him.

The fact that these plots were not randomly placed meant that no extrapolations can be made with regard to the number of plants in the entire Starvation Creek population. This is not considered important, as the aerial survey carried out by the T.P.A.N.E.C. has already given an indication of the total number of plants. What was considered as being important was the age class distribution and the sex ratio within the plots which could be related to the rest of the population. To this end the plots were situated to correspond with the clumped distribution pattern of the plants.

2.3. BASIC HABITAT REQUIREMENTS

The need to determine the basic habitat requirements of *E. laevifolius* developed from the following two objectives. Firstly so that areas of similar habitat may be identified for the possible re-establishment of plants propagated *ex situ*; and secondly, to provide data that may be used to explain abnormalities which may exist within the populations. Absence of recruitment through sexual propagation, for example, may be explained by deviations from the "ideal" habitat.

In order to determine the habitat requirements it was necessary to gather data on the environment of each of the populations. By comparing these data it is hoped that some conclusions may be reached as to which of the environmental components are common to all the populations. These would then be construed as being the ideal habitat requirements of the plant. Those components not common could be seen as being habitat exceptions within which the plants occur.

The following is a list of environmental components for which data were gathered. A brief description of how the data were gathered is also included.

i) Climate

Both rainfall and temperature data was requested from the various authorities closest to the populations. The data were requested from the S.A.A.F. base at Mariepskop and the Officer in Charge of the T.P.A.N.E.C.'s Blydepoort Nature Reserve, the Officer in Charge of the Berlin State Forest, and the Senior Warden of the Maloltja Nature Reserve for the Mariepskop, Kaapsehoop, and Swaziland populations respectively.

ii) Altitude

As mentioned in section 2.2.1., the localities of the plants within the populations were recorded as accurately as possible on 1:50 000 topographical maps. The altitude ranges were then read off these maps and this, therefore, provided the range within which each population is found. It is felt that this information is relatively accurate as the scale of these maps is small enough for reading the altitude.

iii) Geomorphology

The geomorphological characteristics such as slope, aspect, distance from drainage lines and exposure were all noted during the survey of the population structure. Aspect was subsequently checked with the localities on the topographical maps.

iv) Geology

The geology was noted in the field and checked against 1:250 000 Geological maps of the Transvaal.

v) Pedology

Soil pits were dug within the Mariepskop, Starvation Creek and Compartment J populations. These pits were inspected by a pedologist of the South African Forest Research Institute (S.A.F.R.I.). He also made suggestions with regard to the placing of the pits within each population. It was unfortunately not possible to carry out this operation in the Belmont and Swaziland populations because of their inaccessibility to the pedologist.

vi) The Chemical Composition of Foliage and Soil

Under the guidance of personnel at the Citrus and Sub-Tropical Fruit Research Institute (C.S.F.R.I.) in Nelspruit, foliage and soil samples were collected from each population for the analysis of their chemical composition.

Six samples of both soil and foliage were collected from each population. Samples were taken from a cross-section of ages within each population and suckers were given preference over parent plants because they are more actively growing. Sixty leaflets were collected per sample, i.e. per plant, from the inner whorl of leaves and

from the distal one third of the leaf. Firstly because this is the amount of foliage necessary for the analysis, and secondly, because the leaves in the inner whorl are the youngest and those at the distal one third represent the average size of the leaflets. Five leaflets were picked from each of twelve leaves to make up the required total of sixty. Each sample was then placed into a plastic bag, sealed and labelled with the following information; name of population, length of stem in meters, sex (if discernible), and whether the plant was a sucker or a single stem.

Soil samples were taken from below the crown of each of the plants from which the leaf samples were taken. Approximately two kilograms of soil from the "A" horizon was placed in a plastic bag, sealed and labeled with the same information as listed above. *Encephalartos laevifolius* has a relatively shallow root system which draws most of its nutrients from the "A" horizon.

Both the leaf and the soil samples were then given to the laboratory at the C.S.F.R.I. where the analyses were carried out. The results of the analyses were then compared to see if there were similarities or differences between the populations. The detailed results of the analyses are included as Appendix B.

vii) Veld Types

The locality of each population was checked against a map of Acock's Veld Types of South Africa.

2.4. ORGANISMS WITH WHICH *ENCEPHALARTOS LAEVIFOLIUS* HAS SPECIFIC INTERACTIONS

The organisms discussed in this section play a very significant role in either promoting or threatening the survival of the cycad in its habitat. The investigation is divided into two sections, namely those organisms having a positive interaction with the plant, and those having negative interactions.

2.4.1. ORGANISMS WITH POSITIVE INTERACTIONS.

i) Pollinators.

Giddy (1984) states that cycad pollen is wind dispersed and suggests that, because female cones in nature have a high percentage of fertile seed, wind pollination is very effective when it does occur. She also lists a number of factors which tend to support the wind pollination theory. However, the extremely low

percentage of fertile seed being produced within all the *E. laevifolius* populations indicates that the necessary pollen vector/s is possibly more complex than just wind. The question of the sexual viability of the populations as briefly discussed in section 2.2.2.(ii), may only be accurately answered once the role of the wind and/or insects has been thoroughly investigated.

Although some of the literature referred to merely alludes to the possible role of insects in cycad pollination (Newell, 1983; Stobart, 1989), there are others which provide more conclusive evidence in this regard (Norstog, *et al*, 1986; Tang, 1987; Osborne, *et al*, 1988; Norstog and Fawcett, 1989), albeit not in *Encephalartos*. This is, however, discussed in detail in section 3.4.1. below.

In order to investigate this aspect it was necessary to take special note of any cones encountered during field trips. Any insects which were found on or in the cones were placed in small containers filled with alcohol and were sent to the Department of Entomology at the University of Natal Pietermaritzburg. Here the insects were identified and the possible role they could play as pollen vectors was investigated by the entomologist.

It was subsequently established that research into this aspect was also being carried out at the Kirstenbosch Botanic Gardens. The entomologist responsible for this work requested, and was provided with, cone material in exchange for any information relevant to this study. For example, the identification of insects possibly responsible for pollination

All the populations were visited specifically to search for cones. Where mature cones were found they were removed and sent to Kirstenbosch. It was agreed that any fertile seed found in the cones be sent back for propagation in the Lowveld Botanic Gardens (L.B.G.) and for eventual re-establishment into the natural habitat. The localities of plants bearing immature cones were noted and these were then monitored regularly. Once the cones reached maturity they were also collected and sent to Kirstenbosch.

ii)Seed Distributors

It is clear from the literature that a number of birds and mammals are responsible for the distribution of cycad seed. Giddy (1984), Fourie (n.d.), Kluge (1981), and Tang(1988) all discuss the involvement of baboons, monkeys, squirrels, hyraxes and a variety of birds in

seed dispersal. Giddy (1984) lists the Crowned and Trumpeter Hornbills and the Blacknecked Parrot as being particularly prominent in this role. She continues in this discussion by bringing to the notice of the reader the overlapping of the distribution of these birds and that of the *Encephalartos* species along the eastern side of the country.

In order to establish which of these organisms are involved in the dispersal of *E. laevifolius* seed, careful note was made of any signs indicating their activities. Besides actual observations, spore and droppings were also used to indicate the presence of the organisms.

2.4.2. ORGANISMS WITH NEGATIVE INTERACTIONS.

The concern expressed by a number of authorities with regard to the biological damage caused by two specific organisms (i.e. the Leopard Moth and an apparent pathogen) has already been briefly discussed in Chapter One. In order to establish their occurrence throughout the populations, special note was made of any evidence of damage caused by them from the first census and with each subsequent field trip thereafter. Details of other work carried out in this regard is discussed briefly below.

i) The Leopard Moth (*Zeronopsis leopardina*)

The investigation into the leopard moth entailed special field trips to establish the extent of its distribution within the *E. laevifolius* population as a whole. The investigation then continued to establish ways of controlling this pest with the least impact on the plants and their habitat. Entomologists and representatives of chemical companies were approached for their input on this aspect.

ii) The Pathogenic Infection of the Female Cones

As with the black spotted moth it was first necessary to establish whether this problem occurred in all of the populations. Inspections of female cones and seed found during field trips fulfilled this requirement. Pathologists at the Citrus and Sub-Tropical Fruit Research Institute in Nelspruit (C.S.F.R.I.), the Plant Protection Research Institute in Pretoria (P.P.R.I.) and at the Kirstenbosch Botanic Gardens were approached with the request that they attempt to isolate and identify the responsible pathogen. It was then hoped that specific measures could be prescribed for its control.

No work had previously been done in this regard, so the investigation could not be specifically planned. It evolved as each institute attempted isolations and made suggestions. The path of the investigation is, therefore, revealed in the discussion of its findings in section 4.3.2.(ii). The method used by the pathologists at C.S.F.R.I. in their isolation attempt is discussed in this section as well. Otherwise the method used was simply to collect infected cones and deliver of the material to the respective institutes.

2.5.FIRE - ITS ROLE IN THE ECOLOGY OF THE CYCAD AND ITS USE AS A MANAGEMENT TOOL.

In Chapter One a comparison was made between this aspect of the study and a similar study in a pure grassland. The comparison was intended to demonstrate the difficulties facing any research of this nature involving an extremely slow growing endangered species, with three basically inaccessible disjunct populations. The application of a variety of burning regimes and the subsequent monitoring of the response was unfortunately not possible. Each population, however, has experienced a different burning regime which at least facilitates comparisons between populations.

No specific form of data was collected for comparison, but that already collected for the other aspects discussed above proved sufficient. It was, however, necessary to establish the fire history of each population. This information was acquired in the same manner as that of the climatic data discussed in section 2.3.1.

During the investigation it became evident that there exists a potential conflict of interests between land owners adjacent the populations of *E. laevifolius* and the use of fire based on sound ecological principles. The adjacent land owners are predominantly timber growers and their major objective in the use of fire is the protection of their plantations. The frequency and season of these burns are not ecologically based, but are dictated by the fire protection objective. Any ecologically based prescription, setting the frequency and season of burn outside of the limits set by this objective, would immediately result in the above mentioned conflict.

This aspect was investigated by presenting burning regime based on ecological principles to the plantation managers for their comment. Taking their reasoning into consideration all alternatives were considered in an attempt to reach a compromise that would suit both objectives.

2.6. THE ILLEGAL REMOVAL OF HABITAT PLANTS

2.6.1. THE MAGNITUDE OF THE PROBLEM WITH REGARD TO *E. LAEVIFOLIUS*.

Each field trip to any of the populations, irrespective of the reason, entailed a basic "stock taking". Through periodic visitation to the populations, a familiarity with individual plants developed. It was, therefore, possible to immediately determine if plants had been removed. Evidence of removal is usually very clear, i.e. foliage cut off with a sharp instrument and left on the ground in the vicinity of where the plant once grew. Recent excavations are also clearly evident. In addition, any previously collected data compared with the latest survey results indicated any missing plants. If the reason for the discrepancy was mortality, the remains of the stem should still have been present in the vicinity of the original location. If not, then the discrepancy was attributed to theft.

2.6.2. A CRITICAL REVIEW OF THE RELEVANT LEGISLATION

All relevant legislation was reviewed together with a number of publications dealing specifically with this subject. Officials responsible for the enforcement of

this legislation were interviewed to establish if they experienced any short comings and had any suggestions as to how it could be improved. Various other individuals involved in cycads were also approached for their views on this aspect.

2.7. POPULATION ENHANCEMENT AND RE-ESTABLISHMENT

As can be seen in the discussion on the Population Structure of *E. laevifolius* in section 3.1., there is reason to be concerned about the size of some of the populations, the lack of evidence of sexual propagation and the apparent shrinkage of the populations in general. It would be ideal if steps could be taken to reverse this situation, such as the enhancement of existing populations and the re-establishment of others. In order to achieve this , it was necessary to obtain information on methods of propagation and to identify areas into which plants may be re-established.

2.7.1. PROPAGATION METHODS

The method of propagation used depends on the part of the plant used in the propagation process. The alternative sources of material are seed, basal suckers and epicormic

and coppice shoots. The possibility of translocating mature stems also exists, as well as the use of tissue culture.

Although there are no publications dealing with the propagation of *E. laevifolius* specifically, there are a number which discuss the propagation of cycads in general.

The L.B.G. were approached with the request to assist in the investigation of this aspect. Seed and mature stems were subsequently provided for propagation in their "Endangered Flora Seed Orchard". The seed was collected in habitat from cones that were breaking up or had already broken up. On a number of occasions stems were found that had been dug up by poachers and had been left for some reason, probably because they were too heavy to be carried. Senescing stems which had broken off the main plant, but which still showed signs of not being completely rotten, were also encountered. In both cases the stems were taken to the L.B.G. for establishment in the seed orchard. The techniques used in the propagation of this material, and the success gained, are discussed in section 3.6.1.

Other organizations experienced in this aspect were also approached for their input. Mrs. Cynthia Giddy of Giddy's Cycad and Cactus Nursery near Pietermaritzburg in Natal; authoress of "Cycads of South Africa", was interviewed in this regard. Besides all the valuable information she imparted on this aspect, her views on others were also recorded for use in this thesis. The Officer in Charge of the T.P.A.N.E.C.'S Hartbeeshoek Nursery is highly experienced in the propagation of cycads in general, and he was also interviewed in this regard.

2.7.2. SITE SELECTION FOR THE ENHANCEMENT AND RE-ESTABLISHMENT OF POPULATIONS

Three sets of data assisted in this site selection, namely, the data on population structure, habitat requirements and old localities. The data on population structure indicated those populations in need of enhancement. The latter two sets combined to identify areas with the potential for re-establishment.

The feasibility of both operations depends on the stability of the area/s identified and the guarantee of absolute protection by the body or institution responsible for the fostering of the introduced plants. All potential

areas were screened with this in mind. It would be most unfortunate if plants that were carefully propagated and eventually translocated, were mismanaged or even stolen.

The aims and objectives as set out in Chapter One are relatively broad and all encompassing, and it is hopes that the methods discussed above manage to achieve these. The discussion that follows on the results, indicates their success in doing so.

CHAPTER 3

RESULTS

3. RESULTS

The complications faced during this study (see Chapter One) necessitated the utilization of a number of experts and authorities in the field of cycad ecology and management. It was, therefore necessary to make a distinction between the results obtained from work carried out by the author himself, and that of the specialists mentioned above. The author's results are presented briefly below, and are discussed in detail in the following chapter together with the relevant findings of others.

3.1. POPULATION CENSUS

Mention has already been made of where the various populations of *E. laevifolius* occur. This information is also illustrated in Fig. 1 in Chapter One. It is unfortunate that the exact localities cannot be divulged. The demand placed on these plants by unscrupulous collectors necessitates a degree of secrecy in this regard. The results of the population census are recorded in Table 1 below. (The three Kaapsehoop sub-populations are treated as separate populations.) During each survey every effort was made to locate and record each individual plant. (See the discussion on the accuracy of these observations in section 2.2.2..) There is no doubt as to the accuracy of the data recorded for the age classes. The age classification as set out in section 2.2.2.(v) was easily followed. The problem was to

determine the sex of each plant. At no time during the three years in which data were collected for this study, did any of the populations display a hundred percent coning. The search for old cones in the vicinity of the plants was also often fruitless. The data are, however, included in Table 1, although it is of limited value in this study. With the addition of subsequent survey results,however, a clearer picture could be compiled. (Recommendations in this regard are made in Chapter Five.)

Simply by looking at the figures in Table 1, one can see why *E. laevifolius* is categorized as being "endangered". Although there is little known about the numbers needed to constitute a flourishing population of cycads, it should be safe to assume that Starvation Creek is the only one that possibly fits this description. It is most disconcerting to see that the two populations at the distribution poles are the smallest, and that they have only adult plants.

3.2. BASIC HABITAT REQUIREMENTS

To fulfil the need for both simplicity and comparison of habitat components between populations, as much data have been tabulated as possible. Table 2 was compiled for this reason. Where the data were too much to fit into the table, they have been briefly described below. Comments directly applicable to the accuracy of the results have also been included below.

POPULATION	TOTAL No.	AGE CLASS DISTRIBUTION						SEX RATIO	
		A	%	J	%	S	%	M	F
Stv.Crk.	±500								
Stv.Crk.A	48	20	41,7	17	35,4	11	22,9	4	1
Stv.Crk.B	30	25	83,4	4	13,3	1	3,3	11	1
Belmont	166	151	91,0	1	0,6	14	8,4	10	13
Comp.J	116	67	57,8	17	14,7	32	27,5	8	16
Mariepskop	55	55	100	0	0	0	0	5	3
Swaziland	25	25	100	0	0	0	0	4	9

Table 1. The Population Structure of the *E. laevifolius* Populations in the Transvaal and Swaziland.

Legend: Age Class Distribution

A = Adults, J = Juveniles, S = Seedlings

HABITAT COMPONENT	POPULATION				
	Strv. Ck.	Belmont	Comp. J	Mrpskop.	Swzland
Rain(mm/yr.)	1144.37*	1144.37*	1144.37*	416.00#	1184.4*#
Max. Temp.	31.0°C*	31.0°C*	31.0°C*	26.41°C#	30.5°C*#
Min. Temp.	1.0°C*	1.0°C*	1.0°C*	0.28°C#	-5.0°C*#
Max. Alt.(m)	1500	1300	1350	1850	1100
Min. Alt.(m)	1200	1100	1300	1550	850
Slope	±30°	±30°	±30°	±30°	±30°
Aspect	N.NW.S.	W.NE.N.NW	SW.NW.N.	N.NW.W.	All
Dist. From Drnage Line	Variable	Variable	Variable	Variable	Variable
% Population Exposed	100%	70%	100%	100%	100%
Geology	Quartzite	Quartzite	Quartz.	Quartz.	Quartz.
Soil Type	Hutton	Hutton	Hutton	Hutton	Hutton
Soil pH	4.63	4.79	4.85	4.66	5.6
Veld Types**	8 & 9	9	8 & 9	8	9

Table 2. Habitat components per population of *E. laevifolius*.

* Average of twenty years measured at the Berlin Forest station.
\# Average of 1988/89 figures for Bourke's Luck, Steenveld and Swadini (T.P.A.N.E.C. Nature Reserves).
*# Average of five years measured at the Malolotja Nature Reserve in Swaziland
(The temperatures recorded above are the absolute max. and min. for the periods recorded above.)
** Veld type numbers according to Acocks (1975)

3.2.1. CLIMATE

The data gathered for rainfall and temperature are only of limited value. None of the populations has a weather station close enough to record their actual rainfall and temperatures. The data were provided by those institutions that were closest to the populations, but even these are relatively remote. For example the office at the Berlin State Forest where the weather data are recorded, is approximately 5km from the Compartment J population, 6km from Starvation Creek and 8 - 10km from Belmont. The station is set back on the plateau, whereas the majority of the plants in the Kaapsehoop populations are in the valleys below. The situation is complicated by the fact that there is variation in altitude and aspect within and between populations and, the micro-climate varies accordingly. The fact that the temperature and rainfall values obtained for Mariepskop are lower than those for Kaapsehoop and Swaziland illustrates this problem quite clearly. Mariepskop is actually in a high rainfall area as well as being in the mist belt. Figures were unfortunately, not obtainable from the S.A.A.F. base at Mariepskop, which would have been a good representation, but personal observations (military service at the base as a meteorological observer during

1979) indicate that the climate is similar to the other two areas. That is, a high rainfall during the summer with a dry winter, and extremes in temperatures during both summer and winter.

3.2.2. ALTITUDE

All the populations are found at relatively high altitudes with the Mariepskop population being the highest, at an average of 1700m, and Swaziland the lowest at an average of 1025m. The Kaapsehoop populations occur at a mean altitude of approximately 1300m.

3.2.3. GEOMORPHOLOGY

i) Predominant Slope

Table 2 indicate that the predominant slope angle on which the populations are found is around 30°. The situation may have been different in the recent past with a greater percentage of plants occurring on less steep slopes, and the plateau itself.

ii) Aspect

The aspects upon which plants occur are recorded per population in Table 2. Figure 2 below illustrates this data in such a way as to depict preferred aspects.

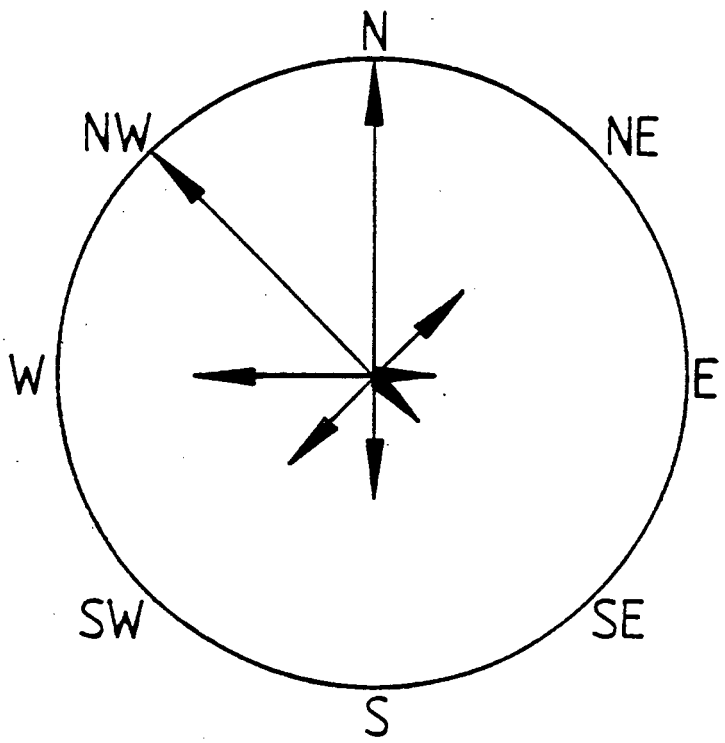


Figure 2. The number of populations within which an aspect was recorded.

In addition to the above, the data were statistically analyzed using the "Chi square" test. This test has been described as a "goodness-of-fit" technique, which permits one to determine whether or not a significant

difference exists between the observed number of cases falling in each category, and the expected number of cases, based on the a hypothesis (Runyon and Haber, 1980). In this instance, the null hypothesis is that cycads occur equally distributed on all aspects within each population. Using the data recorded in Table 2, a "Chi square" value of 11.375 was obtained, this is less than the critical tabled value at the 0.10 confidence level and is, therefore, insufficient to reject the null hypothesis. This means that it must be accepted that cycads occur on all aspects. Although data illustrated in Figure 2 nonetheless indicates a preference for the warmer northern, north western and western slopes.

iii) Distance from Drainage Line

Although no precise measurements were taken to determine the distance of plants from the drainage lines, the observations made during field work clearly indicated that this varied within and between populations. The only exception is the Belmont population within which the greater proportion of the plants are in the vicinity of drainage lines, with a

few scattered individuals further away. The observations made in the field clearly suggest a preference for well drained soils.

iv) Exposure

Virtually all the populations are confined to exposed sites, with the exception of that at Belmont. In this case approximately 30% of the plants in the population occur under the canopy of riparian forests.

3.2.4. GEOLOGY

The geology of each population has been tabulated as quartzite. It became apparent through field observations that this rock type is common to all, although there are variations in colour and texture (Visser, 1956; Geological Survey, 1986a and b).

3.2.5. SOILS

i) Soil Type

The strong similarity in the soils of each of the populations became very clear once soil pits were dug and were inspected. Colour, texture, percentage clay,

depth to parent material are all very similar, and each soil is classified according to the Macvicar, *et al* (1977) system as Hutton. Dôhne (pers. comm.) states that it is derived from quartzitic parent material and is very stony with approximately 40% soil. It is also very sandy with a clay content of approximately 8%. It is well drained and aerated, and is highly leached with a low nutrient status (dystrophic). There are, however, no mineral deficiencies and the depth is unlimited.

ii) Soil pH

The results of tests conducted to establish this parameter are also presented in Table 2. The pH values obtained from these tests indicate that the soil from each population is fairly acidic, which indicates that they are probably well drained and leached.

3.2.6. VELD TYPES

The populations are located in veld types which Acocks (1975) refer to as North Eastern Montane Sourveld (No. 8), and Lowveld Sourveld (No. 9). This was confirmed by the identification of plant species in the field which were

associated with the cycads. (Appendix A includes records of the associated vegetation in the field data forms used in the population census.)

3.3 ORGANISMS WITH WHICH *ENCEPHALARTOS LAEVIFOLIUS* HAS SPECIFIC INTERACTIONS

3.3.1. ORGANISMS WITH POSITIVE INTERACTIONS

i) Pollinators

Most of the work to investigate the apparent role of insects in the pollination of these plants has been and was carried out by experts in this field and is dealt with in the next chapter. However, results from the regular monitoring of cones during their development and after maturity indicate that insects are possibly essential for pollination to occur. Firstly, the pollen of *E. laevifolius* is relatively heavy and does not drift in the air like that of other Gymnosperms, such as the pines. It falls to the leaves and the ground below and is not carried by the wind. Secondly, the cone scales of the female cones never opened during the period they were being monitored. In addition to this, all female cones encountered during field work were found to be tightly

closed. Only those infected by the apparent pathogen (discussed in the following section), together with those that were already rotten, had loose cone scales.

ii) Seed Distributors

Observation made by the author during this study revealed what may be seen as important circumstantial evidence. Seen in the context of other published data and observations, and considering the dearth of such data and the difficulty of obtaining it, all such observations must be considered. The consequences of the activities of baboon, or the lack of, were observed on a number of occasions. Plate No. 4 is of the female cone of an *E. humilis* to which baboon have paid attention. This is one of a host of observations that indicated the possible role of baboon as seed distributors.

During the population census of the Swaziland plants, the consequences of the absence of baboon, as seed distributors, became apparent. Prior to the declaration of the Malolotja Nature Reserve, the local people hunted all the animals, including the baboon, extensively in the area (Boycott, pers. comm.). Consequently animal numbers declined dramatically. It is only until recently that they have begun to return. It was observed that a cone carrying fertile seed had been left on the plant until such time as it fell off of its own accord. The cone broke up at the base of the mother plant where the fertile seed began to germinate. Plate 5 illustrates this phenomenon. Although the detailed discussion on this aspect is to follow in the next chapter, it is necessary to state here that this is seen as being important, since had baboon been there to pick the ripe cone, the fertile seed would have been dispersed instead of concentrated at the base of the parent plant. A high seedling mortality was envisaged because of the seedlings having to compete with each other and their mother in such close proximity to one another.

Plate 4. The cone of an *E. humilis* plant to which baboon have paid attention.

Plate 5. Seed of *E. laevifolius* which was not distributed by baboon and is now germinating in close proximity to each other and their mother plant.

3.3.2. ORGANISMS WITH NEGATIVE INTERACTIONS.

i) The Leopard Moth *(Zeronopsis leopardina)*

Evidence for the presence of this organism was recorded in all of the populations. Most significant were the actual sightings of the moth itself within the Kaapsehoop populations. The moth, which has bright orange wings with black spots, hence its common and scientific names, can be seen in Plate 6. The moth lays her eggs on the actively growing tissue of the young leaves and, on occasions, young cones of the cycads. The caterpillars which hatch out in early spring and/or after rains, devour all tissue that is soft enough for their consumption. They can soon reduce an entire crown of leaves to mere stalks, as illustrated in Plate 7. Plate 8 is of a young cone of *E. laevifolius* which also fell victim to this destructive stage of the leopard moth life cycle. It was clear in this instance that the damage caused by the caterpillars resulted in the pathogenic infection of the cones. The purple discoloration of the cone scales is the symptom of this infection and can be clearly seen in this photograph. Although this aspect is to be discussed in the following section , it is

Plate 5. Seed of *E. laevifolius* which was not distributed by baboon and is now germinating in close proximity to each other and their mother plant.

necessary to mention here that these symptoms otherwise appear when the cones reach maturity. The cones in Plate 8 are approximately two to three months old, and *E. laevifolius* cones take approximately six months to mature. Such evidence was found in all the other populations and indicates that none of them are free of this pest.

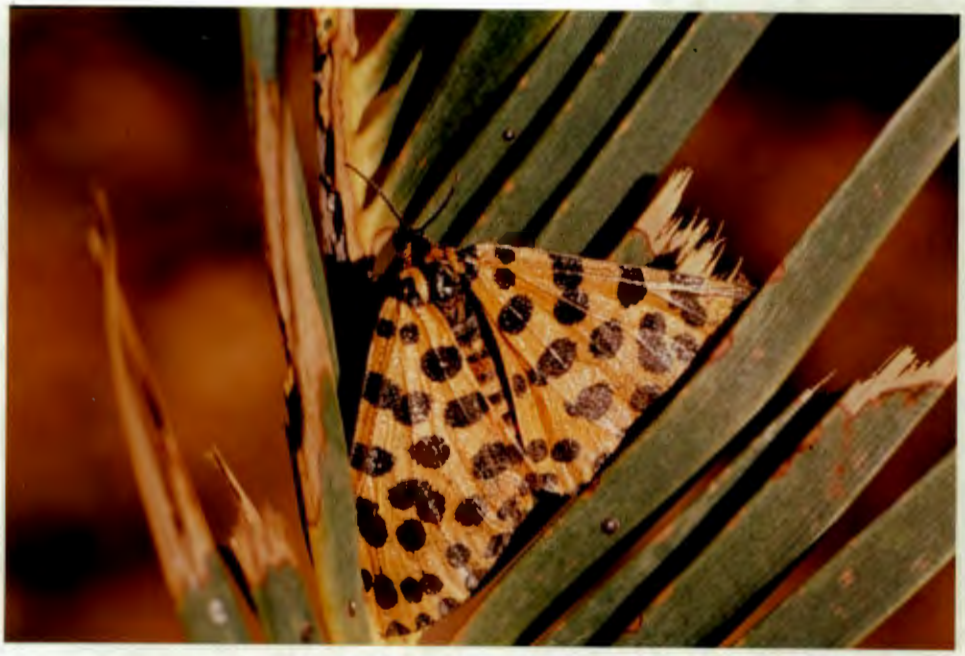


Plate 6. The Leopard Moth on the leaves of an *E. humilis*.

Plate 7. Damage to the leave of a juvenile *E. laevifolius* by the caterpillars of the leopard moth (*Zeronopsis leopardina*).

Plate 8. An immature cone of *E. humilis* being set upon by the caterpillars of the Leopard Moth.

ii) The Pathogenic Infection of the Female Cones

Being such a specialized aspect of the study, the inputs of the author were restricted to the monitoring of cones and the gathering of material for pathologists to work on. The monitoring revealed that the symptoms of this infection are as follows; once the cone reaches maturity, or full size, a purple discolouration sets in from the apex. This discolouration rapidly descends to cover the entire cone within a week. As it descends so the cone scales and seeds begin to shrivel and rot. The endosperm within the seeds attains a glassy appearance and then becomes pulpy before drying up and leaving the shriveled seed an empty shell. Plate 9 and 10 illustrate the appearance of the cone, its scales and the seed once it has become infected.

Plate 9. A comparison between a healthy and an infected cone scale and their seeds. All the symptoms described in the text are clearly visible in the one on the left in contrast to the healthy scale and seeds on the right.

Plate 10. A female cone of *E. laevifolius* which is completely infected by the pathogen, except for a few fertile seeds towards the base, hence the deformed appearance.

Although the significance is not yet known, it was established that fertile seed has a resistance to the infection. If left in the cone on the plant for a

prolonged period, it is possible that this too, will eventually become infected. Prior to this study, the limited work done on this aspect yielded no significant results. Unfortunately, that which was carried out during this study has also failed to produce anything conclusive.

3.4. THE ROLE OF FIRE IN THE ECOLOGY OF *ENCEPHALARTOS LAEVIFOLIUS* AND ITS USE AS A MANAGEMENT TOOL

Fire is undoubtedly one of the most important factors in the ecology of many South African veld types, and those in which *E. laevifolius* occurs are no exception. It must, therefore, be assumed that this cycad has adapted to periodic exposure to fire. The discussion that follows explores this adaption in an attempt to provide guidelines for the correct use of fire as a management tool.

3.4.1. THE ROLE OF FIRE IN THE ECOLOGY OF *E. LAEVIFOLIUS*

The most dramatic response of *E. laevifolius* to fire is the production of new foliage. Populations inspected soon after they had been burnt, revealed only blackened stems; to the untrained eye these stems would probably seem dead. However, follow-up surveys two to three months later, showed all the seemingly lifeless stems to be

carrying a full crown of vigorously growing foliage. Plate 11 depicts the blackened stem of one of these cycads approximately one month after the fire. The new foliage can be seen emerging at the centre of the crown. Further observations indicated that the cycads also produce new foliage independently of the influence of fire. The importance of the role of fire in the ecology of *E. laevifolius* is, therefore, problematic.

Plate 11. The blackened stem of an *E. laevifolius* approximately one month after a fire. The new foliage can be seen emerging at the center of the crown.

Another fire response noted is its stimulation of cone development. Although a number of authorities record substantial evidence to support this (Beaton, 1982; Giddy, pers. comm.), it was only clearly observed in one of the *E. laevifolius* populations. During the census of the Belmont population, which took place approximately three months after a fire, a large percentage of the plants were recorded with cones (see Appendix A). Other than this, no specific trend was noted.

It would have been ideal to have set up a number of experiments to investigate the response of the plants to fire, but this was not possible. Fortunately each of the populations has experienced a different burning regime, the details of which are recorded in Table 3. The sizes of the populations, as well as their age class distributions are also included in an attempt to give an indication of the vigour of the population. The discussion to follow in the next chapter enlarges on the possible correlation between the burning regimes and the population vigour.

POPULATION	BURNING REGIME		POPULATION VIGOUR	
	Frequency	Season	Population number	Age Class Distribution
Starvation Ck	3 yearly	late summer	±500	A,J&S
Belmont	2 yearly	late summer	166	A&S
Compartment J	No	burning	116	A,J&S
Mariepskop	1-10 yrs	variable	55	A
Swaziland	1 yearly	variable	25	A

Table 3. Burning regimes applied per population of *Encephalartos laevifolius*.

Legend: A = Adults, J = Juveniles, S = Seedlings.

3.4.2. THE USE OF FIRE AS A MANAGEMENT TOOL

Mention has already been made, in the previous two chapters, of the limitations placed on the above by the Fire Prohibition Period declared annually by the Minister of Environment Affairs, under the auspices of the Forest Act 1984 (see Appendix C). In addition, mention has also

been made of the conflict of interests which possibly exists between the use of fire as a tool to manage populations of endangered plants, and the protection of timber plantations from fire. In this sense the burning of the various *E. laevifolius* populations has, until this point in time , not being based on ecological considerations. Wilson (n.d.) suggested the tri-annual burn presently being applied in the Starvation Creek Nature Reserve, but there is no record of the reasoning behind this decision. The bi-annual burn applied in Belmont is based purely on fire protection principles (de Villiers, pers. comm.). The population in Compartment J has not been exposed to fire in approximately 50 years. The existence of a pine plantation in and around the population has been the reason for the complete lack of burning. The reason for the irregular burning of the Mariepskop population is unknown, but it can only be assumed that its relative inaccessibility is not conducive to management. The fact that the population occurs on two different properties further complicates the matter. Boycott (pers. comm.) stated that wild fires have crossed into Swaziland annually until 1983. Now that the area is a declared nature reserve, attempts are made to prevent this from happening and limit the burning to every second and third year.

After comparing the vigour of each population in respect to its burning regime, considering the role of fire in the ecology of *E. laevifolius*, and the basic principles propounded by authorities in this field, the "ideal" burning program was formulated. (The program and the reasoning behind its formulation are discussed in the following chapter.) It was then presented to the staff of the Berlin State forest who are responsible for the management of the Starvation Creek and Compartment J populations. They were questioned on the feasibility of its flexibility, the extension of the burning frequency to four or five years, and the carrying out of burns during the winter or early spring as opposed to the late summer burns presently being applied. The response was favourable and they indicated that all the proposals could be accommodated (Byle, pers. comm.). However, they also indicated that in order to ensure the safety of the adjacent plantations, it would be necessary to combine a safe season with a dangerous frequency and *visa versa*. Pohl (pers. comm.) stated that rotations of longer than three years allowed an excess build-up of fuel and that this constituted a dangerous situation, both for the plantations as well as the cycads. If the ecological considerations indicated that this was necessary, however, it could be accommodated by burning during mid-summer or

late summer. On the other hand, burning during early spring, that is when the risk of wild fires are at a peak, could be accommodated only if the rotation was short.

3.5. THE ILLEGAL REMOVAL OF HABITAT PLANTS

3.5.1. THE MAGNITUDE OF THE PROBLEM WITH REGARD TO *E. LAEVIFOLIUS*

Through regular visitation it was possible to gain a relatively clear idea of the above, with the exception of the Swaziland population which was only surveyed on one occasion. The observations made in this regard are briefly discussed below per population. The occurrence of a theft was recognised firstly by the disappearance of a well known individual, or one that was specifically tagged; and secondly, by the pile of dead leaves, which were clearly cut off with a sharp instrument, close to the hole where the plant once stood.

i) Kaapsehoop

a) Starvation Creek

Although only one theft was recorded during the course of this study, there is reason to believe that a large proportion of this population has been

removed in the recent past. The existence of adult plants in the gardens of the C.S.F.R.I., the office at the Berlin Forest Station, the Wayside Inn at Waterval Onder (±30km west of Berlin), and a number of private land owners in the vicinity is clear evidence of this. Table 2 indicates that the predominant slope on which these plants occur is 30°. The suspected inaccuracy of this observation is to be discussed in the following chapter, but it is possible that many more plants formerly occurred on the flat plateau areas, and it is these more accessible individuals that have suffered from poachers.

b) Belmont

This population is mostly concentrated at the bottom of a large basin and it takes approximately two hours walking to reach the first plants. It is possibly for this reason that no incidents of theft were recorded here.

c) Compartment J

A theft frequency of approximately one plant per month was recorded for this population.

ii) Mariepskop

This population was first surveyed by Dr. P. Vorster in 1970 (Vorster, pers. comm.). He recorded 16 groups of plants with a total of 75 stems. The detailed survey carried out by the author and the monitor team from the Flora section of T.P.A.N.E.C. in 1989 also revealed the 16 groups, but only a total of 55 stems. This means that twenty stems have disappeared over the last twenty years.

iii) Swaziland

As already stated above, it was not possible to record any thefts from this population as it was only visited on one occasion. No evidence of recent thefts were recorded. Its extremely small size, nevertheless, does indicate something untoward.

3.5.2. A CRITICAL REVIEW OF THE RELEVANT LEGISLATION

The legislation referred to above is the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) at the international level, the Forest Act of 1984 at the national level, and the Nature

Conservation Ordinance of the Transvaal (12 of 1983) at the provincial level. Research into this aspect revealed a number of short comings in the above which are discussed in the following chapter, and for which recommendations are made in Chapter Five.

3.6. POPULATION ENHANCEMENT AND RE-ESTABLISHMENT

No actual results were achieved by the author during the time allotted to this study, although experience was gained with regard to the collection and storage of pollen, and hand pollination.

Although a number of areas were identified for the possible re-establishment of populations, this almost romantic ideal has fallen prey to the cold realities of practicality. It was established that such a re-establishment operation will be very expensive and difficult to keep from the knowledge of the enthusiastic collector and horticulturist. All thoughts of promoting such an idea have, therefore, been shelved as it would not be practical to go to all the effort of arranging and carrying out the re-establishment of a population if its security could not be guaranteed. The emphasis was, therefore, placed on the *ex situ* propagation of plants for the enhancement of existing

populations. The various methods one can follow to achieve this are discussed in the following chapter.

CHAPTER 4

DISCUSSION

4. DISCUSSION

The purpose of this chapter is to discuss the results as listed in the latter, together with those of other researchers and authorities in the field of cycad ecology and management.

4.1. POPULATION CENSUS

Although the results obtained from the population census are relatively accurate and much effort was put in to ensure this, they must not be seen as being absolute. They must be added to the existing data from Kluge (1981) and Vorster (pers. comm.). With subsequent surveys and the addition of more data, one will eventually be able to gain an idea of the population dynamics of *E. laevifolius*.

The results of the census are clearly indicated in Table 1 and are discussed per population below:

i) Starvation Creek

Table 1 shows three sets of data for this population. The first is the total number of plants obtained from an aerial survey carried out by the T.P.A.N.E.C.. It is possible that plants that are completely, or even partially, under the canopy of trees growing in close

proximity to the cycads, were overlooked. It is, therefore safe to assume that this total is slightly less than the actual number at the time of the survey. The two plots listed in Table 1 were not specifically set out for use in this study, but for the annual monitoring actions of the Flora Unit of the T.P.A.N.E.C.. It was, however, convenient to use them to provide an indication of the age class distribution and sex ratio. The plots are not randomly situated within the population, but are placed so as to encompass at least one group of plants each. Plot A is 1500m^2 and plot B is 750m^2, their size being dependent upon the distribution of the individual plants within the specific group. The detailed surveys carried out in these plots (see Appendix A) established that the Starvation Creek population has substantial evidence of sexual propagation. This suggests agreement with Gilliland (1967), Jacobsen (1973), Oosthuizen (1978), Kluge (1981) who state that this population is flourishing.

ii) Belmont

This may be the second largest population, as illustrated in Table 1, but there is reason for concern as regards its viability. The very low percentage of

juveniles and seedlings indicates that it is not as flourishing as the population in Starvation Creek. The possible reasons for this will emerge in the discussion on the use of fire as a management tool in section 4.4.

iii) Compartment J

The percentage of juveniles and seedlings in this population are greater than those in the plots in Starvation Creek. Therefore, even though the total number of plants is less, it would seem that this population is also flourishing. The actual area covered by this population is approximately 80 - 100ha, while that of the Starvation Creek population is approximately 350 -400ha (areas estimated from 1:50000 topographical maps). Considering this comparison, it can safely be stated that the Compartment J population is flourishing in terms of the total number of plants and the age class distribution.

iv) Mariepskop and Swaziland

These two populations are discussed together as they are both in a critical condition, that is in terms of their total number of plants and the age class distributions. The Mariepskop population is at the northern most pole

of the cycads distribution range, while the Swaziland population is at the southern most pole. Although the total number of individuals is low, the most serious concern is the complete lack of sexually propagated off-spring. Of the two, the status of the Mariepskop population is slightly less critical. It has more than twice the number of plants and they are concentrated in an area of less than 1km^2, at a density of 1.8ha per plant. The plants in the Swaziland population are sparsely located in an area of 1.6km^2, at a density of 10.2ha per plant.

4.2. BASIC HABITAT REQUIREMENTS

4.2.1. CLIMATE

Basically all of the populations are found in areas of high summer rainfall and which experience extremes in temperatures. In summer the maximum may be in excess of 30°, while in winter the minimum may drop to as much as 5° below zero.

4.2.2. ALTITUDE

The mean altitude of the Kaapsehoop populations is almost equal to the average of the means of the Mariepskop and Swaziland populations. The fact that two of the Kaapsehoop populations have been classified as flourishing in section 3.1. supports the assumption that they occur at the most suitable altitude. Perhaps another indication of the suitability of this approximate altitude, is that the average difference between maximum and minimum altitude is less than that between the Mariepskop and Swaziland populations. The latter have differences of 300m and 350m respectively, while the average difference of the Kaapsehoop populations is 150m. It seems, therefore, that the ideal altitude for *E. laevifolius* is approximately at 1300 ± 150m.

4.2.3. GEOMORPHOLOGY

i) Predominant Slope

Although a number of individual plants are found on the plateau above the Starvation Creek and Compartment J populations, the rest all occur on the slopes. It is immediately tempting to conclude, therefore, that

this is a habitat requirement. It is, however, possible that many plants occurred on the plateau in the recent past. The abundance of evidence of thefts leads one to assume that the plants on the plateau, being far more accessible than those on the slope, have been drastically reduced in number. This being the case, then the impression that an average slope of 30° is a habitat requirement is possibly a misconception.

ii) Aspect

Although the results of the statistical analysis of the aspect data indicate rejection of the null hypothesis at a low level of significance (see section 3.2.3.(ii)), Fig. 2 indicates a definite trend towards the colonization of the warmer northern, north western and western slopes. In addition to this it is interesting to note that plot A in the Starvation Creek population is situated on a north north westerly aspect, while plot B is on a south south easterly aspect. The former has a much greater percentage of juveniles and seedlings than the latter, which suggests that the warmer slope is more suitable for the growth and survival of the cycad.

iii)Distance from Drainage Line

The distance at which plants are found from drainage lines varied within all the populations, and although there are cases where plants are growing immediately adjacent a stream, they are always in well drained soil.

iv) Exposure

The occurrence of almost 30% of the plants of the Belmont population within the riparian forest, together with the concentration of the rest of them along the main drainage lines of this area, begs explanation. It is also interesting to note that this distribution pattern is unlike the other four populations. The most obvious reason seems to be the fact that the recorded burning frequency in this area is every two years. This may have been too frequent for the survival of plants outside the protection of the riparian zones. Considering, however, that the plants in the Swaziland population are all exposed and have a history of annual burns, the theory looses its impetus. On the other hand, the bi-annual burn may have allowed sufficient build-up of fuel to cause the death of exposed plants in the Belmont population,

while the annual burning in the Swaziland population kept the fuel load down and ensured a cool burn, and hence the survival of cycads in exposed localities.

4.2.4. GEOLOGY

The parent material within all the populations is quartzitic.

4.2.5. SOILS

i) Soil Type

The soil type within all the populations was basically the same; that is a well drained and leached, dystrophic, and sandy Hutton.

ii) Soil pH

All the populations occur on acidic soils with a pH of approximately 4.8.

4.2.6. SUMMARY

The analysis of the habitat components of each population of *E. laevifolius* indicates that the following may be construed as being basic habitat requirements:

- high rainfall with an average of approximately 1100mm per annum;

- absolute maximum temperatures of approximately 31°C and absolute minimum temperatures of approximately -5°C.

- a mean altitude of 1300m (A.M.S.L.) with a range of 150m above and below the mean;

- northerly, north westerly and/or westerly aspects;

- geology in which quartzites predominate;

- a Hutton soil type with a pH of approximately 4.71;and

- a veld type which is either North Eastern Montane Sourveld or Lowveld Sourveld.

Although organisms which have significant interactions with the cycad are discussed in section 3.3., it is pertinent to mention at this stage that there are indications that specific insects, fulfilling the role of pollinating agents, are essential components within the ecology of *E. laevifolius*. They may, therefore, be classed as being habitat requirements. In this same theme, baboons may also be placed in this category as they seem to be essential as seed distributing agents.

The investigation into the habitat requirements was relatively superficial, but proved interesting to compare the habitat components of each population with the set of basic habitat requirements. All the Kaapsehoop populations fulfil the requirements with very little deviation. The Mariepskop population's minimum altitude is higher than the maximum at Kaapsehoop but otherwise there are no significant deviations. The Swaziland population has two deviations, namely, the maximum altitude is equal to the minimum of Kaapsehoop, and the pH is high than all the other populations (but not significantly).

It is possible to make a preliminary assumption that the Kaapsehoop populations are apparently flourishing because their habitat requirements are being met, whereas, the

other two populations have habitat components which are at the extremes of the habitat requirements. This could possibly explain their low population numbers and lack of sexual propagation.

4.3. ORGANISMS WITH WHICH *ENCEPHALARTOS LAEVIFOLIUS* HAS SPECIFIC INTERACTIONS

4.3.1. ORGANISMS WITH POSITIVE INTERACTIONS

i) Pollinators

When questioned about the optimum size for a sexually viable population of cycads, Giddy (pers. comm.) stated that there should be no fewer than twenty individuals in the population. Kluge (pers. comm.) suggested that considering their longevity, a population of two plants of the opposite sex could be sexually viable. (Although personal observations indicate that the latter statement is true it must be emphasized that a population must be as large as possible to be genetically sound.) Cycads need to produce male and female cones simultaneously so that pollen is available for the female cones when they mature. Kluge (pers. comm.) continued to suggest that the sexual viability may ultimately depend upon the

presence of specific pollinating agent/s. This statement led to further investigations, as until this point in the study it was believed that wind was responsible for pollination. The investigation revealed three theories; firstly, that cycads are wind pollinated; secondly, that they are insect pollinated, and thirdly, that both wind and insects play a role in their pollination.

a) Information in Support of Wind Pollination:

- Wind pollination is a wasteful method of pollination, and, therefore, immense amounts of pollen are produced.

- The number of male cones usually outnumber the female cones.

- The male cones do not all mature at once, thereby ensuring that pollen is available over a long period of time.

- When the male cones mature they elongate and the cone scales become well spaced so that the pollen may easily be dispersed by the wind.

- The cone scales and seeds in the female cones are spirally arranged around the cone stalk so that when the pollen enters the cone it is effectively distributed.

- The fleshy covering of the seeds is smooth and offers no hindrance to the pollen which must reach the micropyle end of the seed which is nearest the cone axis.

b) Information in Support of Insect Pollination:

- Pearson (1906) and Rattray (1913) record that the male cones of *E. villosus* emit a powerful aroma which could be responsible for the presence of the weevil *Porthetes hispidus* which they found on the cones.

- Rattray (1913) states that he found *Antliarhinus* weevils in both male and female cones of *E. altensteinii*. Their role as pollen vectors is suggested by the fact that many pollen-bearing individuals were found within female cones.

- Marloth (1916) records the collection of two species of *Porthetes* from *E. caffer*, and states that *A. zamia* is the principal agent in the pollination of *E. altensteinii* and *E. villosus*

- After her investigation into the reproduction in a natural population of the cycad *Zamia pumila* in Puerto Rico, Newell (1983) suggests that further research is necessary to determine what the pollination agent is, indicating that it may be an insect or insects.

- Norstog, *et al* (1986) state that a snout weevil, *Rhopalotria mollis*, is found to complete the reproductive phase of its life cycle upon and within male cones of the cycad, *Zamia furfuracea*. The pollen-coated adults visit pollen-receptive female cones and are nondestructive to ovules and seeds.

- Tang (1987) determined that two beetles, *Pharaxonotha zamia* and *Rhopalotria slossoni*, were definitely responsible for the pollination of *Z. pumila*.

- Norstog and Fawcett (1989) add to the findings of Norstog, *et al* (1986) by stating that *R. mollis* is apparently host specific to *Z. furfuracea*. They found that toward the end of the breeding season of both the weevil and the cycad, some larvae enter diapause in thick-walled pupal cases within microsporangial stalks of pollen-spent cones. These remain in diapause until the next reproductive season of the cycad.

- Jacot Guillarmod (1958) recorded temperature variations in the male cones of *Encephalartos* species, and a cyclic heating pattern in the male cones of *Macrozamia moorei* was discovered by Tang, *et al* (1987). Further investigation by the latter authors showed that this phenomenon, known as thermogenesis, appears to direct specific insect pollinators to the male cones. They obtained similar results from five cycad species, including *E. ferox* and *E. hildebrandtii*.

- Stobart (1989) reports on preliminary investigations into the role of insects in the pollination of *E. altensteinii*. Sequential sampling revealed nine beetle species occurring

on either the male or female cones, eight of which were curculionids. Of these, four species occurred regularly on cones of both sexes, and photographic evidence that pollen was transferred from male to female cones was obtained for two of the species.

- The weevil *Platymerus* has been recorded on both the male and female cones of *E. friderici-guilielmi* (Oberprieler, 1989). The female cone of this S.A. cycad is woolly and he observed that the wool greatly impedes the entry of pollen into the cone, and the *Platymerus* definitely carry pollen on their bodies. It, therefore, appears that this weevil is responsible for the pollination of this cycad species.

- Many weevils of the genus *Porthetes* were found in both larvae and pupae stages in an old male cone of *E. laevifolius* in the Belmont population (Oberprieler, pers. comm.). (This is a new species which is as yet undescribed.) *Porthetes* usually develop in semi-decaying scales of male cones and some have been known to attack the female cones of Eastern Cape cycads.

- Donaldson (pers. comm.) states that there are at least three species of *Porthetes* which appear to be host specific. He reports that *P. hispidus* carries substantial pollen loads and that this may also be true for the new species from *E. laevifolius*. He also states that pollen baring individuals of the cycad weevil, *Antliarhinus zamiae*, visit both male and female cones of *E. natalensis* and *E. villosus*. This insect may, therefore, be a pollinator of its host cycads, although it has never been recorded from wild populations of *E. laevifolius*.

- It is evident that the cone scales of *E. laevifolius* do not open to allow the entry of wind borne pollen. During the course of this study a female cone was monitored every three days, for the entire duration of its development, in an attempt to observe an opening of the cone scales. Unless this occurred over a shorter period, the scales never opened. When consulted with regard to the hand pollination of this cycad, Giddy (pers. comm.) suggested that two to three of the sterile cone scales at the apex of the cone be removed to facilitate the entry of

the pollen. If one has to go to such lengths for hand pollination, surely nature must provide a vector more penetrating than the wind. Perhaps a weevil?

- The pollen grains of *E. laevifolius* do not have air sacs or relative appendages to assist them in being carried by the wind (Hertog, pers. comm.)

- Tang (1987) found that a drop of fluid which is secreted through the micropyl of the ovules of *Zamia* species, at the time of pollination, contains simple sugars and amino acids in a mixture similar to the nectar of higher plants (angiosperms). He suggests that these droplets might serve as a reward for the visiting insect pollinators.

c) Information Supporting a Combination of Wind and Insect Pollination:

- Investigations by Niklas and Norstog (1984) have shown that some cycad cones have aerodynamic features which trap wind borne pollen on the scales. From here it is possibly carried in by insects. Oberprieler (1989) also makes this

suggestion with regard to the pollination of *E. friderici-guilielmi* where the wind borne pollen is trapped in the wool of the cone scales and is carried into the cone by insects.

Although there is little direct evidence with regard to the involvement of insects in the pollination of *E.laevifolius* in particular, it would be wise to follow the advice of Osborne, *et al* (1988) and Oberprieler (1989). They suggest that further research is essential in this regard as the close association of insects and cycads in general emphasizes the need for the conservation of the habitat and not just the species. Finally, programs for the re-establishment of cycads must include a program by which it will be established which insects, if any, are responsible for the pollination. Until such time as this is established, hand pollination needs to be carried out.

ii) Seed Distributors

a) The Need for the Seed to be Distributed.

The previous discussion on pollen vectors illustrates the value of fertile seed to the population in which it is produced. It would be very unfortunate if such valuable seed was wasted because of the absence of the necessary seed distributors. If seed is left to fall to the ground at the base of the mother plant, the seedlings that emerge have to compete with each other and the mother plant for light, water and nutrients (Giddy, pers. comms. and Tang, 1988). A high density of seedlings under the mother plant may also make them more prone to predation by baboons (Tang, 1988), or browsing by small antelope or domestic stock (i.e. in the case of the Belmont population). A single seedling would be far less noticeable that a concentration of seedlings. This point will be of greater significance if it is established that the cycad seedlings are selectively browsed. Observations made by the author indicate that this may be the case.

Unlike the cones of other cycad species such as *E. ferox*, *E. laevifolius* cones do not break up on their own but are serotinous (i.e. they remain intact on the plant for a relatively long time). It is, therefore, essential that the cones receive "assistance" in both releasing and distributing their seeds.

b) Aspects of *E. laevifolius* Morphology that Ensure Seed Distribution.

Tang (1988) refers to primary and secondary features for seed dispersal and both are applicable to *E. laevifolius*. The primary feature is the edible fleshy coat which surrounds the seed kernel. It is not only edible, but also brightly coloured and the colour probably serves to attract the organisms responsible for seed distribution, while the edible fleshy coat functions as a food reward as they disperse the seed. The seed kernel itself is toxic, which dissuades seed distributors from becoming seed predators and restricts them to feeding only on the fleshy coat. It is, unfortunately, not clear as to exactly how the seed distributors are aware of the toxicity of the

seeds. It is possible that experience has taught them that seed consumption causes illness or even death (Norstog, pers. comm.).

The secondary features are the seed colour, cone form and cone colour, and the foliage. *E. laevifolius* has a glossy orange coloured seed and besides being effective in displaying the seed, it also contrasts well with the surrounding green vegetation. Although the latter is important, the fact that the cones are serotinous places the emphasis of attraction on the cone itself. Mature *E. laevifolius* cones are relatively large (approximately 30-40cm in height and 15-20cm in diameter) and are yellow in colour, making them highly visible from a distance. From closer, the contrast of colour between the orange seed coating and the yellow cone may also be attractive to appropriate vectors. Assuming that baboon do have colour vision, this factor would serve to prove that they are a seed distribution vector, whose function as such is assisted by the cone/seed colour contrast.

Foliage also seems to be an important factor. As the cones develop the leaves are pushed out so that they spread to almost being at right angles to the stem. *E. laevifolius* have yellow rachises (leaf stems) which emphasizes the spread of the leaves and forms a pattern akin to the spokes of a wheel. This may serve to focus the attention of the seed distributors, especially if the plant is viewed from above.

c) The Seed Distributors of *E. laevifolius*.

In addition to the observations listed in section 3.3.1.(ii), Giddy (1984) and Tang (1988) list a number of small mammals and birds involved with the dispersal of cycad seed. Kluge (1981) and Fourie (n.d.) mention the specific role played by baboon. Both have observed baboon breaking off female cones, carrying them off for a considerable distance and then dismantling it to get to the seed. The fleshy outer covering is then chewed off and the seed kernel discarded. The latter observations were made in the Kaapsehoop populations, while observations indicating the need for the involvement of baboon in the Swaziland population have been recorded in section 3.3.1.(ii). It would appear, then, that

baboon is a very important component of the ecology of *E. laevifolius*. It is, therefore, unsettling to know that they are classified, both in the Forestry Act of 1984 and the Nature Conservation Ordinance of the Transvaal (12 of 1983), as a problem animal due to the damage they cause to timber plantations. Plantation managers trap and shoot baboon whenever a troop begins to cause damage. It is essential, especially with regard to the Kaapsehoop populations, that the importance of the baboon in the ecology of the cycad is recognised. A compromise must be sought that will satisfy both plantation managers and the cycads. Either the baboons must be left to carry out this function, or if the plantation managers still feel it necessary to eradicate them, this function must be carried out artificially. The other alternative is for all the female cones to be collected when mature and for the fertile seed to be distributed to appropriate Botanic Gardens for cultivation and eventual re-establishment into the population from which it was collected.

4.3.2. ORGANISMS WITH NEGATIVE INTERACTIONS.

i) The Leopard Moth (*Zeronopsis leopardina*)

a) The Consequences of its Presence within the *E. laevifolius* Populations

Giddy (1984) states that museum records indicate that this moth is found only in the coastal areas from Uitenhage, through the Eastern Cape, into Natal and inland as far as Eshowe. She continues by issuing a warning that the injudicious translocation of plants to inland areas would result in this serious pest being introduced into the Transvaal.

Her reference to the moth being a "serious pest" is possibly because the emphasis of her publication is on the cultivation of cycads. However, knowing her genuine concern for these plants in their natural environment, it can safely be stated that her fears extend beyond the spheres of domestic cultivation. Even if it is only indigenous to the areas she describes it could easily become a pest in others.

On the other hand, if its natural distribution does extend further inland then it must be accepted as part of the cycad's natural ecosystem.

Recent communications with an entomologist from the Plant Protection Research Institute in Pretoria (P.P.R.I.) indicate that the Leopard Moth is possibly indigenous to the Transvaal (Oberprieler, pers. comms.). Considering that the cycad is an endangered species, the moth must be seen as a pest and a threat to the cycads. In which case the fears expressed by Giddy (1984) have already become a reality. All three stages in the life cycle of the moth have been recorded in the Kaapsehoop populations, and evidence of its presence have been recorded in the other two.

Norstog (pers. comm.) states that in Florida and Mexico, lepidopterans seem to use visual clues to find food plants. Personal observations have indicated that this may well be the case with regard to the Leopard Moth. After an area has been burnt and all moribund material removed, the blackened stems of the cycads stand out very clearly. They are, therefore, highly visible to the moth at this stage. However, juvenile plants without stems are

also used by the moth. The newly forming whorl of leaves probably serves to attract the moth to plants in this age class.

b) Control Methods and their Feasibility.

There are both direct and indirect methods that could be applied to control the Leopard Moth. The direct methods would entail the use of chemical insecticides. If the eggs of the moth have already hatched, a contact insecticide should destroy the caterpillars. Repeated applications every eight to ten days should destroy those that hatch later as contact insecticides do not appear to destroy dormant eggs (Giddy, 1984). A systemic insecticide that remains effective for a relatively long period of time would perhaps be more practical to apply than the latter. It would not be necessary to wait for the eggs to hatch before applying the chemical, but could be done so where and when eggs are found. Applications could then be repeated at intervals corresponding to the time it takes for the chemical to lose its effectiveness.

A potential indirect method of controlling the moth concerns the use of fire. This could be achieved by manipulating the time of leaf emergence to coincide with the dry season. A mid-winter burn would stimulate the leaves to emerge with sufficient time to mature and become hard, leathery and unpalatable before the onset of spring when the caterpillars hatch. There would, therefore, be no soft tissue for them to feed on and they would have to find an alternative source of nutrition, or die.

The latter method is the most feasible for two reasons. It would be tragic if potential pollen vectors were destroyed by chemical insecticides while fulfilling this extremely important role. Coning plants could be excluded from the treatment but it is possible that these insects frequent plants without cones as well. It is also possible that if all the plants without cones are treated the moth and its caterpillars would then concentrate on those plants with cones. This would be most undesirable and emphasizes the fact that utmost caution needs to be exercised when and if chemicals are used.

Furthermore, while the use of chemicals on plants in cultivation is not a problem, the relative inaccessibility of the natural *E. laevifolius* populations makes the implementation of such prescriptions basically impossible. If there were sufficient personnel employed specifically for the protection of these plants, then regular patrols could be carried out and the prescriptions could be applied with ease. If this was the case, then the most efficient means of controlling the caterpillars would be to physically pick them off into a container of petrol or similar liquid (Norstog, pers. comm.). This is unfortunately not the case and it is highly unlikely that such personnel will ever be available.

ii) The Pathogenic Infection of the Female Cones.

a) The Significance of the Infection

During the initial stages of this study there were indications that all was not well with the sexual reproduction of *E. laevifolius*. Oosthuizen (1978, pp.38) records that, "Over the past few years the female cones have begun to rot on the plants.". He expresses concern at the possible threat this

infection could have on the plants and records that only 2.6% of 18899 seed collected in March 1978 escaped the infection. Kluge (1981) records that in 1975, 99% of the seeds were rotten, and in 1976 only seven fertile seeds were found out of a total of 3600. All of these observations were made in the Starvation Creek population, while all the other populations have also produced little or no fertile seed during the duration of this study. In addition, they have also displayed the symptoms recorded in section 3.3.2.(ii).

It is possible that the above was also assumed by Kluge (1981) as he records that female cones were sent to P.P.R.I. at Stellenbosch. Although a number of saprophytic fungi were found, the feeling was that the cones had already been infected by a parasitic fungus while still on the plant. Kluge (1981) states that it is not known whether this infection is an old or a new occurrence, but suggests that it deserves further investigation.

Giddy (1984) and Tang (1988) both record *E. laevifolius* as having yellow female cones, although during the entire four years of the present study no

such cones were encountered. They were all, or soon became infected. It may be that without the influence of the infection, the cones become yellow once they reach maturity and have been pollinated, thus attracting the seed dispersal agents.

Considering the above, it seems safe to conclude that this infection is a new occurrence and that the fears expressed by Oosthuizen (1978) are real and must be heeded. If one considers that fertile and infertile cycad seeds are morphologically identical, then this infection should not be coupled to the failure of pollination. Under normal circumstances, the only difference between fertile and infertile seed would be the absence of an embryo in the latter. Both should remain healthy until either germination or predation by insects. The presence of this infection is, therefore, a problem for potential insect granivores, as well as for the *E. laevifolius* plants themselves.

Although the above discussion basically proves that the failure of pollination is not necessarily a reason for the infection, the only seeds to have survived the infection seem to be fertile seeds.

This observation has been discussed with various pathologists but its significance is not yet clear.

b) Results From Work Carried Out by Various Pathologists

Pathologists at C.S.F.R.I. in Nelspruit were approached with the request that they attempt to isolate and identify the responsible pathogen. Their work indicated the presence of a *Fusarium* fungus (Oosthuizen, pers. comm.). They could, unfortunately, not say whether it was the pathogen or a secondary infection. Reference was then made to a pathologist at P.P.R.I. in Pretoria who was a specialist on *Fusarium*. His work indicated that a fungus, identified as *Fusarium polyphylyticum*, was responsible for the infection (Anelich, pers. comm.). Due to the fact that the material upon which he worked was relatively old and that the possibility of secondary infections existed, he suggested that a pathologist at C.S.F.R.I. attempt further isolations with fresher material.

Contact was made with a pathologist at C.S.F.R.I. and he was provided with cones that were showing the first signs of infection. Thompson (pers. comm.) related that the cones were cut in two and small pieces of tissue were cut out of the infected area with a scalpel. Care was taken to ensure that each piece was not artificially contaminated and they were then placed on a variety of growth mediums. No *Fusarium* fungus was isolated and the only consistent isolation revealed a bacterium, and a fungus of the Basidiomycetes (Thompson, pers. comm.). The fact that these results radically contrasted with those of the pathologist at P.P.R.I. led to the suggestion that the plants be treated against all possible pathogens (Grech, pers. comm.). The following treatment was prescribed by Grech (pers. comm.):

- citromycin at 1 gram/liter and captab or dithane at 1.5 grams/liter, to be applied in solution to the cones and crown of the plants, and

- temik at 50 grams/plant, to be sprinkled on the ground around the base of the plants.

- Treatment to be applied once a month from cone emergence until the cones reach maturity, i.e. once a month for approximately six to seven months.

Shortly after this treatment was suggested, the author established that three of the female plants in the gardens of C.S.F.R.I. were beginning to cone. The treatment was immediately applied with the assistance of their staff. An additional bonus was the production of cones by a male plant. The pollen was collected by the nurseryman of the institute and frozen to pollinate the female cones once they had reached maturity.

In essence this exercise was totally artificial and would be impractical in real management situations. Even if it was successful, its implementation within the natural populations would face the same limitations as those discussed with regard to the control of the Leopard Moth. It was, however, necessary as the results would give an indication of which direction further research was to move.

Treatment of the cones and their plants was stopped when the cones reached maturity, and the cones of one of the plants were hand pollinated. The cones of the plants that were not pollinated soon developed the symptoms of the infection. Although the pollinated cones did not become yellow as expected, they retained their relatively healthy appearance.

The results thus far were discussed with the pathologist at C.S.F.R.I., and it is now felt that the failure of the prescribed treatment to prevent the infection, indicates the possible involvement of a virus (Thompson, pers. comms.). If this is not the case, then the problem may be the result of a physiological disorder.

Baines (1989) reports on preliminary work that has been carried out by S.A.F.R.I. on symptoms of possible atmospheric pollution in *Pinus patula* in Natal and Transvaal. The areas in which the highest occurrence of symptoms were recorded corresponds almost directly with both of the Transvaal populations of *E. laevifolius*, as well as the Swaziland population. The difficulty being experienced in isolating the apparent pathogen and

preventing its infection of the cones, as well as this preliminary evidence of possible atmospheric pollution, suggests that the latter may be the cause of the rotting of the cones. It would possibly be best to continue monitoring the situation and wait for the results of the S.A.F.R.I. project.

4.4. FIRE : ITS ROLE IN THE ECOLOGY OF *E. LAEVIFOLIUS* AND ITS USE AS A MANAGEMENT TOOL.

4.4.1. THE ROLE OF FIRE IN THE ECOLOGY OF *E. LAEVIFOLIUS*.

As mentioned in section 3.2., *E. laevifolius* occurs in Acocks veld types 8 and 9, namely North Eastern Montane Sourveld and Lowveld Sourveld. Both of these veld types experience fire by both natural and unnatural causes and it is most likely that the plants have adapted to survive periodic exposure to fire. Norstog (pers. comm.) states, however, that fire could be detrimental to the survival of cycads in general. He motivates this statement by referring to mature, even senescent, foliage as being the defensive armor of a cycad. Fire removes this defensive feature and provides easy access to the young and succulent juvenile foliage. However, at no time during the course of this study were observations made to support these fears. He also expressed the fear that fire will

have a detrimental effect on populations of insects which may be pollen vectors. Oberprieler (pers. comm.), however, states that these fears may be unfounded as his observations indicate that the insects are protected amongst the persistent leaf bracts of the cycads. Grove, *et al* (1980), state that the characteristics of the growth of the Australian cycad *Macrozamia riedlei* demonstrate its adaption to recurrent fire. It is, therefore, possible that this is also the case with *E. laevifolius*. The discussion that follows should bear witness to this assumption.

Only Kluge (1981), discusses the response of specifically *E. laevifolius* to fire and it is, therefore, necessary to discuss the work done by Raison (1979), Grove *et al* (1980) and Beaton (1982), although these do not deal with the species or the genus in question.

i) <u>The Direct Effects of Fire on *E. laevifolius*</u>

Grobbelaar (pers. comm.) has suggested that burning should have a negligible effect on coralloid roots and their ability to fix nitrogen. Spratt (1915) refers to these as root-nodules and states that they are perennial, modified lateral roots, repeatedly branched and typically forming large coralloid masses

immediately below the surface of the soil and protruding above it. DeLuca and Sabato (1980) use the term "coralloid roots" and state that they are an inherent feature of the root system of cycads. Dinitrogen fixing Cyanobacteria (blue-green algae) invade these coralloid roots and live in mutualistic symbiosis with them (Grobbelaar, *et al*, 1987). Plate 12 shows coralloid roots protruding above the surface at the base of an adult *E. laevifolius* plant.

Plate 12. A mass of coralloid roots above the surface of the soil at the base of an *E. laevifolius* plant.

Grove, *et al* (1980) state that the capacity of *M. riedlei* for nitrogen fixation is indirectly proportional to the time since burning and that burning stimulates the development of coralloid roots. Their records indicate a rapid growth of coralloid roots in the first year after burning, and that the rate of nitrogen fixation was six times greater for a recently burnt site than that estimated for a site burnt seven years previously.

There is, unfortunately, no such data available with regard to *E. laevifolius*, but the healthy population structure of the Compartment J population, which has not been burnt in the last fifty years (see Table 3), suggests agreement with the view point of Grobbelaar (pers. comm.) as mentioned above. Other factors do, however, suggest that burning can be beneficial, and these should become clear throughout this discussion.

ii) The Indirect Effect of Fire on *E. laevifolius*

An indirect effect of fire is the redistribution and change in the availability of nutrient elements in general (Raison, 1979). Grove, *et al* (1980).

established that there is an increase in the amount of plant-available nutrients at the soil surface after a fire.

Other indirect effects of fire are the removal of litter and senescent foliage which could alter the micro-climate of the plants (Raison, 1979 and Grove, *et al*, 1980); as well as an increase in light intensity and a reduction of competition.

The above effects are possibly evident in the response of *E. laevifolius* to fire as recorded in section 3.4.1.

The positive influence of fire on cone formation has been documented by Beaton (1982). His study on Australian Aboriginal management of cycads with fire and water revealed that *Macrozamia communis* produced seven times the number of cones in burnt plots than in unburnt plots. Giddy (pers. comm.) has observed a population of *E. ghellinckii* in which half of the population was exposed to fire and the other half not. The former half responded with almost 100% cone development, while the latter half produced no cones.

The idea that fire stimulates cone development in

E. laevifolius is supported by observations on the approximately three year cycle of cone production that was evident in the Starvation Creek Nature Reserve. However, Kluge (1981) observed that cone formation has occurred in both burnt and unburnt veld. This is not to say that fire does not stimulate cone development, but rather indicates that cone development is not absolutely dependent on fire.

In addition to the above, it was observed during the survey of the Belmont population (see Appendix A), that *E. laevifolius* has shown the same positive response to fire in similar circumstances as observed by Giddy (pers. comm.). It is, therefore, possible that with regular periodic burning, cone development may be stimulated. More importantly, it may be synchronized. This could have the long term effect of increasing the productivity of the populations (Harris, *ex* Beaton, 1982). Reservations in this regard have been expressed by Norstog (pers. comm.) who feels that although productivity may be increased, it is not a wise long-term practice. When one considers the possible role of insects as pollen vectors and the importance of such a function to the survival of the plants, the latter reservations are indeed valid. It is evident from the discussion in section 4.3.1.(i) that insect/s are responsible for the pollination of

E. laevifolius and it is, therefore, necessary to consider their survival when contemplating the use of fire as a management tool. Unfortunately this aspect still requires further research in order to ensure that the recommendations which are made are completely sound. Until such time it would be to the benefit of the plants if management remains as flexible as possible to allow the necessary research to take place. Specific recommendations in this regard are made in section 5.4.

4.4.2. THE USE OF FIRE AS A MANAGEMENT TOOL

The effect of fire on the growth of the cycads and the soil is very complex and the efficient use of fire as a management tool must be based on sound ecological principles (Raison, 1979). It is unfortunate that no research has been done with respect to the use of fire for the management of cycads in South Africa. Much general research has, however, been carried out in the different major veld types or biomes. The South African Forestry Research Institute (S.A.F.R.I.) has conducted research in the fynbos biome in the mountains in the Cape Province and in the grassveld in the Natal Drakensberg, the latter being of some relevance to *E. laevifolius*. The most

relevant data available in the Transvaal are those from the work done by National Parks Board in their Kruger National Park (K.N.P.) (Gertenbach, 1988).

Gertenbach (1988), in his analysis of the burning programs in the K.N.P., states that fire is a natural factor in the Lowveld. Irwin, *et al* (1980) state that fire has been an important factor in the Drakensberg for a very long time, and even more so since the arrival of *Homo sapiens*. As soon as land falls under the ownership of individuals or institutions a diversity of land management develops from a diversity of land uses. Natural fires are normally then prevented as far as possible and burning plans are implemented to suit the objectives of the land owners.

Where the land-use management objective is conservation orientated, the use of fire should simulate the natural conditions as far as possible. In order to achieve this, the natural season and frequency of burning must be determined.

i) The Season of Burn

Gertenbach (1988) states that burning should take place to coincide with the occurrence of lightning, and while plants in general are in a state of dormancy

or reduced growth rate. This is contradictory as lightning is associated with summer storms and growth rates begin to increase with an increase in day length shortly after the winter. The scientists of S.A.F.R.I. at Cathedral Peak in the Natal Drakensberg have established that a winter burn results in a greater species diversity and basal cover than a late-spring to summer burn (Rossouw, pers. comm.). It would, therefore, initially seem that the winter is the best season in which to burn.

Stevenson (1981) provides data with regard to the timing of leaf flush of 15 *Encephalartos* species. Unfortunately *E. laevifolius* is not one of them, but the data show that leaf flush (or growth or development) could take place anytime from autumn to mid-winter, from approximately April to July. Considering that fire stimulates leaf growth, it would then be ideal to burn at the time that the plant would naturally produce new leaves. If it so happened that the plants within a population that was to be burnt had already begun to produce their leaves, there is evidence that a cool fire would burn off the old leaves but not damage the young leaves at the centre of the crown (Beaton, 1982). (A cool burn may be achieved if the burn is carried out on a cool overcast

day and the direction of the burn is down slope.) It is important to know this , as the presence of new foliage may deter a manager from carrying out a planned July burn.

The occurrence of the leopard moth (*Zeronopsis leopardina*) and the damage caused by its caterpillars has been recorded in section 3.3.2.(i) and discussed in section 4.3.2.(i). Giddy (1984) states that the eggs of this moth hatch in spring and/or after rain which apparently triggers hatching. Considering the damage caused by this organism and the fact that it is probably alien to the ecosystem of *E. laevifolius*, the need to control it is obvious. The apparent complexity of the ecosystem of this cycad (the possible role of insects as pollination vectors) rules out the use of chemicals. However, it was established that control could be achieved by using fire at a specific time of the year, instead of having to apply insecticides. This would be beneficial to the ecosystem as a whole and not just to the cycads themselves. As already discussed, it is possible that fire stimulates cone as well as leaf development. It would also be beneficial, therefore, if the time of coning could be manipulated so as to avoid damage and/or destruction by leopard moth caterpillars. An

early winter burn could be successful in achieving this. New leaf growth and cone development would be stimulated long before the caterpillars are due to hatch. When they do hatch, the foliage would have already become hard, leathery and unpalatable, and the cones too advanced in their development to be susceptible to their demand for sustenance.

In addition to the damage and destruction caused by these caterpillars, personal observations by the author have revealed much evidence of browsing damage by livestock. Fortunately this may be prevented by keeping livestock out of the area in which the cycads occur, especially for the critical period of leaf growth. At this stage the leaves are very soft and seemingly palatable, notwithstanding their toxicity (Whiting, 1963).

Considering the above, it would seem that the most ecologically sound season in which to burn is between late-autumn and mid-winter, between May and July. The exact time of burn would depend on the duration of the rainy season. If the rains stop early, then the burn could take place in May, but if the season is

prolonged the burn would be delayed. A safe "rule of thumb" would be to delay the burn as long as possible to cater for late rains.

Although this is relatively decisive, there is an element of doubt which exists. The record of times of leaf flush by Stevenson (1981) does not include that of *E. laevifolius*, and plants have been observed to produce new leaves at times other than between April to July. Gertenbach (1988) states that veld burning on a rigid rotational frequency is unnatural and may be detrimental to the vegetation being managed. Although this statement is made with regard to the frequency of burning, it may be best to apply this principle to the season of burn as well. A burning program should, therefore, include both autumn to mid-winter burns and spring to early-summer burns. Both should be very closely monitored for any signs of detrimental effects. An increase in the occurrence of damage and destruction by the leopard moth caterpillars, for example, would be an obvious sign that the fire regime should be altered.

ii) The Frequency of Burn

As mentioned above, veld burning on a rigid rotational frequency could be detrimental to the veld or plants being managed (Gertenbach, 1988), but a manager should have an indication of what the best average rotational frequency is. The burning program could then be compiled so as to move either side of this average. For example, if it were established that a rotational frequency of three years was ideal for the management of *E. laevifolius*, alternative frequencies of two and four years could be applied. The feasibility of the latter was discussed with the personnel responsible for the management of the Starvation Creek Nature Reserve and the results of this discussion are included in section 3.4.2. From the analysis of the data presented in Table 3, it would seem that the tri-annual burn applied in the Starvation Creek Nature Reserve should be the best average rotational frequency to follow.

Additional reasoning to support a tri-annual rotational frequency is found in the time it takes for seedlings to develop sufficiently to survive a fire. As has been established fire stimulates cone

development, the plants then have three years in which to carry out successful sexual propagation leaving sufficient time for seedling establishment. Cones take approximately six months to mature after which pollination and fertilization may take place. It then takes approximately nine months for the fertile seed to germinate. This allows approximately twenty one months for seedling establishment. Kluge (1981) records that seedlings which totally lose their foliage during controlled burns, rapidly produce new leaves with no evidence of detrimental effects.

Although it has been suggested that the rotational frequency be moved between two and four years with a tri-annual burn as the rule, it would be best to make the tri-annual burn the minimum instead of the average. It would be very unfortunate if successful sexual propagation were to be nullified by a premature burn. In other words, it is likely that a bi-annual burn could destroy seedlings before they had sufficient time to form a large enough root stock necessary for their survival against fire. Conversely, a burning frequency of four to five years could allow a build up of litter that would result in

a very hot fire. The heat generated from such a burn could destroy seedlings and even damage mature plants.

3.4.3. LAND OWNERS AND LEGISLATION

The above discussion has so far looked only at biological and ecological considerations which should be taken when deciding on the season and frequency of burning. Two very important factors still to be considered are the policy of the land owners concerned, and the relevant legislation. It is possible that the management suggested by biological and ecological considerations could conflict with the objectives of the land owners and the relative legislative stipulations.

All the *E. laevifolius* populations are associated with forestry areas, and the primary objective of controlled burning in these areas is for fire protection. All open areas and fire breaks are burnt on as short a rotation as possible, and in the safest season. Most burning, in the summer rainfall area, takes place during late summer to early autumn when there is sufficient moisture in the soil to ensure a cool burn and prevent ground fires from starting. The evidence of this can clearly be seen when visiting the Eastern Transvaal, for example, during this

time of the year. Most fire breaks are burnt annually, unless they are double breaks which are burnt on a bi-annual rotation. Burning rotations of longer than two years are an exception. The latter observations were made by the author while he was employed by the Forestry Branch of the Department of Environment Affairs.

Legislation is also aimed at protecting the plantations from fire. The Minister of Environment Affairs annually publishes notice of a fire prohibition period in the Government Gazette, under the auspicious of the Forestry Act 1984 (Act No. 122 of 1984). (A copy of this declaration is included as Appendix D.) This period is from the 1 August to the 31 October but may be flexible to a degree depending on the lengths of the wet- and dry seasons. In order to burn during this prohibition period it is necessary to obtain a permit from the nearest Regional Office of the Forestry Branch of the Department of Environment Affairs. It is very unlikely that a permit will be granted as this period is set to co-incide with the peak of the dry season, where the risk of wildfires is at its highest.

This policy exists with regard to both the season and the frequency of burn. It is undesirable in terms of fire protection to allow a build up of fuel (moribund

vegetation). The risk involved in using fire as a management tool increases with the age of the veld. At present the tri-annual burning program applied by the Forestry Branch in the Starvation Creek Nature Reserve is possibly at the limit acceptable by their management and it is unlikely that they will accept a rotational frequency of longer than three years.

Seeing that the potential for a conflict of interests existed by comparing the conservation and management objectives, the situation was discussed with the forestry personnel responsible for the management of the Starvation Creek Nature Reserve and the fire protection on the adjacent State Forest. The ecological considerations which indicated; firstly, the need for a flexible program, secondly, the need to delay burning until at least early winter, and thirdly, to extend the rotation to four years, with the three year rotation being the average, were presented as clearly as possible.

The reaction of the plantation managers was very positive and it was indicated that flexibility could easily be accommodated and that burning during the early winter was acceptable. With regard to the increased rotational frequency, concern was expressed at the amount of fuel

that would be allowed to accumulate. They indicated that their experience had shown an undesirable build-up of fuel after three years (Byle, pers. comm.).

The possibility of extending the rotational frequency was, however, not lost. The suggestion was made that by combining a "safe" season with a "dangerous" frequency the potentially unacceptable burning program could be implemented. Although this could be seen as being a compromise, the indications are that it would not only be beneficial to the cycads, but to the associated vegetation as well. This would fulfil the need for habitat as well as species conservation.

In the same way, if, by analyzing the conditions of the veld and the cycads (for example, fuel load, moisture content of fuel and the presence of germinating seeds), it was established that a spring burn was necessary. That is, during the fire prohibition period. The chances of implementing the burn could be enhanced if the rotational frequency was shortened to two years. Therefore, by manipulating the season and frequency of burn, most of the ecological considerations could be catered for.

Finally it must be stated that, although the results of this investigation indicate a solution, there is still room for improvement. Recommendations in this regard are made in section 5.4.

4.5. THE ILLEGAL REMOVAL OF HABITAT PLANTS

Both habitat destruction and the removal of cycads from their habitat have been cited as reasons for their "endangered status (see Chapter One). Although the former may have been responsible for greater losses in the past, the impression has developed through this study that "poaching" is now the biggest threat. Tang (1985) gives international trade figures of 40000 to 150000 plants per year, and Gilbert (1984), in her publication on the status, trade, exploitation and protection of cycads, states that they are the most endangered group of plants to date.

There are basically two reasons why cycads are removed from their habitat. Firstly, enthusiastic collectors desire to have at least one of each species in their collection; and secondly, because they have become a status symbol (Osborne, 1989) of great horticultural interest (Tang, 1985; Comrie-Greig, *et al*, 1989). Comrie-Greig, *et al* (1989) state that the cycad collectors are genuine in their love for cycads, but others are motivated because cycads are rather fashionable things to have in ones garden and they are not prepared to take seed grown specimens

from recognised nurseries. According to Osborne (1989), such people are not concerned with the actual species, but rather with the size of the plant. It is also unfortunate that these people seem to have more money than conservation principles. Gilbert (1984); Tang (1985); Van Bart (1987); Osborne, *et al* (1988); Osborne (1989) all refer to the extensive international trade in cycads and the exorbitant prices that are paid for these plants. Comrie-Greig, *et al* (1989) record the sale of a 1m high *E. woodii* for R30000.

Although the enthusiastic cycad collector may not remove as many specimens as the horticulturist would, there are a large number of these collectors. Even if each collector only took one or two plants, the impact on a population would be great. The problem with the collectors is that the rarer the species, the greater their desire to have it in their collection (Gilbert, 1984). Personal experience has shown that collectors sometimes have knowledge of localities of populations before the nature conservation authorities. Gilbert (1984) states that the latter circumstances have lead to the exploitation of a population even before the species has been described by botanists. Lavranos and Goode (1989) state that since the discovery of a population of approximately 200 *E. cerinus* in 1987, nearly all the seedlings and juveniles and about three quarters of the mature plants have been removed.

Work recently carried out by the author (in his capacity as Nature Conservation Scientist with the T.P.A.N.E.C.) revealed a small population of an *Encephalartos* species in the north eastern Transvaal which were though to be extinct. The population is adjacent to a "Self-Governing State" and the value of the plants is apparently not yet known to the local people. Osborne (1989) refers to the fact that it is often the local inhabitants that are employed by the collector to perform the physical removal of the plants. They are unaware of the ecological value of the plants, the monetary value attached to them, or the illegality of their actions: but they are willing to carry out the task as the few rands they are paid mean more to them than the conservation of a plant and/or its population.

4.5.1. THE MAGNITUDE OF THE PROBLEM WITH REGARD TO *ENCEPHALARTOS LAEVIFOLIUS*

It is unfortunate that *E. laevifolius* is not immune from any of that which has been discussed in the above section. Reference has been made in this report to the fact that the Kaapsehoop plateau must have, until relatively recently, hosted a greater number of the "Kaapsehoop Cycads" than it does today. If time and money allowed, a survey of all the private cycad collections would surely reveal many of these plants. The fact that the offices at the Berlin Forest Station, the C.S.F.R.I.,

the Wayside Inn at Waterval Onder (± 30km west of Berlin), and a number of private land owners in the vicinity all have specimens of *E. laevifolius* in their gardens, bears evidence to the latter.

The etiquette on a herbarium specimen of *E. laevifolius* at the Kirstenbosch Botanic Gardens records the locality as being 16km east of Nelspruit. This was apparently a new locality and was recorded as such in the local newspaper (Anon. 1971). The same newspaper also recorded their "mysterious disappearance" (Anon. 1973). Fourie (1983) also refers to the extinction of this population as well as another at Josefsdal which suffered the same demise. It is, therefore, evident that the pressure on these plants in the past has been substantial. To obtain a clearer picture of the situation to date, each population is considered separately below.

i) Kaapsehoop

Besides the drastic thinning out of this population with emphasis on the plants on the plateau (as discussed above), a theft frequency of approximately one plant per month was recorded in Compartment J. The possible reason is that this population was under a canopy of a pine plantation, and the poachers could

work unseen. The pine have recently been cleared, and it is expected that the occurrence of thefts will decrease or stop all together. Numerous cases of thefts of plants from the plateau areas were recorded during this study, but there were no cases from the valleys (i.e. Starvation Creek and Belmont).

ii) Mariepskop

Being in close proximity to the S.A.A.F. base at Mariepskop, this population possibly enjoys as much security as the base itself. Vorster (pers. comm.) completed a survey of this population in 1970. He recorded 16 groups of plants with a total of 74 stems. The most recent survey carried out by the author and a monitoring team from the Flora Section of T.P.A.N.E.C. in 1990 revealed that all that all sixteen groups were still present, but a total of 55 stems was counted. Evidence of mortality indicates that this could be the reason for this discrepancy. However, a survey of the gardens of high ranking officials of the S.A.A.F. in the elite suburbs outside Pretoria may reveal otherwise. (Personal communications with one such official has cultivated this suspicion.)

iii)Swaziland

In her review of the legislation pertaining to the conservation of the cycads in South Africa, Gilbert (1984) states that it is easy to obtain illegal plants from neighbouring Independent States. Considering that the Malolotja Nature Reserve was only declared as such in 1978 (Boycott, pers. comm.), it is possible that many *E. laevifolius* have been exploited from this population. Although there are many other factors one could consider in attempting to explain the small size of the population, there are indications that theft was a major factor. Kluge (pers. comm.) observed that rapid decline in the numbers of *E. heenanii* populations which grow/grew in relatively close proximity to the *E. laevifolius*. This is an indication that the latter species may have suffered the same fate and that the declaration of the reserve has been effective in putting a stop to the poaching.

4.5.2. A CRITICAL REVIEW OF THE RELEVANT LEGISLATION

Legislation at the Provincial level (Nature Conservation Ordinances; Natal No. 15 of 1974, Cape No. 19 of 1974 as amended in 1985, Transvaal No. 12 of 1983), the National level (Forestry Act of 1984) and the International level (CITES regulations) are all intended to prevent the illegal collection and trade in habitat collected cycads specimens (Osborne, 1989). However, Gilbert(1984); Osborne, *et al* (1988); Osborne (1989); Giddy (pers. comm.) all state that these activities persist despite the legislation. Gilbert (1984) suggests that laws are only as strong as the bodies responsible for their enforcement. In addition, Osborne (1989) states that these bodies are not co-ordinated and that the existing legislation requires revision. The discussion that follows attempts to critically review this legislation and make suggestions with regard to its revision.

i) International Legislation

South Africa is party to the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which Gilbert (1984) believes affords cycads a measure of protection. Commercial

trade in any of the species of wild fauna and flora listed on Appendix I of the treaty is prohibited, and all species of *Encephalartos* are on this list.

CITES requires that all parties to the treaty report yearly imports and exports of listed species in an annual report (Gilbert, 1984). From these reports, trade may be monitored and specific problems identified. The success of the treaty, therefore, relies heavily on the efficiency of those responsible for the compilation of the annual reports. In S.A. each conservation body is responsible for reporting their figures to a central committee who then compile the annual report (Fourie, pers. comm.).

Table 4 illustrates that CITES does not only rely on the quality of the report, but on the actual compiling of the report itself. The treaty should become more effective once more of the parties begin to comply with its prerequisites.

DATA FROM CITES REPORTS	YEAR					
	77	78	79	80	81	82
Available data from CITES reports						
Number of parties to CITES	40	47	55	61	74	77
CITES parties submitting reports	28	33	34	32	35	17
CITES reports including plant data	8	12	11	12	11	9
Available cycad data from CITES reports						
Reports from parties with native cycads	10	13	14	15	18	7
- from cycad nations including cycad data	4	4	4	6	6	2
- from other nations including cycad data	2	4	1	1	0	0
- from all CITES parties including cycads	6	8	5	7	6	2

Table 4. The potential of CITES annual reports as a source for cycad trade data (TRAFFIC(U.S.A.) *ex* Gilbert, 1984).

The figures in Table 4 indicate that although the number of countries party to the treaty increased from 1977 to 1982, those submitting reports decreased. The very low figures of reports including cycad data could be seen as being an encouraging sign, but Gilbert (1984); Osborne, *et al* (1988); Osborne (1989); all

state that illegal collection and trade continues despite legislation. Considering the trade figures quoted earlier in this section, these figures should be considerably higher. The reasons why they are not are not clear, but it is assumed that most of the trade takes place on the "black market" and is, therefore, not recorded. Bribery and corruption amongst officials could also account for the low figures.

There is unfortunately no quantitative data with regard to the export of *E. laevifolius* out of the Transvaal. The permits which are issued by the T.P.A.N.E.C. are not computerized, and it would be almost impossible to sift through many permit duplicates in search of those recording *E. laevifolius*. In addition to this, the accuracy of the information on the permit applications is doubtful (Osborne, pers. comm.). It is highly likely that mistakes can be made with the identification of plants, but it is also possible that false information is submitted to ensure the granting of a permit. An application featuring a less threatened species will no doubt be more successful, or attract less attention, than one for a highly endangered species.

ii) National Legislation

The Forestry Act of 1984 includes a list of fauna and flora species which it protects by virtue of a permit system and by prohibiting their exploitation. It basically achieves the same as the Ordinance (discussed below), but the list is not entirely the same. It includes some species not in the Ordinance and *visa versa*. The future of this section of the Act is presently uncertain, and will, therefore, not be discussed any further. The privitisation within the Forestry Branch of the Department of Environment Affairs are set to move this part of the Act to the Ordinance. This will simply result in an increase in the number of species afforded protection under the Ordinance.

iii)Provincial Legislation

Schedule 12 of the Nature Conservation Ordinance of the Transvaal (12 of 1983) lists all the Transvaal cycads as "Specially Protected Plants". (A copy of the pertinent sections of this Ordinance is included as Appendix D.) According to Gilbert (1984), this declaration was the first step taken at Provincial level to protect S.A. cycads, and that was in 1971.

Section 96 of the Ordinance states that no person may buy, sell, pick, donate, transport, import, export and even own a specially protected plant without a permit to do so. Possession of such a plant with out a permit is only allowed if the plant is growing naturally in its natural habitat and was not planted. Section 87 lists the circumstances which will possibly justify the relocation of specially protected plant/s. For example, the clearing of land required for cultivation, the erection of buildings, the construction of a road, etc. A permit is also necessary before any relocation is carried out.

Any person found guilty of contravening any of the above shall be guilty of an offence and liable on conviction to a fine not exceeding R1000, or to a prison sentence not exceeding 12 months, or to both; if it is a first offence. Persons found guilty with previous convictions will be liable for a fine not exceeding R1500, or to a prison sentence not exceeding 18 months, or to both the fine and the prison sentence.

In 1985 the *E. laevifolius* specimen in the L.B.G. was stolen, and it cost R1000 to replace it with a 1m high plant (Kluge, pers. comm.). A press release (Anon. 1988b) records the penalty of a R1000 fine or 100 days in prison for the removal of 61 cycads from their habitat. A simple comparison between the latter two cases should illustrate the major shortcoming of the Ordinance (and there are many other examples). The fine of R1000 is classed as an "overhead" by the well organised cycad poachers. Enquiries made during this study revealed prices of R3000 to R5000 being asked per meter of plant (Giddy, per. comm.). It is, therefore, necessary to increase the penalty drastically, and enforce the legislation ruthlessly, making public any convictions as examples to those contemplating similar activities.

Although rather philosophical, the following quotation by Comrie-Greig, *et al* (1989, pp. 300) is relevant as a final thought in this section; "It is ironic that the cycads should survive the various geological and climatic cataclysms that have afflicted the world over the past 100 million years, only to be brought to the brink of extinction by the averice - or misplaced love - of *Homo sapiens* in the closing decades of the 20th

century.". The legal side of combating this has been discussed briefly above, the following section explores the botanical alternatives.

4.6. POPULATION ENHANCEMENT AND RE-ESTABLISHMENT

4.6.1. INTRODUCTION

Osborne, *et al* (1988) refer to the principle of "conservation through cultivation" in the sense of propagating cycads and making them available through authorised channels to collectors and nurseries. To this end the cycad Society of South Africa (C.S.S.A.) has initiated a seed and pollen bank to encourage the artificial propagation of seedlings to lessen the threat to plants in habitat (Giddy, 1987). Giddy (1984) suggests a "salvage and relocation" effort to conserve cycads. the motivation for this suggestion comes from the need transplant cycads that are in a threatened habitat to a more hospitable one. In addition to this, the harvesting of fertile seed which is often lost through natural predation would ensure the provision of seedlings for planting back into habitat and to supply the demand (Gilbert, 1984; Gerber, 1987).

Although two cycads of the same species and of the opposite sex constitutes a sexually viable population by virtue of their extremely long life span, sexual viability will increase with an increase in numbers. It would, therefore, be ideal if enhancement programs could be undertaken to increase the size of small populations. Fourie (1983) suggests that isolated plants be translocated to fulfil this need. In addition, populations may be re-established into areas where there are indications that they use to occur there. Such indications would be the presence of habitat components and/or old locality records. Such re-establishment will only be of value if the safety of the plants can be guaranteed. Areas that were identified for possible re-establishment operations are discussed in section 4.6.3.(ii).

Fourie (1984); Koeleman and Raal (1985) provide techniques and guidelines for the collection and cultivation of a nucleus of cycads for *ex situ* conservation. The important role which the Botanic Gardens of South Africa can play in this regard is highlighted by Gilbert (1984) and Osborne (1989). These institutions have the facilities, staff and expertise necessary to develop and manage seed orchards for cycads and other threatened plants. The problems associated with such an operation, such as the prevention

of hybridization, maintaining a large enough population for a viable gene pool, protecting the plants from pests and diseases and guarding against theft should be within their capabilities.

All of the above indicates that the need to enhance and/or manipulate both *in situ* and *ex situ* populations of cycads is necessary to ensure their conservation. This is particularly true for *E. laevifolius*. It should be clear from the discussions in previous chapters that there are a number of factors which threaten the existence of this cycad in nature. It is,therefore, of the utmost importance that the advice of the authors referred to above, be followed as closely as possible. Specific methods which may be used to fulfil this need are briefly discussed below.

4.6.2. METHODS OF POPULATION MANIPULATION

The actual method/s which may be used to achieve either population enhancement or re-establishment, depend on the type and origin of the material used. That is, seed, vegetatively propagated shoots, or mature stems.

i) Seeds

Earlier discussions have indicated the scarcity of fertile seed in habitat. The success of fertilization depends on pollen being available when the female cones are receptive and possibly also on the presence of the necessary insect pollen vectors. In addition to this, the rotting of the female cones and seeds seems to have drastically reduced the percentage of fertile seeds (Oosthuizen, 1978; Kluge, 1981). Evidence that much of the healthy fertile seed is predated, leads one to believe that it is necessary to harvest any fertile seed that is found (Gilbert, 1984: Gerber, 1987). It is unfortunate that this seed will not be able to fulfil its role in the food chain, but the scarcity of the seed and the long periods between cone production suggest that this role is a very small, and possibly only a supplementary one.

Seed that is harvested from habitat plants must be made available to institutions such as the L.B.G. and the Hartbeeshoek Provincial Nursery in Pretoria. Here it may receive the attention necessary to aid germination. Forsyth and Van Staden (1983); Giddy

(1984); Fourie (1984); Koeleman and Raal (1985); Tang (1987b) all provide details with regard to the germination of cycad seeds.

Once the seeds have germinated, the seedlings may be planted out into bags and cared for until they are approximately five years old. *Encephalartos laevifolius* seedlings of this age that were grown from seed harvested from the Starvation Creek population in the L.B.G. are now robust enough to be planted back into the reserve. The origin of the seed must always be well documented to ensure that the seedlings are planted back into the population from which the seed was harvested. However, it may be necessary to plant Kaapsehoop seedlings into the Mariepskop and Swaziland populations, as the latter two show such little evidence of sexual propagation. In this case the salvation of the populations themselves is more important than their genetic purity.

ii) Vegetatively Propagated Material

Observations made by the author during this study indicated that vegetative propagation is practically an ongoing process, particularly in the form of basal suckers. During the monitoring operations there were

occasions when the suckers were so abundant that they could not be counted. Subsequent visits revealed a high percentage of sucker mortality. It seems a waste to allow this mortality without attempting to utilize this material. Bursey (1988) gives a detailed account of how to remove a sucker successfully.

Other vegetative propagates are offsets and branches as referred to by Giddy (1984). She also provides details as to how plants may be grown from this material. Epicormic shoots are those which grow from the side of a mature stem and are probably equivalent to what is described as an offset.

It is seldom that branches are seen in *E. laevifolius*, but they probably form through the growth of coppice shoots. A number of these cycads have been seen where the crown has broke off and shoots have begun to grow from the broken surface of the remaining plant. As these grow, two or three begin to dominate while the others die-back. It is possible that these smaller shoots could be removed for propagation before they die-back.

Gilbert (1984) states that, although cycads grow readily from seed, off-shoots are the preferred source of cultivated plants. She adds that another method of vegetative propagation is the cutting off and potting of newly developing fronds.

As with seed, all vegetatively produced material should follow the same path, i.e. to an institution such as the L.B.G., where it should be cultivated until large enough to be planted back into habitat.

iii) Mature Stems

The use of mature stems for the establishment of a seed orchard would be ideal as there would be very little delay before the production of seed (Giddy, pers. comm.). The problem lies in the acquisition of such material and it is only under extreme circumstances that mature stems should be removed from habitat.

Osborne (1989) suggests that plants confiscated from illegal trafficking operations should be used for establishing or expanding existing stock. Any

E. laevifolius found in private collections without the necessary permits should also be confiscated for the same purpose. The suggestion has also been made that plants in private collections be used for pollen collection, seed propagation and possibly for the re-introduction of plants to the Mariepskop and Swaziland populations (Osborne, pers. comm.).

On a number of occasions during field work, mature stems. that had been dug out by poachers but not removed, were found. It is not clear as to why they were left, but it is possibly because they were too heavy for the poachers to carry. (A stem of two meters in length takes at least six people to carry it without damaging it.) On these occasions the stems have been taken to the L.B.G. where they were treated with a fungicide and planted in the seed orchard.

Mature stems have also been obtained from mature stems that were senescing. Although they can never be saved as a single mature stem, it is possible that, with the correct and timely treatment, they could be persuaded to produce root suckers before they finally die. The treatment consists of a long soak in a fungicide bath after all the rotten sections of the stem have been

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CONCLUSIONS AND RECOMMENDATIONS

removed. The pieces of stem that are still firm are then planted in large pots in the hope that vegetative propagation will follow.

As with the removal of seed, one needs to consider the effect the removal of a rotting stem might have on the ecosystem. The loose fibrous structure of the stem allows a host of insects and other organisms to colonize it with relative ease. It is possible, therefore, that it plays an important role. However, if new individuals are propagated by such a stem after it has been treated and planted, it may be worth the price the ecosystem has to pay.

After mature stems are established in a seed orchard and begin to produce cones, they must be monitored closely. If male cones are produced first, their pollen must be collected and stored for pollinating the female cones when they develop and mature. The collection and storage of pollen is a simple but very important operation and must be undertaken with care. Tang (n.d.a); Giddy(1984); Giddy (1987) all provide detail instructions as to how pollen is collected and stored.

If female cones are produced before male cones, then all natural populations should be inspected in an attempt to locate pollen. The pollen bank of the C.S.S.A. may also be contacted in this regard (Giddy, 1987). Some cycad species are easier to pollinate than others, but *E. laevifolius* could rank as one of the most difficult.

Although Giddy (1987); Fourie (1984); Koeleman and Raal (1985); Tang (n.d.b); Tang (1987b) all provide detailed accounts of how hand pollination should be carried out, it is necessary to discuss the difficulties that were experienced with *E. laevifolius*.

After monitoring the development of both the male and female cones on a weekly basis until they had reached maturity, the monitoring continued every three days in an attempt to establish when the female cone scales opened to receive pollen. Unless this occurred over a shorter period, the observations lead to the conclusion that the scales do not open. Besides providing further evidence of the necessity of insects as pollen vectors, this presents a problem for hand pollination. Giddy (pers. comm.) provided the following solution: " remove two to three of the

sterile cone scales from the apex of the cone and apply the pollen. Repeat this application once a week for six weeks.". A complication which was encounted while applying this advice was the good wound-healing capacity of cycads as referred to by Gilbert (1984). The openings made by the removal of the sterile scales soon became closed with gum exudations. When more pollen was to be applied, more scales had to be removed. By the end of the six weeks the entire apex of the cone had been removed. It is unfortunate that the results of this exercise cannot be recorded as there is a long time lapse from pollination to seed release. Tang (1987b) states that this period could be from four months to a year, but success is expected as the percentage of fertile seed from hand pollination is usually much higher than that of plants in habitat (Newell, 1983).

If the hand pollination exercise is successful, the fertile seed must be planted and the resultant seedlings cultivated until they are four to five years old. They should then be able to survive within their habitat and should be planted out as discussed earlier.

iv) Tissue Culture

Mention has already been made of the possible effects that the removal of seeds and mature stems could have on the ecosystem of the cycad. Although the threats facing this plant lead one to overlook this aspect, it would be ideal if an alternative method of propagation could be found. Tissue culture has been used to propagate a number of threatened plants and work has been done on the South African cycads.

Osborne, *et al* (1988) report that callus growth is quite readily obtained from leaf, root and stem tissue from nine *Encephalartos* species, but no further morphogenesis is promoted. There are, however, encouraging results from primary root tissue culture of *Stangeria eriopus*. Callus formation progresses to light-induced emergence of meristematic zones, buds and leaves in sequence.

4.6.3. POPULATIONS IN NEED OF ENHANCEMENT AND RE-ESTABLISHMENT

i) Enhancement

When one considers the size of each population as recorded in Table 1 of section 3.1., it is clear that enhancement priorities must be inversely proportional to population size. The Swaziland and Mariepskop populations should receive immediate attention. The Compartment J and Belmont populations also require enhancement, but not as urgently. The Starvation Creek population is the largest and most flourishing and should, therefore, not need attention in this regard.

ii) Re-establishment

Possibly the most important consideration in determining areas suitable for re-establishment was and is the safety of the plants after the operation. Even if such an exercise is carried out in secret, the new localities would soon be discovered by determined and enthusiastic collectors and/or poachers. Such an

operation will be very expensive and could not be carried out if there was any doubt as to the safety of the plants.

One of the major reasons for the endangered status of this species is the habitat destruction by forestry, and mention was made in section 3.4. of the proximity of plantations to all the populations. An area in the mountains above the Braum-Robenheimer dam between Lydenburg and Machadodorp fulfils most of the basic habitat requirements. It is, however, private land and the safety of the plants cannot be ensured.

Personal observations during an aerial survey of the mountains west of Kaapsehoop (courtesy of T.P.A.N.E.C.) revealed a complete absence of *E. laevifolius*. This could be for one of two reasons. Firstly, the natural distribution of the cycad could be restricted to the narrow eastern band as depicted on Fig. 1; or secondly, all the plants that use to occur in these mountains have since been removed. This area is relatively inaccessible and the first reason seems to be the most likely, even though superficial observations indicate similar habitat to that of Kaapsehoop.

Considering the fact that safety of re-established populations cannot be guaranteed, it would be best to concentrate all population manipulation efforts on the enhancement of existing populations, until such time as the circumstances change.

Now that both the results obtained from this study and others have been reviewed and discussed in context, it is possible to go ahead and make conclusions. The conclusions made are listed in the following chapter together with the necessary recommendations.

5. CONCLUSIONS AND RECOMMENDATIONS

This study has faced a number of limitations and constraints. Initially the aims and objectives were outlined in Chapter One as follows: to investigate and enlarge upon the ecology of *E. laevifolius*; establish the nature, extent and means of mitigating the threats that face the plant; and develop guidelines for the appropriate management of both the plant and its habitat. The objectives set to achieve these aims were to determine the distribution and structure of each population, establish their basic habitat requirements, investigate the interactions with specific organisms, as well as the role of fire in the cycads ecology and how it may be used as a management tool, evaluate the seriousness of the threat of poaching and the effectiveness of the relevant legislation, and establish suitable methods of *ex situ* propagation. It is apparent in retrospect that all of these have been achieved. A number of avenues of research have been identified as requiring the attention of various specialists, and specific recommendations in this regard have been made below.

5.1. THE POPULATION CENSUS AND FUTURE POPULATION CENSUSES

Even without detailed knowledge of the threats facing the continued existence of this cycad in its natural habitat,

E. laevifolius would undoubtedly be classified as "rare". This is obvious since the total number of plants in all the populations is only approximately 800. However, considering that only two of the five populations, Starvation Creek and Compartment J, have sound age class distributions and sexually propagated off-spring, it may further be conclude that the species is not only rare, but endangered as well. It is, therefore, essential that all the populations of *E. laevifolius* be monitored on a regular basis. An annual monitoring action would be ideal, but the only organisation with the man power and the necessary insights to carry out this task (i.e. the Flora Section of T.P.A.N.E.C.)would probably only be able to manage this every third year.

Tri-annual monitoring only is feasible because the organisation concerned is responsible for the monitoring of all rare and endangered plants in the Transvaal, and an action of this intensity would not fit into their annual program. Furthermore, the Starvation Creek population is burnt on a tri-annual basis and monitoring which takes place approximately three months after the burn would be most appropriate. The reason being that all moribund vegetation would be removed by the burn and those cycads responding with vigouruosly growing whorls of foliage could be easily accounted for. This would enhance the accuracy of the census as well as most of the plants should be in this condition.

Finally, it is recommended that this monitoring continue for as long as possible, and that all information gathered be documented very carefully. (The information presently gathered on the annual monitoring form used by T.P.A.N.E.C., as can be seen in Appendix A, is sufficient.) These data should then be sufficient for one to gain an insight into the population dynamics of *E. laevifolius*. In addition to this it will provide an indication as to the success of any particular management measures that are being applied.

5.2. BASIC HABITAT REQUIREMENTS

Irrespective of the fact that the investigation into the above was relatively superficial, and that *E. laevifolius* is found growing successfully in cultivation outside of its natural habitat, this cycad appears to be habitat specific. The data presented in Table 2 may not be absolute proof of this conclusion, but the fact that no plants occur within areas with habitat components other than those described in this table, gives credibility to the conclusion. Where the information gathered, such as the climatic data, was inaccurate or insufficient, improved techniques could be applied. For example, automatic weather stations could be placed at strategic positions within each population.

5.3. ORGANISMS WITH WHICH *ENCEPHALARTOS LAEVIFOLIUS* HAS SPECIFIC INTERACTIONS

5.3.1. ORGANISMS WITH POSITIVE INTERACTIONS

Of the four interactions investigated and discussed in this report, the significance of only one is certain. The role of the baboon as a seed distribution vector is now confirmed. It must, however, be mentioned that the baboon are probably not dependent on the seeds as an essential part of their diet, as they do have other sources of nutrition. It is the function which they fulfil as a seed distribution vector which is essential for the cycad. If this function is to be fulfilled artificially as described in section 4.6.2.(i) then the presence of baboon is not critical. However, if not, then it is essential that they be available to carry out this function naturally.

From the discussion on pollination, it is difficult to draw any firm conclusions. It would seem safest to say that a combination of both wind and insect pollination is what actually happens. The pollen grains of *E. laevifolius* have no appendages to facilitate wind travel and are "heavy", which leads to the conclusion that insects are, at least in part, necessary for the transportation of the pollen from the male to the female cones. They are probably also necessary for taking the pollen into the cone.

It is unfortunate that entomologists have only recently begun work on this aspect, but it is encouraging that this work is to continue (Oberprieler and Donaldson, pers comm.). The recommendation in this regard is, therefore, that these specialists must receive as much assistance as possible, as they are not able to visit the plants as regularly as they should. If mature cones are encountered during monitoring actions by the Flora Section of T.P.A.N.E.C., a single male and female cone should be sent to P.P.R.I. for attention Mr. R. Oberprieler, or to the Kirstenbosch Botanic Gardens for attention Mr. J. Donaldson. In addition to this, any insects found on plants with cones, on and/or inside the cones, should be collected and sent to one of the above entomologists. Details of where, when, and by whom the collection was carried out must be included with each specimen sent. It is essential that clarification in this regard is obtained as soon as possible as management needs to take all aspects of the cycads ecology into consideration to ensure their conservation.

5.3.2. ORGANISMS WITH NEGATIVE INTERACTIONS

Although there is uncertainty with regard to the exact significance of the role of the leopard moth and the pathogenic infection of the female cones, the danger they pose to the continued existence of the relatively few plants left in their

natural habitat leads one to conclude that solutions to these problems must be found. The use of insecticides should be avoided as far as possible due to the possible role of insects in the pollination of the female cones. The manipulation of leaf and cone emergence by burning during early to mid-winter, May to June, should be applied to prevent the caterpillars of leopard moth from causing any damage. In this way, the possibility that the moth is indeed indigenous to the same area as the cycads, is taken into consideration and it would have to find alternative plants to lay its eggs on. An investigation should be implemented to establish the original distribution of the moth in order to determine if it is alien to ecosystem of the cycad.

With regard to the pathogenic infection of the female cones, the following questions still need to be answered:

- is it an old or new occurrence?

- is it a natural component of the cycad ecology?

- are the low percentages of fertile seed a result of this infection and if so, why are fertile seeds seemingly not infected?

- if the infection is being caused by a pathogen, what is it and how can it be controlled or eradicated?

- is the infection indicative of a physiological disorder which is predisposing the plants to infection which otherwise would not occur?

- what role does atmospheric pollution play in the above?

The recommendation is that this aspect continue to be studied by specialists in this field on a full time basis. It could be given to a post-graduate student in the pathology section of the Botany department at one of our universities. In such a situation all the necessary knowledge and facilities would be readily available and the study could be carried out on a full-time basis.

5.4. THE ROLE OF FIRE IN THE ECOLOGY OF *ENCEPHALARTOS LAEVIFOLIUS* AND ITS USE AS A MANAGEMENT TOOL

Unlike certain grass species, for example, fire is not absolutely essential for the survival of this cycad. The species does, however, occur within veld types which naturally experience fire, and, therefore, has itself a specific response to fire. By alternating the season and frequency of burning, these responses may be manipulated to the benefit of the plants. Fire may, therefore, be used as a management tool, although if not used according to ecological principles, it may be to the detriment of

the plants. All the factors which need to be considered when formulating an ecologically based burning program are discussed in detail in section 4.4., and after considering those of which there is most certainty, the following program is recommended:

Frequency: an average of a tri-annual burn with alternate 2 and 4 yearly burns.

Season: as late as possible before the beginning of the Fire Prohibition Period, avoiding spring and early summer burns, at least until the leopard moth has been eradicated.

It must be noted that, although, this program is presently the most feasible and practical to implement, it may not be ideal for *E. laevifolius*. Further research is necessary to confirm its ecological suitability.

The populations, in which intensive management is to be applied, should be inspected annually by an officer of the T.P.A.N.E.C. Flora Section. This officer should then advise the land owners

or managers with regard to whether or not the planned burn should be carried out or postponed. If this is not possible then the land owners or managers must be made aware of the following factors which will aid their decision:

- if the build-up of moribund vegetation is such that a burn during a dangerous season (1 August to 30 September) will cause the death of seedlings and damage to adult plants, it should be carried out as soon as it is safe (1 April to 30 June),

- if the moribund vegetation has not build up to a dangerous level, then the evidence of sexual propagation should be considered,

- if it is found that there are plants carrying cones and/or there are seedlings with only a single leaf, the burn should be postponed until at least the following year,

- if there is no evidence of sexual propagation, then the burn should take place as late as possible, but before 1 August.

The above is simplified as a flow chart in Figure 3 below.

If the burn has to be carried out and there is a danger of seedling mortality and damage to adult plants, the area immediately around each of the plants must be cleared. The clearing should be sufficient to allow the burn and secure the safety of the cycads. It is essential that close liaison is maintained between land owners with *E. laevifolius* populations on their property and the Flora Section of T.P.A.N.E.C., irrespective of who is taking the decision to burn or not. The latter organisation is responsible for the threatened plants of the Transvaal and must, therefore, provide as much assistance as possible in this regard, to ensure the sound management of these populations.

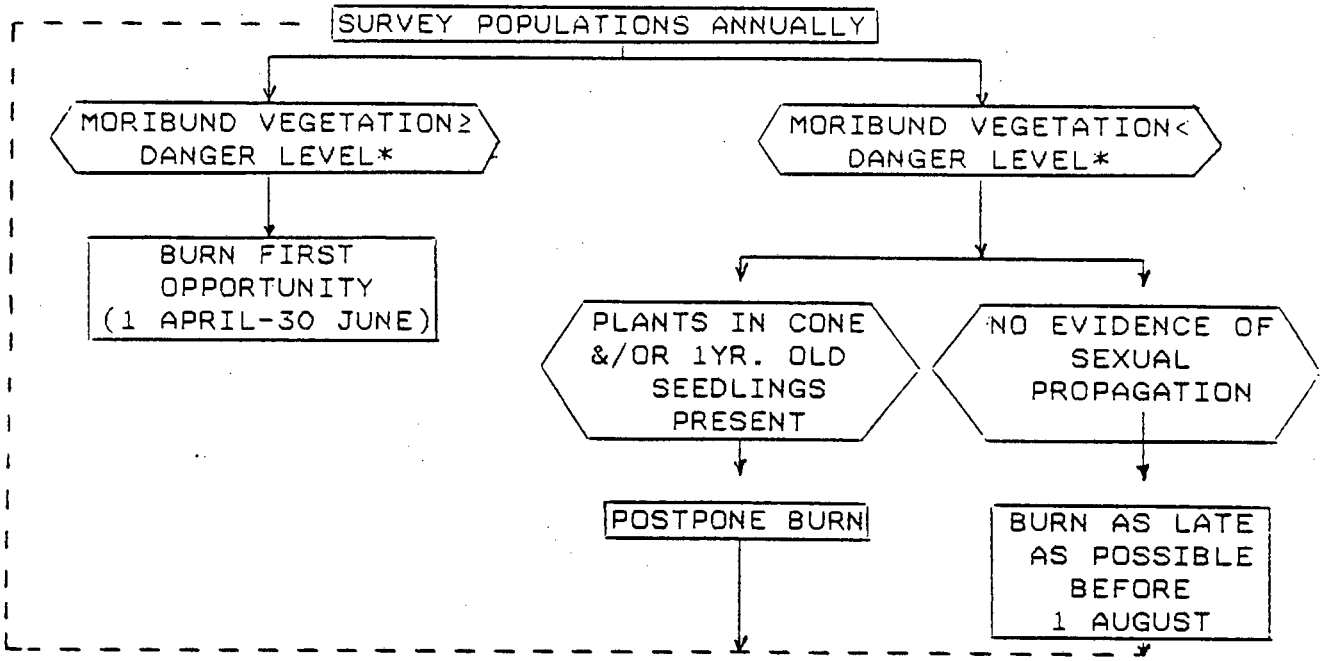

Figure 3. A flow chart illustrating the factors that need to be considered when deciding whether to burn a population or a part of a population of *Encephalartos laevifolius*.

* The manager will have to make a decision with regard to when the danger level is reached as it depends on a number of factors. For example, the amount of personnel available to ensure the safety of adjacent plantations and other land use activities, and the topography of the area to be burnt.

Legend: ACTIVITIES DECISIONS Steps of iterations

Although the above may seem quite clear and relatively easy to implement, it is essential to recall the concerns expressed with regard to the survival of possible insect pollinators. As discussed in section 4.4.1. research still needs to be carried out in this regard. It is possible that a burning frequency of an average of three years may be detrimental to the survival of these important organisms. They may require up to ten years to regain the population size necessary to effect pollination. If this is the case then management by fire must be adapted accordingly.

Up until this point in this report the recommendations which have been made have been sympathetic to the objectives of the timber growers, and possibly subject to the statement made by Harris (1981) as recorded in Chapter One. It is, therefore, at this point that one must ask the question, "are the Forestry Branch of the Department of Environment Affairs and other relevant land owners prepared to accept full responsibility for the successful conservation of this endangered species?". If they are, then they must accept the fact that it may be necessary to set areas within the natural populations of *E. laevifolius* aside to research this aspect of insect pollination. This may require a series of different burning regimes which range from plots where fire is applied at increasingly greater intervals to at least one in which fire is completely excluded. This work will require close co-operation between all concerned, will have to be

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co-ordinated by an entomologist and will have to be very well documented to ensure the continuity and success of this very important long term project. The Flora Section of the T.P.A.N.E.C. should initiate this project.

5.5. ILLEGAL REMOVAL OF HABITAT PLANTS

Of the causal factors which have resulted in this plant being classed as "endangered", the above is the most significant. The damage caused by the leopard moth and the pathogenic infection of the female cones does have a detrimental effect on the plants and the populations as a whole, but the plants remain intact and have the ability of recovering to regain their function within and value to the population. When they are removed they leave a gap, the significance of which is inversely proportional to the size of the population. This is not to say that it may be acceptable to remove plants from the larger populations. The status of these cycads is such that a theft from any of the populations will have serious ramifications. Recommendations are made in the following section with regard to the *ex situ* propagation of these plants. It is, however, better to allow natural recruitment to take place through sexual propagation, and the chances of this occurring are directly proportional to the number of individuals in a population. It is, therefore, recommended that every effort is made to put a stop to this practice. The following are recommendations which, if implemented, should achieve the latter.

They are discussed per level of legislation.

i) The International Level (CITES)

The percentage of countries submitting annual reports under the CITES agreement should be improved, and these reports should be both complete and as accurate as possible. There should be co-ordination between conservation and law enforcement bodies at an international level. The attention given to the illegal collection and trade in cycads in general should be of the same magnitude as that recently given to the international trade in ivory.

ii) The National Level (Forest Act of 1984)

The section of the Forest Act of 1984 which is applicable to protected trees should be transferred to the Provincial Ordinances. It should retain the authority of the Act, as the latter over rules an Ordinance.

iii) The Provincial Level (The Nature Conservation Ordinance of the Transvaal (12 of 1983))

In general, the Ordinances of each Province should be co-ordinated to ensure the maximum protection of all threatened and specially protected plants throughout the country.

The penalty for a person found guilty of the collection and/or trade in cycads should be increased drastically. The amount payable should be in excess of that which can be obtained for the plants. The theft of plants from their natural habitat is far more severe a crime than that of the theft from a garden; the legislation presently acknowledges the reverse and this should be rectified.

The Ordinance should be extended to make it illegal to possess cycads of any size without a valid permit. It presently caters only for adult cycads with the exception of *E. humulis* and *E. cupidus*, which remain small plants. Lavranos and Goode (1989) cite the case of *E. cerinus*, which shortly after it had been discovered and described, had nearly all the seedlings and juvenile plants removed from the population. It is, therefore, essential that no distinction be made with regard to the age of cycads. A

valid receipt from a registered nursery will be sufficient as a permit for seed grown individuals, and thus should not hamper any legal trade.

As a final recommendation with regard to the legislation pertaining to the protection of cycads and threatened plants in general; the bodies responsible for the enforcement of the legislation should be made as effective as possible. It is of no use to make changes to existing legislation if its enforcement is not ensured. There should be a marked increase in the number of personnel actively involved in putting a stop to these illegal activities, and they must receive sufficient remuneration so as to ensure that they will not accept bribes and will remain faithful to the cause. They must also have a full understanding of the ecological importance of the plants they are protecting. This should ensure job satisfaction and enable them to educate others.

5.6. POPULATION ENHANCEMENT AND RE-ESTABLISHMENT

Although there are areas where populations may be re-established, it is suggested that this option not be pursued. The safety of the plants cannot be guaranteed and it is, therefore not practical to put them at risk, as well as waste valuable time and

money. All efforts must be concentrated on the enhancement of the existing populations. The following are steps that should be followed to achieve the latter:

- All populations should be monitored on a regular basis and mature cones should be harvested for their seed.

- The cones should be given to the L.B.G. where they will receive the necessary attention to prepare them for cultivation.

- Seedlings that are propagated in the L.B.G. should be transplanted back into the population from which they were harvested when they are four to five years old.

- At the risk of introducing different genetic material, seedlings from the stable populations should be planted into those which are not producing their own, (i.e. seedlings from the Kaapsehoop populations should be used to enhance the Mariepskop and Swaziland populations).

- Plants that are confiscated from poachers should immediately be planted into the seed orchard at the L.B.G., unless their successful re-establishment into the population from which they were removed can be guaranteed.

- Senescing stems should be removed to the L.B.G. where they must be treated in a fungicide bath and planted. The shoots that may develop should then be removed and planted out as separate plants. They should then be treated as if they were seedlings.

- Plants uprooted by poachers but not removed from the population should receive the same treatment as the latter.

In all of the above the guidelines of the experts referred to in section 4.6. must be followed closely.

5.7. THE FUTURE OF *ENCEPHALARTOS LAEVIFOLIUS*

The definition of the status "endangered" is cited fully in Chapter One. Within the definition it states that if the causal factors, which have placed *E. laevifolius* in this category, are not curtailed, there is a danger of the plant becoming extinct. It was also stated in Chapter One that this report is intended to be a working document; that is, one in which the recommendations that have been made are feasible and should be implemented as soon as possible. Although one tends to lose heart when faced with the long procedures involved in changing legislation, whether on the international or provincial level, optimism must be maintained in this regard, especially in the light of recent

developments with regard to other endangered species such as the African Elephant and the Black Rhino. It will be unfortunate if the recommendations to make legislation more strict and the penalty for contravention more severe are not adhered to. An example has been set in the case of the Elephant and the Rhino, species which are probably not as endangered as most of our cycads, including *E. laevifolius*. The removal of habitat plants could have massive impacts on the natural populations of this cycad before the entomologists and pathologists have found answers to the questions set for them. In other words, the recommendations listed above are not only feasible, but they require urgent attention if those involved in the research and conservation of our threatened flora want to contribute to the prevention of *E. laevifolius* becoming extinct.

Finally, it must be noted that all of the Tranvaal cycads are either classified as being rare or endangered. Some species, such as *E. heenanii*, *E. dolomiticus* and *E. dyerianus*, are even more endangered than *E. laevifolius*. It is, therefore, essential that the principles and avenues explored in this study be extended to other cycad species in South Africa, which are in need of specific management measures to secure their future in nature.

Endpiece.

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Hertogs, R. Entomologist at the Zoology Department at the University of Natal, Pietermaritzberg.

Kluge, J.P. Curator of the Lowveld Botanic Gardens in Nelspruit.

Koen, T. Officer in Charge, Laboritory for soil and foliage analysis at C.S.F.R.I.

Norstog, K.J. Chairman: Species Survival Commission, I.U.C.N.'s Cycad Specialist Group, Waterloo, Illinois.

Oberprieler, R.G. Entomologist at the Plant Protection Research Institute in Pretoria.

Onderstal, J. Amateur Botanist and Free-lance Journalist.

Oosthuizen, J.C. Officer in Charge, Hartbeeshoek Provincial Nursery, Pretoria.

Osborne, R. President of the Cycad Society of South Africa.

Pohl, J. Control Forester at the Berlin State Forest of the Forestry Branch Of the Department of Environment Affairs.

Rossouw, J. Conservation Officer for the Southern and Eastern Transvaal Forest Regions of the Forestry Branch of the Department of Environment Affairs, Nelspruit.

Vorster, P. Taxonomist at the Botany Department of the University of Stellenbosch.

APPENDICES

APPENDICES

APPENDIX A

FIELD DATA FORMS USED FOR THE POPULATION CENSUSES: MARIEPSKOP

KAAPSEHOOP - STARVATION CREEK

COMPARTMENT J

BELMONT

SWAZILAND

ANNUAL MONITORING DATA SHEET

TAXON: Enc. laevifolius DATE: 13/10/89

SITE NO 2 ● (Mariepskop) PLOT NO: 1

MONITORING OFFICIAL: K. Zuntel + T. Steyn.

ECOLOGICAL INFORMATION

PRECIPITATION FOR YEAR OF MONITORING: 1800 MM

LAND USE PRACTICE:

~~GAME~~	CROP	ORCHARDS	MINING	URBAN
STOCK	POULTRY	PLANTATIONS	INDUSTRY	REC.SITE
OTHER/:				

FIRE/:

TIME PREVIOUS FIRE/		MONTHS
~~PLANNED~~/ACCIDENTAL	X	

PROPORTION OF POPULATION AFFECTED/

20	40	60	80	~~X~~	%

WAS AREA GRAZED/

YES/	X	NO/	

GRAZING INTENSITY/.....

LIGHT/....X....	MEDIUM/.....	SEVERE/.....

PROPORTION OF POPULATION GRAZED/

20	40	60	80	100	%

MAP SHOWING DAMAGE APPENDED (FIRE/GRAZING

YES	~~X~~

VEGETATION STRUCTURE (EDWARS 1983)

	LOW	SHORT	TALL	HIGH	CLOSED	OPEN	SPARSE
FOREST							
WOODLAND		X	X			X	
BUSHLAND							
SHRUBLAND	X	X				X	
GRASSLAND		X			X		
HERBLAND	X						X

NOTES: Areas has been burnt for a long time & grass etc. is becoming very matt burnt.

DOMINANT ASSOCIATED VEGETATION/INDICATOR SPECIES:

TREES	% COVER ABUNDANCE
1. Protea roupelliae	1 2 3 4 5
2. Greyia radlkoferi	1 2 3 4 5
3.	1 2 3 4 5
4.	1 2 3 4 5
5.	1 2 3 4 5
SHRUBS	
1. Cephalanthus natalensis	1 2 3 4 5
2. Gnidia canoargentea	1 2 3 4 5
3.	1 2 3 4 5
4.	1 2 3 4 5
5.	1 2 3 4 5
HERBS/GRAMINOIDS	
1. Pteridium aquilinum	1 2 3 4 5
2. Hebenstretia dura	1 2 3 4 5
3. Tetraselago nelsonii	1 2 3 4 5
4. Carbera ambigua	1 2 3 4 5
5. Wahlenbergia sp.	1 2 3 4 5

DISTURBANCE TO HABITAT OF POPULATION:

NONE APPARENT					
AGRICULTURE	1	2	3	4	5
URBANIZATION	1	2	3	4	5
INDUSTRIALIZATION	1	2	3	4	5
WEEDS/ALIEN VEGET.	1	2	3	4	5
FIRE	1	2	3	4	5
SHEET EROSION	1	2	3	4	5
DONGA EROSION	1	2	3	4	5
ENCROACH. VEGET.	1	2	3	4	5
OTHER	1	2	3	4	5

NAME ALIEN/WEEDS/ENCROACHING SPECIES:

COLLECTERS NUMBERS:

DEFINE OTHER: _____

HABITAT STABILITY: - (N) +

DEFINE: Lack of burning could be having a deleterious effect on the habitat

K

TAXON DATA:

POPULATION AREA

ESTIMATED	ACTUAL
1 - 10m²	
10 - 100m²	
100 - 1000m²	30 000
1000 - 1km²	
1km²-5km²	
> 5 km²	

PLANT DISTRIBUTION PATTERN IN POPULATION

SCATTERED	X
RANDOM	
CLUMPED	

NUMBERS OF PLANTS IN MONITORING PLOT

ACTUAL	6
ESTIMATED	6
% GROUND COVER	-1%

ESTIMATED NUMBER OF PLANTS IN POPULATION:

POPULATION SIXE x NOs OF PLANTS IN PLOT = [ ]
MON. PLOT SIZE 1

AGE CLASS STRUCTURE OF PLANTS IN PLOT

	NO	%	♂	♀	
(Seilings) JUVENILES	6				
MATURE	7		3	1	
SENESCENT	3				
TOTAL		100%			

*Geen Saailinge

AGE CLASS STRUCTURE OF POPULATION

	EST %
JUVENILES	
MATURE	
SENESCENT	

REPRODUCTION:
PRECENTAGE PLANTS IN MONITORING PLOT THAT ARE:

DORMANT	
FLOWERING	
FRUITING	
DISPERSING SEED	
SHOOT GROWTH	

THREATS TO TAXON:

NONE APPARENT					
COLLECTORS	1	2	3	4	X
MUTI	1	2	3	4	5
GRAZING/BROWZING	1	2	3	4	5
TRAMPLING	1	2	3	4	5
NATURAL PATHOGENS	1	2	3	4	5
OTHER	1	2	3	4	X

DEFINE OTHER: Fire : Veld thick + excess fuel could damage or destroy plants, Especially

NOTES: (POPULATION SIZE, SHAPE, VIGOUR ETC).
those lying on the ground.

ENCEPHALARTOS

NO.	M/F	CONES	HEIGHT	AGE	VIGOUR +/-/0	COMMENTS

MARIEPSKOP POPULATION MONITORED 12/10/89

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
1.1			3.6	A	+	FOLIAGE SENESCING AND IN NEED OF A BURN.
1.2			2.7	A	+	ALL 3 STEMS LYING PROSTRATE, DOWN SLOPE.
1.3			2.0	A	+	FOUR YOUNG SUCKERS.
2			2.7	A	+	PLANT LYING PROSTRATE DOWNSLOPE. ONE SUCKER AND 3 EPICOEMIC SHOOTS ON MAIN STEM.
3.1	♀	(OLD RECORDS)	2.3	A	+	ONE PLANT PRODUCING NEW FOLIAGE, WHILE THE
3.2	♀		1.2	A	+	OTHERS ALL HAVE HEALTHY MATURE FOLIAGE.
3.3	♀		1.7	A	+	
3.4	♀		2.8	A	+	
3.5	♀		3.9	A	+	
3.6	♀		2.3	A	+	
3.7	♀		3.5	A	+	
3.8	♀		2.4	A	+	
3.9	♀		0.3	A	+	
4.1	♂	6	1.4	A	+	ONE JUVENILE SUCKER PLUS APPROXIMATELY 4 OTHERS
4.2	♂	(CONES OLD + WOODY).	1.6	A	+	BUT DIFFICULT TO DETERMINE EXACT AMOUNT.
5.1	♂	6	1.8	A	O	WERE PRODUCING CONES IN MARCH '89 AS WITH PLANT 4.1.
5.2	♂	5	2.1	A	O	BUT CONES DID NOT MATURE. CROWN STILL FIRM.
5.3	♂		1.9	A	—	
5.4	♂		1.5	A	—	PLANT COMPLETELY DEAD. CROWNS SOFT AND ROTTING.
5.5	♂		0.8	A	—	
6			1.2	A	O	STEM PROSTRATE AND IN POOR CONDITION. FIRE DAMAGE TO STEM.

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
7			1.5	A	+	
8.1	♂	(OLD CONES)	2.4	A	+	APPROXIMATELY 8 SMALL SUCKERS. GRASS VERY RANK
8.2	♂		3.0	A	+	AND MORIBUND AND A BURN WILL PROBABLY
8.3	♂		2.0	A	+	KILL THE SUCKERS NOW. NEED TO CLEAR AREA
8.4	♂		1.2	A	+	IMMEDIATELY AROUND THE PLANTS BEFORE BURNING.
8.5	♂		2.3	A	+	
8.6	♂		1.5	A	+	
8.7	♂		2.1	A	+	
8.8	♂		1.3	A	+	
8.9	♂		0.1	A	+	
9.1	♀	(OLD CONES)	2.2	A	+	ALL STEMS LYING PROSTRATE.
9.2	♀		1.3	A	+	
9.3	♀		1.7	A	+	CATERPILLAR DAMAGE TO FOLIAGE
9.4	♀		1.5	A	+	
9.5	♀		0.7	A	+	
9.6	♀		0.5	A	+	CATERPILLAR DAMAGE TO FOLIAGE
10.1			1.5	A	+	GROUPS 9 & 10 COULD BE MISTAKEN FOR A
10.2			0.8	A	+	SINGLE GROUP, BUT ARE CLEARLY SEPARATE.
10.3			0.1	A	+	
11.1	♀	(OLD CONES)	3.0	A	+	
11.2	♀		2.6	A	+	
11.3	♀		1.6	A	+	

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
11.4	♀		0.25	A	+	
12			0.05	A	+	COVERED BY AN EXCESS OF MORIBUND VEGETATION
13			1.5	A	+	ONE EPICORMIC SHOOT NEAR BASE OF STEM.
14.1			1.5	A	—	DEAD.
14.2			1.2	A	+	CROWN DEAD, BUT TWO COPPICE CROWNS EMERGING
14.3			0.9	A	+	TWO YOUNG SUCKERS AT BASE
15.1	♂	(OLD CONES)	3.6	A	+	
15.2	♂		2.6	A	+	
15.3	♂		0.5	A	+	
15.4	♂		1.3	A	+	
15.5	♂		1.0	A	+	
15.6	♂		0.5	A	+	
16.1			2.0	A	—	DEAD AND BREAKING UP
16.2			1.4	A	+	
17.1	♂		3.2	A	+	STEMS RADIATING OUT FROM THE CENTRE IN
17.2	♂		2.7	A	+	A 180° ARC, MOSTLY PROSTRATE.
17.3	♂		1.3	A	+	FIVE SMALL SUCKERS.
17.4	♂		1.4	A	+	
17.5	♂		1.5	A	+	
17.6	♂		3.3	A	+	
17.7	♂		3.6	A	+	

ANNUAL MONITORING DATA SHEET

TAXON: Enc. Rosulatus DATE: 5/10/89

SITE NO 1 (Station (road A)) PLOT NO: A

MONITORING OFFICIAL: T. Stigen & K. Zimbel

ECOLOGICAL INFORMATION:
PRECIPITATION FOR YEAR OF MONITORING: _____ MM
LAND USE PRACTICE:

GAME	CROP	ORCHARDS	MINING	URBAN
STOCK	POULTRY	PLANTATIONS	INDUSTRY	RESIDENTIAL
OTHER/: Omring deur plantasies				

FIRE/:

TIME PREVIOUS FIRE/	17	MONTHS
PLANNED/~~ACCIDENTAL~~	P	

PROPORTION OF POPULATION AFFECTED/

20	40	60	80	100	%

WAS AREA GRAZED/

YES/		NO/	

GRAZING INTENSITY/.....

LIGHT/...X...	MEDIUM/.....	SEVERE/.....

PROPORTION OF POPULATION GRAZED/

20	40	60	80	100	%

MAP SHOWING DAMAGE APPENDED (FIRE/GRAZING

YES	~~NO~~

VEGETATION STRUCTURE (EDWARS 1983)

	LOW	SHORT	TALL	HIGH	CLOSED	OPEN	SPARSE
FOREST							
WOODLAND							
BUSHLAND		X	-	-	X		
SHRUBLAND		X			X		
GRASSLAND		X			X		
HERBLAND		X			X		

NOTES: Creek begin onder dig wood.

DOMINANT ASSOCIATED VEGETATION/INDICATOR SPECIES:

TREES	% COVER ABUNDANCE
1. Combretum molle	1 2 3 4 5
2. Syzygium cordatum	1 2 3 4 5
3. Faidherbia spaciosa	1 2 3 4 5
4. Cussonia spicata	1 2 3 4 5
5.	1 2 3 4 5

SHRUBS	
1. C. molle	1 2 3 4 5
2.	1 2 3 4 5
3.	1 2 3 4 5
4.	1 2 3 4 5
5.	1 2 3 4 5

HERBS/GRAMINOIDS	
1. Pteridium aquilinium	1 2 3 4 5
2. Hyparrhenia dissoluta	1 2 3 4 5
3. Imperata cylindrica	1 2 3 4 5
4.	1 2 3 4 5
5.	1 2 3 4 5

DISTURBANCE TO HABITAT OF POPULATION:

NONE APPARENT					
AGRICULTURE	1	2	3	4	5
URBANIZATION	1	2	3	4	5
INDUSTRIALIZATION	1	2	3	4	5
WEEDS/ALIEN VEGET.	1	2	3	X	5
FIRE	1	2	3	4	5
SHEET EROSION	1	2	3	4	5
DONGA EROSION	1	2	3	4	5
ENCROACH. VEGET.	1	2	X	4	5
OTHER	1	2	3	4	5

NAME ALIEN/WEEDS/ENCROACHING SPECIES: Dorne/Wattle/
COLLECTERS NUMBERS:
Smilax

Adelaars vaning

DEFINE OTHER: _____

HABITAT STABILITY: - X +

DEFINE: Ag.v. in disgr plots

TAXON DATA:

POPULATION AREA

ESTIMATED	ACTUAL
1 - 10m²	
10 - 100m²	
100 - 1000m²	
1000 - 1km²	
1km²-5km²	
> 5 km²	

PLANT DISTRIBUTION PATTERN IN POPULATION

SCATTERED	X
RANDOM	
CLUMPED	

NUMBERS OF PLANTS IN MONITORING PLOT

ACTUAL	
ESTIMATED	
% GROUND COVER	

ESTIMATED NUMBER OF PLANTS IN POPULATION:

POPULATION SIXE / MON. PLOT SIZE x NOs OF PLANTS IN PLOT / 1 = ☐

AGE CLASS STRUCTURE OF PLANTS IN PLOT OF POPULATION

	NO	%
JUVENILES	19	
MATURE	20	
SENESCENT	5	
TOTAL	44	100%

AGE CLASS STRUCTURE

EST %

JUVENILES	
MATURE	
SENESCENT	

REPRODUCTION:

PRECENTAGE PLANTS IN MONITORING PLOT THAT ARE:

DORMANT	
FLOWERING	
FRUITING	
DISPERSING SEED	
SHOOT GROWTH	

THREATS TO TAXON:

NONE APPARENT					X
COLLECTORS	1	2	3	4	5
MUTI	1	2	3	4	5
GRAZING/BROWZING	1	2	3	4	5
TRAMPLING	1	2	3	4	5
NATURAL PATHOGENS	1	2	3	4	5
OTHER	1	2	3	4	5

DEFINE OTHER: _____

NOTES: (POPULATION SIZE, SHAPE, VIGOUR ETC).

ENCEPHALARTOS

NO.	o o	KONES	HEIGHT	AGE	VIGOUR +/-/0	COMMENTS

POPULATION DATA FOR **ENCEPHALARTOS LAEVIFOLIUS**

KAAPSEHOOP POPULATION MONITORED: 5/10/89

SUB-POPULATION: STARVATION CREEK

PLOT A

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
1				J	+	EVIDENCE OF LEOPARD MOTH DAMAGE TO FOLIAGE
2						MISSING
3				A	+	CROWN JUST EMERGING
4.1	♀		1.8	A	−	
4.2			0.8	A	O	
4.3			0.8	A	+	
5				J	+	
6				J	+	
7				J	+	TAGGED
8				J	+	"
9				J	+	NOT TAGGED
10				A	+	STEM JUST ABOVE THE SURFACE
11				J	+	TAGGED
12				J	+	"
13				J	+	"
14	♂	1	0.1	A	+	NB SINGLE CONE ON A ♂ PLANT IS UNUSUAL
15				J	+	NOT TAGGED
16				J	+	" "
17				S	+	

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
18.1				J	+	8 LEAVES } GROWING CLOSE TOGETHER.
18.2				S	+	5 LEAVES }
19				J	+	
20				A	+	CROWN JUST ABOVE SURFACE
21				J	+	BROWSING DAMAGE, BUT NOT SEVERE
22				S	+	4 LEAVES
23				A	+	CROWN JUST ABOVE SURFACE
24				J	+	3 LEAVES AND 4 STALKS
25				J	+	CROWN EMERGING
26				J	O	FIRE MAY STIMULATE GROWTH, BUT GUM
						EXUDATIONS FROM EMERGING CROWN MUST BE
						MONITORED.
27				S		1 LEAF
28						MISSING
29.1	♂	5	3.3	A	+	
29.2	♂	3	2.3	A	+	
29.3	♂	(2 ABORTED) 3	1.3	A	+	
29.4	♂		0.9	A	+	
29.5	♂		0.05	A	+	
30.1			2.9	A	—	CROWN STILL FIRM BUT STEM LIGHT AND DEFINITELY
30.2			1.4	A	—	SENESCENT. KLUGE (1981) RECORDS THIS PLANT AS BEING 2.93M
						AND HAVING ONE SUCKER (KLUGE NO. 21).

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
31.1			2.7	A	+	KINK IN STEM AT ±2m.
31.2			1.5	A	+	
31.3			0.2	A	+	
31.4			0.0	J	+	
31.5			0.0	J	+	
32			0.6	A	+	COPPICE GROWTH → 8 CROWNS WITH ONE DOMINANT
33	♂	OLD CONES	1.0	A	+	
34				S	+	1 LEAF + 2 STALKS
35				S	+	2 LEAVES + 3 STALKS
36				S	+	3 LEAVES. TAGGED.
37				S	+	1 LEAF + 1 DEAD LEAF
38				S	+	1 LEAF. NOT TAGGED
39				S	+	1 LEAF. 3 STALKS
40				S	+	2 LEAVES

ANNUAL MONITORING DATA SHEET

TAXON: Enc laevifolius DATE: 5/10/89

SITE NO ● ● (Starvation Creek B) PLOT NO: _____

MONITORING OFFICIAL: T. Steyn & K. Zunkel

ECOLOGICAL INFORMATION:
PRECIPITATION FOR YEAR OF MONITORING: _____ MM
LAND USE PRACTICE:

~~GAME~~ X	CROP	ORCHARDS	MINING	URBAN
STOCK	POULTRY	~~PLANTATIONS~~	INDUSTRY	REC.SITE
OTHER/:				

FIRE/:

TIME PREVIOUS FIRE/	5	MONTHS
PLANNED/~~ACCIDENTAL~~	P	

PROPORTION OF POPULATION AFFECTED/

20	40	60	80	~~100~~ X	%

WAS AREA GRAZED/

YES/ X	NO/

GRAZING INTENSITY/.....

LIGHT/.. X	MEDIUM/.....	SEVERE/.....

PROPORTION OF POPULATION GRAZED/

20	40	60	80	100	%

MAP SHOWING DAMAGE APPENDED (FIRE/GRAZING

YES	~~NO~~ X

VEGETATION STRUCTURE (EDWARS 1983)

	LOW	SHORT	TALL	HIGH	CLOSED	OPEN	SPARSE
FOREST							
WOODLAND							
BUSHLAND		X				X	
SHRUBLAND		X				X	
GRASSLAND		X				X	
HERBLAND		X				X	

NOTES: Gras in habitat is opgebrand

DOMINANT ASSOCIATED VEGETATION/INDICATOR SPECIES:

TREES	% COVER ABUNDANCE
1. Faurea speciosa	1 2 3 4 5
2. Syzygium cordatum	1 2 3 4 5
3. Cussonia spicata	1 2 3 4 5
4. Protea caffra	1 2 3 4 5
5. Greya radlkoferi	1 2 3 4 5

SHRUBS	
1. Protea caffra	1 2 3 4 5
2. Erica drakensbergensis	1 2 3 4 5
3.	1 2 3 4 5
4.	1 2 3 4 5
5.	1 2 3 4 5

HERBS/GRAMINOIDS	
1. Pteridium aquilinum	1 2 3 4 5
2. Hemizonia triandra	1 2 3 4 5
3. Cymbopogon	1 2 3 4 5
4. Pentaschistis patula	1 2 3 4 5
5.	1 2 3 4 5

DISTURBANCE TO HABITAT OF POPULATION:

NONE APPARENT					
AGRICULTURE	1	2	3	4	5
URBANIZATION	1	2	3	4	5
INDUSTRIALIZATION	1	2	3	4	5
WEEDS/ALIEN VEGET.	1	2	3	X	5
FIRE	1	2	3	4	5
SHEET EROSION	1	2	3	4	5
DONGA EROSION	1	2	3	4	5
ENCROACH. VEGET.	1	2	X	4	5
OTHER	1	2	3	4	5

NAME ALIEN/WEEDS/ENCROACHING SPECIES:
COLLECTERS NUMBERS:

DEFINE OTHER: _____

HABITAT STABILITY: - X +

DEFINE: Heelwat indringer plant species in proefkamp omgewing.

TAXON DATA:

POPULATION AREA

ESTIMATED	ACTUAL
1 - 10m²	1900 / 200
10 - 100m²	
100 - 1000m²	
1000 - 1km²	
1km²-5km²	
> 5 km²	

PLANT DESTRIBUTION PATTERN IN POPULATION

SCATTERED	X
RANDOM	
CLUMPED	

NUMBERS OF PLANTS IN MONITORING PLOT

ACTUAL	
ESTIMATED	
% GROUND COVER	

ESTIMATED NUMBER OF PLANTS IN POPULATION:

POPULATION SIXE / MON. PLOT SIZE x NOs OF PLANTS IN PLOT / 1 = ____

AGE CLASS STRUCTURE OF PLANTS IN PLOT

	NO	%
SEEDLINGS	1	
JUVENILES	5	
MATURE	25	
SENESCENT	3	
TOTAL	34	100%

AGE CLASS STRUCTURE OF POPULATION

	EST %
JUVENILES	
MATURE	
SENESCENT	

REPRODUCTION:
PRECENTAGE PLANTS IN MONITORING PLOT THAT ARE:

DORMANT	
FLOWERING	
FRUITING	
DISPERSING SEED	
SHOOT GROWTH	

THREATS TO TAXON:

NONE APPARENT					
COLLECTORS	1	2	3	4	X
MUTI	1	2	3	4	5
GRAZING/BROWZING	1	2	3	4	5
TRAMPLING	1	2	3	4	5
NATURAL PATHOGENS	1	2	3	4	5
OTHER	1	2	3	4	5

DEFINE OTHER: _____

NOTES: (POPULATION SIZE, SHAPE, VIGOUR ETC)..
Pergeil is in die jaar gebrand.

ENCEPHALARTOS

NO.	o o	KONES	HEIGHT	AGE	VIGOUR +/-/0	COMMENTS

PLOT B

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
1.1			1.8	A	+	5 VERY IMMATURE SUCKERS
1.2			0.1	A	+	
2				J	+	
3.1	♂		2.2	A	+	7 IMMATURE SUCKERS
3.2	♂		1.3	A	+	
3.3	♂		1.2	A	+	
3.4	♂	3	1.0	A	+	
3.5	♂		0.5	A	+	
3.6	♂		0.5	A	+	
3.7	♂		0.3	A	+	
3.8	♂			J	+	
4				J	+	SLIGHT DAMAGE TO FOLIAGE BY CATERPILLARS.
5				A	+	CROWN JUST EMERGING.
6				J	+	
7						MISSING
8				A	+	CROWN JUST EMERGING
9	♀		2.7	A	O	NEWLY DEVELOPED FOLIAGE DEAD. POSSIBLY BECAUSE OF FIRE. HAS 4 LARGE COPPICE CROWNS.
10						MISSING
11.1	♂		3.4	A	+	(Kluge's No. 3)
11.2	♂		1.3	A	+	
11.3	♂		0.5	A	+	

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
11.4	♂		0.2	A	+	
11.5	♂		0.2	A	+	
11.6	♂		0.2	A	+	
11.7	♂		1.3	A	+	
11.8	♂		0.1	A	+	
11.9	♂		0.15	A	+	
11.10	♂		0.2	A	+	
11.11	♂		0.3	A	+	
11.12	♂		0.8	A	+	
11.13	♂		2.4	A	+	
12						MISSING
13				S	+	
14				J	+	

SUB-POPULATION: BELMONT MONITORED: 4/10/89

* PLANTS NUMBERED L = LEFT AND R = RIGHT OF STREAM AS MONITOR PARTY MOVED DOWN AND THEN UP THE VALLEYS.

* PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
1.1 L	♀		2.0	A	+	PLANTS GROWING WITHIN RIPARIAN VEGETATION.
1.2	♀		2.0	A	+	EVIDENCE OF PATHOGENIC INFECTION.
1.3	♀		0.6	A	+	
1.4	♀		0.1	A	+	
1.5	♀		0.05	A	+	
2.1 R	♂	3	2.0	A	+	GROWING ON ROCKY OUTCROP ABOVE STREAM
2.2	♂		0.3	A	+	(± 100-200m ABOVE). BROWSING DAMAGE TO
2.3	♂		1.5	A	+	FOLIAGE AND CONES.
2.4	♂		0.2	A	+	
2.5	♂		0.2	A	+	
2.6	♂		0.2	A	+	
2.7	♂		0.3	A	+	
2.8	♂	2	0.35	A	+	
3.1 L	♂		2.5	A	+	GROWING WITHIN RIPARIAN VEGETATION.
3.2	♂		1.5	A	+	HAS 1 SMALL SUCKER.
3.3	♂		0.4	A	+	
3.4	♂		0.1	A	+	
3.5	♂		0.1	A	+	
4.1 L	♀		1.8	A	+	EVIDENCE OF PATHOGEN.
4.2	♀	3	1.3	A	+	CONES VERY IMMATURE.
4.3	♀		0.1	A	+	

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
5.1 L	♀	3	1.5	A	+	1 EPICORMIC SHOOT OF 0.15m + 16 BASAL SUCKERS.
5.2				S	+	EVIDENCE OF PATHOGEN BUT HEALTHY SEED ALSO
5.3				S	+	FOUND. SEEDLINGS IN CLOSE PROXIMITY TO
5.4				S	+	PARENT PLANT.
5.5				S	+	
6 L			1.0	A	+	
7 L				J	+	BROWSING DAMAGE TO FOLIAGE
8 L				S	+	" " " "
9 L				S	+	" " " "
10 L			0.25	A	+	" " " "
11 L				S	+	" " " "
12 L				S	+	" " " "
13 L				S	+	" " " "
14 R				S	+	ON EDGE OF CLIFF ABOVE STREAM.
15 L	♂	2	2.5	A	+	CONES IMMATURE.
16 L			1.0	A	+	
17.1 L			3.8	A	+	
17.2			2.0	A	+	
17.3			1.5	A	+	
18.1 R	♂	5	1.8	A	+	
18.2	♂	3	1.3	A	+	
18.3	♂		1.6	A	+	

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
18.4	♂		0.4	A	+	
18.5	♂		1.4	A	+	
18.6	♂		1.7	A	+	
19 R			1.2	A	+	
20 IR			1.8	A	+	
20.2			0.25	A	+	
21.1 L	♀	3	4.0	A	+	RECENTLY EXPOSED TO FIRE.
21.2	♀	3	1.0	A	+	
22.1 L			2.2	A	+	NOT EXPOSED TO FIRE.
22.2			1.3	A	+	
22.3			1.0	A	+	
23 L				S	+	SLIGHT BROWSING DAMAGE
24 R			0.05	A	+	
25 L				A	+	STEM JUST EMERGING.
26 L	♀		4	A	+	2 BASAL SUCKERS
27.1 L			2.2	A	+	
27.2			0.1	A	+	
27.3			0.05	A	+	
28 L	♂		1.8	A	+	2 IMMATURE SUCKERS.
29 L	♂	3	1.8	A	+	
30 L			0.05	A	+	
31 R			2.0	A + 9	+	10 BASAL SUCKER (FROM 1.8 m — NO STEM)

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
32 L			0.3	A	+	
33.1 L	♀		2.3	A		
33.2	♀	3	1.3	A		
33.3	♀		0.8	A		
33.4	♀		3.0	A		
34 L			2.0	A +4	+	4 BASAL SUCKERS (FROM 0.4 M - 0.05 m)
		(PARTY NOW MOVING UP STREAM)				
35 L			2.5	A +5	+	6 BASAL SUCKERS (FROM 1.0 m - 0.0m)
36 L	♀	3	4.0	A + 12	+	12 " " (" 4.0m - 0.1m)
37 L	♀		2.5	A	+	
38 L			3.0	A + 3	+	3 " " (" 2.0 m - 0.5 m)
39.1 L	♀	3	4.0	A	+	
39.2	♀	3	2.5	A	+	
39.3	♀		1.0	A	+	
40 L	♀	3	3.2	A + 2	+	2 " " (" 0.15m - 0.05 m)
						BROWSING DAMAGE.
41 L	♂	3	3.0	A + 3	+	3 BASAL SUCKERS (0.4m + 2 x 0.3 m)
42 L			1.5	A + 1		1 " " (0.8 m). BOTH STEMS
						COVERED IN MORIBUND VEGETATION.
43 L	♂	4	3.5	A	+	
44 L			4.0	A + 3	+	3 BASAL SUCKERS (2.5 m, 1.5 m & 0.3 m)
45 L			3.0	A + 2	+	2 " " (0.5 m & 0.4 m)

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
46 L			4.0	A +2	+	2 BASAL SUCKERS (1.5m + 0.1m) VERY
						IMMATURE CONES. IMPOSSIBLE TO SEX PLANT.
47 L			1.0	A	+	1 IMMATURE SUCKER.
48 L				S	+	1 LEAF
49 L				S	+	"
50 L			4.5	A +2	+	2 BASAL SUCKERS (1.3m + 1.2m)
51 L	♂		4.5	A	+	1 IMMATURE SUCKER
52 L			4.0	A +5	+	6 BASAL SUCKERS (4.0m - 0.0m)
53 L	♀	3	4.5	A +3	+	3 " " (2.0m, 1.0m + 0.3m)
54 L	♂	5	1.3	A	+	1 IMMATURE SUCKER.
55 L			2.2	A +2	+	2 BASAL SUCKERS (2.0m + 1.0m)
56 L			2.0	A +3	+	3 " " (0.3m + 2 x 0.15m)
57 L			3.0	A +4	+	4 " " (0.3m, 0.2m + 2 x 0.1m)
58 L			0.3	A	+	
59 L				S	+	1 LEAF
60 R	♀	2	2.4	A +1	+	1 BASAL SUCKER (1.2m)
61 L			3.5	A	+	2 IMMATURE SUCKERS.

SUB-POPULATION: COMPARTMENT J MONITORED: 6/10/89

(MONITORING PARTY MOVING ACROSS THE COMPARTMENT FROM $J_1 \rightarrow J_2$)

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
1	♂	3	1.8	A	+	NO FOLIAGE, CROWN FIRM.
2	♀	2	0.6	A	+	" "
3				S	+	4 LEAVES
4.1	♂	5	1.2	A	+	
4.2	♂		0.25	A	+	
5			3.5	A	+	NO FOLIAGE, CROWN FIRM.
6				J	+	NEW FOLIAGE
7				S	+	5 LEAVES
8				S	+	1 LEAF
9				S	+	2 LEAVES
10				S	+	1 LEAF
11				S	+	2 LEAVES
12	♀	2	1.2	A	+	NO FOLIAGE, CROWN FIRM
13				S	+	1 LEAF
14				S	+	"
15.1			1.8	A	+	
15.2			0.15	A	+	
16	♂	3	1.1	A	+	
17				S	+	4 LEAVES
18				S	+	3 LEAVES
19			0.1	A	+	

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
20.1				J	+	PLANTS CLOSE TOGETHER.
20.2				S	+	1 LEAF
21			0.03	A	+	2 SMALL SUCKERS
22			1.5	A	+	PINE TREE FALLEN ON TOP OF PLANT, BUT GROWTH CONTINUES.
23						PARENT PLANT STOLEN BUT 4 SUCKER GROWING FROM ROOTS LEFT IN THE GROUND.
24				S	+	1 LEAF
25				J	+	
26				S	+	1 LEAF
27				S	+	"
28				S	+	"
29				S	+	"
30				S	+	"
31				S	+	"
32				S	+	"
33				S	+	"
34				S	+	"
35				S	+	"
36				S	+	"
37				S	+	"
38			2.2	A	+	4 SINGE LEAF SUCKERS.

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
39			1.2	A	+	LEAVES CUT OFF, READY TO BE DUG OUT BY POACHERS.
40			1.1	A	+	ONE SUCKER WITH 2 LEAVES.
41.1	♀	2	3.0	A	+	
41.2	♀		3.0	A	+	
42.1			3.2	A	+	
42.2			3.0	A	+	
43.1	♂	2	2.2	A	+	BROWSING DAMAGE TO CONES, POSSIBLY BY BABOON.
43.2	♂	1	1.5	A	+	UNUSUAL TO HAVE ♂ PLANTS WITH SO FEW CONES.
44.1			1.9	A	+	
44.2			0.3	A	+	
45.1			3.0	A	−	
45.2			0.5	A	0	
45.3			1.6	A	+	
46	♀		0.7	A	+	
47			0.4	A	+	
48.1			3.0	A	+	STEM BENT OVER ROCK, BUT RESPONDING TO PHOTOTROPISM
48.2			0.05	A	0	CATERPILLAR DAMAGE TO FOLIAGE. NEEDS A BURN.
48.3					—	PLANT DEAD.
49			1.5	A	+	NO FOLIAGE, CROWN FIRM.
50			1.8	A	+	
51.1				J	+	

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
S1.2						IMMATURE SUCKER.
S2.1	♂	2	2.0	A	O	NEIGHBOURING PLANT REMOVED BY POACHERS CAUSING
						THIS PLANT TO TOPPLE. PLANT REMOVED BY SURVEY
						PARTY TO LOWVELD BOTANIC GARDENS.
S2.2				J	+	SUCKER GROWING FROM WHERE S2.1 STOOD.
S3	♀	3	1.5	A	+	
S4	♀	OLD CONES	2.5	A	+	
S5				J	+	
S6				J	O	FOLIAGE SENESCENT.
S7.1	♀	5	1.6	A	+	CONES 1 3 MONTHS OLD, ONE EATEN, POSSIBLY BY
S7.2	♀	4	1.0	A	+	BABOON. 3 IMMATURE SUCKERS ALSO PRESENT.
S7.3	♀	5	0.5	A	+	
S7.4	♀		3.5	A	−	PLANT SENESCING
S8			0.05	A	+	
S9	♀	4	1.2	A	+	
60			0.02	A	+	
61				J	+	NEEDS A BURN
62				S	+	
63				J	+	
64	♀	1	1.0	A	+	
65	♂	OLD CONES	1.1	A	+	
66.1			3.0	A	+	

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
66.2			1.3	A	+	
67	♂	2	2.5	A	+	
68.1			2.0	A	+	
68.2			2.0	A	+	
68.3			1.5	A	+	
69.1	♀		3.3	A	−	PLANT SENESCENT
69.2	♀	4	2.6	A	+	
70.1	♀	3	1.1	A	+	
70.2	♀		2.0	A	+	
		(SURVEY	PARTY NOW IN	COMP. J2)		
71			1.5	A	+	
72				S	+	
73	♀	PAST RECORD	3.0	A	+	
74	♀	3	1.8	A	+	
75			2.0	A	+	+SINGLE IMMATURE SUCKER
76.1			3.2	A	+	
76.2						SENESCENT STEM
77				J	+	
78	♀	OLD CONES		A	+	
79				S	+	
80				J	+	
81				J	O	DAMAGED BY TIMBER HARVESTING

PLANT NO.	SEX	CONES	HEIGHT ± (M)	AGE CLASS	VIGOUR	COMMENTS
82				J	+	
83				J	+	
84				J	+	
85				S	+	1 LEAF
86				S	+	2 LEAVES
87			3.1	A	+	
88			2.2	A	+	+ 1 IMMATURE SUCKER
89	♀	3	3.3	A	+	
90				S	+	2 LEAVES
91				J	+	
92	♀	3	3.5	A	+	
93			1.7	A	+	+ 1 SUCKER WITH 6 LEAVES
94			1.0	A	—	SENESCENT
95			2.2	A	+	
96			1.5	A	—	SENESCENT
97			0.2	A	+	
98				S	+	2 LEAVES
99				S	+	5 LEAVES.

TABLE 1 DETAILS OF ENCEPHALARTOS LAEVIFOLIUS ON THE MALOLOTJA NATURE RESERVE – SWAZILAND

GROUP NO.	A		B	C		D	E	
PLANT NO.	1	2		1	2		1	2
SEX	FEMALE	?	MALE	FEMALE	MALE	?	MALE	?
Approx. stem length in M.	4 Stems 2x 0.5m 2x 0.1m	5 Stems from 0.1m to 0.7m	1 Stem of 1.0m and 5 small suckers	5 Stems 3 damaged by fallen tree	1 Stem of 0.2m	5 Stems, from 0.7m-1.5m + 6 small root suckers	2 Stem, each 1m, one is Dichotomously branced	2 Stems of 1.0m
Condition of plant	Evidence of damage by leopard moth	Foliage twisted and leaflets compacted	All are in good condition	2 in good condition. Other 3 should recover from tree damage	Good condition and possibly responsible for pollenating Cl	All in good condition	Plants in good condition. Including the 10 root suckers	Good condition
Slope aspect	SE	SE	SW	WNW	WNW	ENE	NW	NW
Attitute in M.A.S.L.	890	890	1040	840	820	1040	1070	1070
Dates of previous fires	5/8/83 14/5/86 possibly also in 1987		21/5/85	5/8/83 14/5/86 possibly also in 1987		5/8/83 Possibly '87	5/8/83 and Possibly in 1987	

APPENDIX B

DATA FORMS FROM THE ANALYSIS OF SOIL AND FOLIAGE FROM EACH POPULATION:

MARIEPSKOP

KAAPSEHOOP - STARVATION CREEK
COMPARTMENT J
BELMONT

SWAZILAND

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIREKTEUR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME K. Zijnckel ADRES/ADDRESS Boskou BOORD NO/ORCHARD NO 1A MARIEPSKOP GEWAS/CROP Cycads

♂ 2.5m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987					
pH	4,59					
Ohms	2820					
Ca mg/kg	85					
Mg mg/kg	32					
K mg/kg	138					
P mg/kg *	2,0					
Al mg/kg	242					
Ca/Mg						
TEKSTUUR/TEXTURE						
PROD.TON/ha						
LAB. NO.	95					

BLAARONTLEDINGS/LEAF ANALYSIS

	1987					
N %	1,85					
P %	0,098					
K %	0,52					
Ca %	0,18					
Mg %	0,101					
Zn mg/kg	9					
Cu mg/kg	9					
Mn mg/kg	125					
Fe mg/kg	72					
B mg/kg	21					
LAB. NO.	116					

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

_____ na DIR
_____ pp DIR

Al = Titreerbare Suurtegraad. (1MKCl ekstrak.
* P = Hars ekstrak (X 2,83 = Bray No2 P)
Ca+Mg+K = 1N NH4OAc ekstrak

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIREKTEUR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME: K. Zünckel ADRES/ADDRESS: Basbou

BOORD NO/ORCHARD NO: 1B MARIEPSKOP 1.2m GEWAS/CROP: Cycads

GRONDONTLEDINGS/SOIL ANALYSIS

	7987						
pH	4,45						
Ohms	3720						
Ca mg/kg	70						
Mg mg/kg	26						
K mg/kg	53						
P mg/kg	45						
Al mg/kg	254						
Ca/Mg							
TEKSTUUR/TEXTURE							
PROD.TON/ha							
LAB. NO.	96						

BLAARONTLEDINGS/LEAF ANALYSIS

	7987						
N %	1,65						
P %	0,028						
K %	0,50						
Ca %	0,16						
Mg %	0,093						
Zn mg/kg	4						
Cu mg/kg	6						
Mn mg/kg	19						
Fe mg/kg	56						
B mg/kg	16						
LAB. NO.	117						

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of N.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIREKTEUR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Bosbou BOORD NO/ 1C GEWAS/CROP Cycads
OBSERVED NO MARIEPSKOP 0.0m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987					
pH	4,72					
Ohms	4900					
Ca mg/kg	65					
Mg mg/kg	25					
K mg/kg	75					
P mg/kg	45					
Al mg/kg	206					
Ca/Mg						
TEKSTUUR/TEXTURE						
PROD.TON/ha						
LAB. NO.	97					

BLAARONTLEDINGS/LEAF ANALYSIS

	1987					
N %	1,49					
P %	0,028					
K %	0,61					
Ca %	0,16					
Mg %	0,100					
Zn mg/kg	3					
Cu mg/kg	5					
Mn mg/kg	20					
Fe mg/kg	70					
B mg/kg	19					
LAB. NO.	118					

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or F.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
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Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIREKTEUR, CSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME K. Zuinckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 1D MARIEPSKOP GEWAS/CROP Cycads

♂ 0.3m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987						
pH	4,66						
Ohms	3150						
Ca mg/kg	60						
Mg mg/kg	31						
K mg/kg	135						
P mg/kg	1,2						
Al mg/kg	266						
Ca/Mg							
TEKSTUUR/TEXTURE							
PROD.TON/ha							
LAB. NO.	98						

BLAARONTLEDINGS/LEAF ANALYSIS

	1987						
N %	1,68						
P %	0,077						
K %	0,73						
Ca %	0,08						
Mg %	0,056						
Zn mg/kg	7						
Cu mg/kg	9						
Mn mg/kg	74						
Fe mg/kg	70						
B mg/kg	21						
LAB. NO.	119						

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOUWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or F.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

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_____ns DIR:
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIREKTEUR, GSERI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME K. Zuinckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 1E MARIEPSKOP GEWAS/CROP Cycads.

1.5m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987						
pH	4,63						
Ohms	3590						
Ca mg/kg	75						
Mg mg/kg	29						
K mg/kg	100						
P mg/kg	4,2						
Al mg/kg	190						
Ca/Mg							
TEKSTUUR/TEXTURE							
PROD.TON/ha							
LAB. NO.	99						

BLAARONTLEDINGS/LEAF ANALYSIS

	1987						
N %	1,54						
P %	0,082						
K %	0,43						
Ca %	0,16						
Mg %	0,108						
Zn mg/kg	6						
Cu mg/kg	7						
Mn mg/kg	67						
Fe mg/kg	74						
B mg/kg	24						
LAB. NO.	120						

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of N.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

as DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIRECTOR, CSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME: K. Zünckel ADRES/ADDRESS: Bosbou BOORD NO/ORCHARD NO: 1 F GEWAS/CROP: Cycads

MARIEPSKOP ♂ 1.5m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987				
pH	4,74				
Ohms	1820				
Ca mg/kg	90				
Mg mg/kg	36				
K mg/kg	295				
P mg/kg	1,5				
Al mg/kg	241				
Ca/Mg					
TEKSTUUR/TEXTURE					
PROD.TON/ha					
LAB. NO.	100				

BLAARONTLEDINGS/LEAF ANALYSIS

	1987				
N %	1,72				
P %	0,059				
K %	0,50				
Ca %	0,13				
Mg %	0,120				
Zn mg/kg	8				
Cu mg/kg	8				
Mn mg/kg	51				
Fe mg/kg	66				
B mg/kg	24				
LAB. NO.	121				

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIRECTOR, CSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 2A STARVATION CREEK GEWAS/CROP Cycads

1.5m

GRONDONTLEDINGS/SOIL ANALYSIS

	7987						
pH	4,52						
Ohms	2520						
Ca mg/kg	185						
Mg mg/kg	50						
K mg/kg	104						
P mg/kg	20						
Al mg/kg	389						
Ca/Mg							
TEKSTUUR/TEXTURE							
PROD.TON/ha							
LAB. NO.	101						

BLAARONTLEDINGS/LEAF ANALYSIS

	7987						
N %	1,20						
P %	0,044						
K %	0,68						
Ca %	0,21						
Mg %	0,176						
Zn mg/kg	13						
Cu mg/kg	9						
Mn mg/kg	27						
Fe mg/kg	64						
B mg/kg	22						
LAB. NO.	122						

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of S.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

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DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIREKTEUR, OSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Basbou BOORD NO/ORCHARD NO 2B STARVATION CREEK GEWAS/CROP Cycads

♀ 0.0m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987						
pH	4,72						
Ohms	5750						
Ca mg/kg	80						
Mg mg/kg	24						
K mg/kg	44						
P mg/kg	45						
Al mg/kg	286						
Ca/Mg							
TEKSTUUR/TEXTURE							
PROD.TON/ha							
LAB. NO.	102						

BLAARONTLEDINGS/LEAF ANALYSIS

	1987						
N %	1,82						
P %	0,040						
K %	0,43						
Ca %	0,18						
Mg %	0,292						
Zn mg/kg	3						
Cu mg/kg	4						
Mn mg/kg	22						
Fe mg/kg	82						
B mg/kg	26						
LAB. NO.	123						

A=HOEVEELHEID AANBEVEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

as DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIRECTOR, CSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME K. Zuinckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 2C GEWAS/CROP Cycads

STAKVATTING CREEK 0.6m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987					
pH	4,33					
Ohms	2620					
Ca mg/kg	105					
Mg mg/kg	55					
K mg/kg	91					
P mg/kg	2,0					
Al mg/kg	537					
Ca/Mg						
TEKSTUUR/TEXTURE						
PROD.TON/ha						
LAB. NO.	103					

BLAARONTLEDINGS/LEAF ANALYSIS

	1987					
N %	1,65					
P %	0,044					
K %	0,31					
Ca %	0,27					
Mg %	0,259					
Zn mg/kg	5					
Cu mg/kg	4					
Mn mg/kg	66					
Fe mg/kg	70					
B mg/kg	12					
LAB. NO.	124					

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIREKTEUR, CSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME: K. Zünckel ADRES/ADDRESS: Bosbou BOORD NO/ORCHARD NO: 2D GEWAS/CROP: Cycads

STALVATION CREEK 0.0m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987						
pH	5,05						
Ohms	2440						
Ca mg/kg	345						
Mg mg/kg	255						
K mg/kg	315						
P mg/kg	4,5						
Al mg/kg	239						
Ca/Mg							
TEKSTUUR/TEXTURE							
PROD.TON/ha							
LAB. NO.	104						

BLAARONTLEDINGS/LEAF ANALYSIS

	1987						
N %	1,43						
P %	0,082						
K %	0,46						
Ca %	0,16						
Mg %	0,182						
Zn mg/kg	9						
Cu mg/kg	5						
Mn mg/kg	24						
Fe mg/kg	83						
B mg/kg	14						
LAB. NO.	125						

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

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_____ as DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIRECTOR, CSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.32071

NAAM/NAME _____ ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 2E STARVATION CREEK GEWAS/CROP Cycads

♂ 2.5m

GRONDONTLEDINGS/SOIL ANALYSIS

	7987							
pH	5,17							
Ohms	3900							
Ca mg/kg	200							
Mg mg/kg	178							
K mg/kg	105							
P mg/kg	1,0							
Al mg/kg	206							
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.	105							

BLAARONTLEDINGS/LEAF ANALYSIS

	7987							
N %	1,52							
P %	0,099							
K %	0,40							
Ca %	0,15							
Mg %	0,151							
Zn mg/kg	7							
Cu mg/kg	6							
Mn mg/kg	26							
Fe mg/kg	71							
B mg/kg	17							
LAB. NO.	126							

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word. Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

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DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIREKTEUR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 2F STARVATION CREEK GEWAS/CROP Cycads

♂ 1.0m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987					
pH	4,97					
Ohms	5140					
Ca mg/kg	100					
Mg mg/kg	67					
K mg/kg	125					
P mg/kg	1,5					
Al mg/kg	278					
Ca/Mg						
TEKSTUUR/TEXTURE						
PROD.TON/ha						
LAB. NO.	106					

BLAARONTLEDINGS/LEAF ANALYSIS

	1987					
N %	1,41					
P %	0,084					
K %	0,36					
Ca %	0,27					
Mg %	0,139					
Zn mg/kg	7					
Cu mg/kg	6					
Mn mg/kg	54					
Fe mg/kg	83					
B mg/kg	20					
LAB. NO.	127					

	A-HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED	T-HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED						
BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIREKTEUR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Bosbou BOORD NO/BOREHOLE NO 3A GEWAS/CROP Cycads

COMPARTMENT J

0.0m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987					
pH	4,44					
Ohms	3300					
Ca mg/kg	110					
Mg mg/kg	82					
K mg/kg	110					
P mg/kg	10					
Al mg/kg	316					
Ca/Mg						
TEKSTUUR/TEXTURE						
PROD.TON/ha						
LAB. NO.	107					

BLAARONTLEDINGS/LEAF ANALYSIS

	1987
N %	1,53
P %	0,050
K %	0,60
Ca %	0,33
Mg %	0,27
Zn mg/kg	6
Cu mg/kg	6
Na mg/kg	70
Fe mg/kg	65
B mg/kg	20
LAB. NO.	128

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or F.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIRECTOR, CSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 3B COMPARTMENT J GEWAS/CROP Cycads

2.0m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987					
pH	4,68					
Ohms	2040					
Ca mg/kg	295					
Mg mg/kg	346					
K mg/kg	123					
P mg/kg	2,5					
Al mg/kg	275					
Ca/Mg						
TEKSTUUR/TEXTURE						
PROD.TON/ha						
LAB. NO.	108					

BLAARONTLEDINGS/LEAF ANALYSIS

	1987					
N %	1,44					
P %	0,040					
K %	0,35					
Ca %	0,35					
Mg %	0,271					
Zn mg/kg	6					
Cu mg/kg	5					
Mn mg/kg	31					
Fe mg/kg	69					
B mg/kg	33					
LAB. NO.	129					

BEMESTINGSTOWWE/FERTILIZERS		A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T	T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED A	T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant										
UREUM/UREA(46%)	g/plant										
AM.SULFAAT/AM.SULPHATE(21%)	g/plant										
SUPERS(10,5%)	g/plant										
CALMAFOS	g/plant										
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant										
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha										
KALSITIES/CALCITIC KALK/LIME	Ton/ha										
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha										
BORAKS/BORAX	g/100 l water										
SINKOKSIED/ZINC OXIDE	g/100 l water										
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water										
ANDER/OTHER											

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME K. Zuinckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 3C COMPARTMENT J GEWAS/CROP Cycads

3.5-4.0m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987
pH	4,39
Ohms	4150
Ca mg/kg	75
Mg mg/kg	41
K mg/kg	75
P mg/kg	42
Al mg/kg	448
Ca/Mg	
TEKSTUUR/TEXTURE	
PROD.TON/ha	
LAB. NO.	109

BLAARONTLEDINGS/LEAF ANALYSIS

	1987
N %	1,46
P %	0,066
K %	0,35
Ca %	0,24
Mg %	0,281
Zn mg/kg	8
Cu mg/kg	4
Mn mg/kg	46
Fe mg/kg	72
B mg/kg	26
LAB. NO.	130

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

_____

_____

_____

_____

_____ns DIR
pp DIR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSIR,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 3D COMPARTMENT 3 GEWAS/CROP Cycads

0.7m

GRONDONTLEDINGS/SOIL ANALYSIS								BLAARONTLEDINGS/LEAF ANALYSIS							
	1987								1987						
pH	5,67							N %	1,60						
Ohms	1220							P %	0,084						
Ca mg/kg	745							K %	0,36						
Mg mg/kg	560							Ca %	0,34						
K mg/kg	310							Mg %	0,337						
P mg/kg	3,0							Zn mg/kg	5						
Al mg/kg	37							Cu mg/kg	6						
Ca/Mg								Na mg/kg	66						
TEKSTUUR/TEXTURE								Fe mg/kg	67						
PROD.TON/ha								B mg/kg	21						
LAB. NO.	110							LAB. NO.	131						

	A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED				T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED							
BEMESTINGSTOWWE/FERTILIZERS	T	A	T	A	T	A	T	A				
KAN/LAN(28%)	g/plant											
UREUM/UREA(46%)	g/plant											
AM.SULFAAT/AM.SULPHATE(21%)	g/plant											
SUPERS(10,5%)	g/plant											
CALMAFOS	g/plant											
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant											
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha											
KALSITIES/CALCITIC KALK/LIME	Ton/ha											
K.MIS of N.MIS/K.MANURE or P.MANURE	Ton/ha											
BORAKS/BORAX	g/100 l water											
SINKOKSIED/ZINC OXIDE	g/100 l water											
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water											
ANDER/OTHER												

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

---

as DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIRECTOR, CSIRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Rosbou BOORD NO/ORCHARD NO 3 E COMMITMENT 3 GEWAS/CROP Cycads

0.1m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987							
pH	4,85							
Ohms	3950							
Ca mg/kg	95							
Mg mg/kg	90							
K mg/kg	170							
P mg/kg	4,5							
Al mg/kg	279							
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.	111							

BLAARONTLEDINGS/LEAF ANALYSIS

	1987							
N %	1,61							
P %	0,088							
K %	0,85							
Ca %	0,29							
Mg %	0,333							
Zn mg/kg	4							
Cu mg/kg	5							
Mn mg/kg	91							
Fe mg/kg	78							
B mg/kg	26							
LAB. NO.	132							

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

as DIR
pp DIR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSIR,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 3F. COMPARTMENT 3 GEWAS/CROP Cycads

1.2 m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987														
pH	5,05														
Ohms	1430														
Ca mg/kg	700														
Mg mg/kg	405														
K mg/kg	145														
P mg/kg	30														
Al mg/kg	83														
Ca/Mg															
TEKSTUUR/TEXTURE															
PROD.TON/ha															
LAB. NO.	112														

BLAARONTLEDINGS/LEAF ANALYSIS

	1987														
N %	1,50														
P %	0,091														
K %	0,39														
Ca %	0,15														
Mg %	0,274														
Zn mg/kg	7														
Cu mg/kg	6														
Mn mg/kg	48														
Fe mg/kg	72														
B mg/kg	19														
LAB. NO.	133														

	A-HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED	T	A	T	A	T	A	T	A
BEMESTINGSTOWWE/FERTILIZERS									
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIREKTEUR, CSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200. - TEL. 52071

NAAM/NAME: K. Zünckel ADRES/ADDRESS: Bosbou BOORD NO/ORCHARD NO: 4A BELMONT GEWAS/CROP: Cycads

♂ 0.5m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987						
pH	4,77						
Ohms	2660						
Ca mg/kg	175						
Mg mg/kg	65						
K mg/kg	151						
P mg/kg	32						
Al mg/kg	286						
Ca/Mg							
TEKSTUUR/TEXTURE							
PROD.TON/ha							
LAB. NO.	113						

BLAARONTLEDINGS/LEAF ANALYSIS

	1987						
N %	1,74						
P %	0,099						
K %	0,65						
Ca %	0,17						
Mg %	0,108						
Zn mg/kg	7						
Cu mg/kg	6						
Mn mg/kg	14						
Fe mg/kg	71						
B mg/kg	20						
LAB. NO.	134						

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or F.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME K. Zijnckel ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO 4B BERMONT GEWAS/CROP Cycads

♂ 1.5m

GRONDONTLEDINGS/SOIL ANALYSIS

	1981																		
pH	4,65																		
Ohms	2810																		
Ca mg/kg	160																		
Mg mg/kg	53																		
K mg/kg	230																		
P mg/kg	20																		
Al mg/kg	361																		
Ca/Mg																			
TEKSTUUR/TEXTURE																			
PROD.TON/ha																			
LAB. NO.	114																		

BLAARONTLEDINGS/LEAF ANALYSIS

	1982																		
N %	1,52																		
P %	0,093																		
K %	0,43																		
Ca %	0,14																		
Mg %	0,117																		
Zn mg/kg	11																		
Cu mg/kg	6																		
Mn mg/kg	11																		
Fe mg/kg	69																		
B mg/kg	19																		
LAB. NO.	135																		

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS/of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

as DIR
pp DIR

DIREKTEUR, NISSV, PRIVAATSAK X11208, NELSPRUIT, 1200/DIREKTEUR, CSFRI, PRIVATE BAG X11208, NELSPRUIT, 1200.- TEL.52071

NAAM/NAME: K. Zünckel ADRES/ADDRESS: Rosbou BOORD NO/ORCHARD NO: 4C+D GEWAS/CROP: Cycads

♀ 1.0m † ♀ 2.5m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987
pH	4,56
Ohms	1560
Ca mg/kg	295
Mg mg/kg	120
K mg/kg	430
P mg/kg	16,5
Al mg/kg	545
Ca/Mg	
TEKSTUUR/TEXTURE	
PROD.TON/ha	
LAB. NO.	115

BLAARONTLEDINGS/LEAF ANALYSIS

	1987
N %	2,21
P %	0,179
K %	1,03
Ca %	0,13
Mg %	0,154
Zn mg/kg	15
Cu mg/kg	9
Mn mg/kg	14
Fe mg/kg	63
B mg/kg	21
LAB. NO.	136

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or F.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIE
pp DIE

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME K. Zünckel ADRES/ADDRESS Rosbou BOORD NO/ORCHARD NO 4 D SEMONT GEWAS/CROP Cycads

♀ 1.0m

GRONDONTLEDINGS/SOIL ANALYSIS

	1987
pH	
Ohms	
Ca mg/kg	
Mg mg/kg	
K mg/kg	
P mg/kg	
Al mg/kg	
Ca/Mg	
TEKSTUUR/TEXTURE	
PROD.TON/ha	
LAB. NO.	

BLAARONTLEDINGS/LEAF ANALYSIS

	1987
N %	2,81
P %	0203
K %	1,11
Ca %	020
Mg %	0,197
Zn mg/kg	17
Cu mg/kg	10
Mn mg/kg	15
Fe mg/kg	64
B mg/kg	32
LAB. NO.	137

BEMESTINGSTOWWE/FERTILIZERS		A-HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED		T-HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED					
		T	A	T	A	T	A	T	A
KAN/LAN(28%)	g/plant								
UREUM/UREA(46%)	g/plant								
AM.SULFAAT/AM.SULPHATE(21%)	g/plant								
SUPERS(10,5%)	g/plant								
CALMAFOS	g/plant								
KALIUMCHLORIED/POTASSIUM CHLORIDE	g/plant								
DOLOMIET/DOLOMITIC KALK/LIME	Ton/ha								
KALSITIES/CALCITIC KALK/LIME	Ton/ha								
K.MIS of H.MIS/K.MANURE or P.MANURE	Ton/ha								
BORAKS/BORAX	g/100 l water								
SINKOKSIED/ZINC OXIDE	g/100 l water								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE	g/100 l water								
ANDER/OTHER									

BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns DIR
pp DIP

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME Mr. Zünckle ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO A1 GEWAS/CROP Cycad

OUDERDOM/AGE 0,5m

GRONDONTLEDINGS/SOIL ANALYSIS

DATUM / DATE	1989	*		*		*		*
pH (water)	4,80							
Ohms	2300							
Ca mg/kg	295							
Mg mg/kg	165							
K mg/kg	75							
P mg/kg	1,8							
Al mg/kg	249							
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.	1255							

BLAARONTLEDINGS/LEAF ANALYSIS

	1989	*		*		*
N %	1,59					
P %	0,101					
K %	0,20					
Ca %	0,55					
Mg %	0,303					
Zn mg/kg	25					
Cu mg/kg	7					
Mn mg/kg	64					
Fe mg/kg	66					
B mg/kg	47					
LAB. NO.	1246					

	A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED		T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED					
BEMESTINGSTOWWE/FERTILIZERS Hoeveelheid/Quantity								
KAN/LAN(28%)								
UREUM/UREA(46%)								
AM.SULFAAT/AM.SULPHATE(21%)								
SUPERS(10,5%)								
CALMAFOS								
KALIUMCHLORIED/POTASSIUM CHLORIDE								
DOLOMIET/DOLOMITIC KALK/LIME								
KALSITIES/CALCITIC KALK/LIME								
K.MIS of E.MIS/K.MANURE or P.MANURE								
BORAKS/BORAX								
SINKOKSIED/ZINC OXIDE								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE								
ANDER/OTHER								

* BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

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ns. DIREKTEUR
pp. DIRECTOR

DIREKTEUR,NIGSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME Mr. Zünckle ADRES/ADDRESS Bomboli BOORD NO/ORCHARD NO A2 SWAZILAND GEWAS/CROP Cycad OUDERDOM/AGE ? 0.1m

GRONDONTLEDINGS/SOIL ANALYSIS

DATUM / DATE	1989	*		*		*		*
pH (water)	5,22							
Ohms	3100							
Ca mg/kg	525							
Mg mg/kg	225							
K mg/kg	65							
P mg/kg	1,5							
Al mg/kg	157							
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.	1256							

BLAARONTLEDINGS/LEAF ANALYSIS

	1989	*		*		*		*
N %	1,37							
P %	0,200							
K %	0,15							
Ca %	0,48							
Mg %	0,141							
Zn mg/kg	62							
Cu mg/kg	6							
Mn mg/kg	119							
Fe mg/kg	83							
B mg/kg	19							
LAB. NO.	1247							

	A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED			T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED				
BEMESTINGSTOFFE/FERTILIZERS Hoeveelheid/Quantity								
KAN/LAN(28%)								
UREUM/UREA(46%)								
AM.SULFAAT/AM.SULPHATE(21%)								
SUPERS(10,5%)								
CALMAFOS								
KALIUMCHLORIED/POTASSIUM CHLORIDE								
DOLOMIET/DOLOMITIC KALK/LIME								
KALSITIES/CALCITIC KALK/LIME								
K.MIS of H.MIS/K.MANURE or F.MANURE								
BORAKS/BORAX								
SINKOKSIED/ZINC OXIDE								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE								
ANDER/OTHER								

* BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns. DIREKTEUR
pp. DIRECTOR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME: Mr. Zürckle ADRES/ADDRESS: Bosbou BOORD NO/ORCHARD NO: B GEWAS/CROP: Cycad
OUDERDOM/AGE: 1.0m SWAZILAND

GRONDONTLEDINGS/SOIL ANALYSIS

DATUM / DATE		*		*		*		*
pH (water)								
Ohms								
Ca mg/kg								
Mg mg/kg								
K mg/kg								
P mg/kg								
Al mg/kg								
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.								

BLAARONTLEDINGS/LEAF ANALYSIS

	89	*		*		*
N %	1,60					
P %	0,080					
K %	0,18					
Ca %	0,31					
Mg %	0,172					
Zn mg/kg	28					
Cu mg/kg	6					
Mn mg/kg	74					
Fe mg/kg	60					
B mg/kg	12					
LAB. NO.	1248					

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS Hoeveelheid/Quantity								
KAN/LAN(28%)								
UREUM/UREA(46%)								
AM.SULFAAT/AM.SULPHATE(21%)								
SUPERS(10,5%)								
CALMAPOS								
KALIUMCHLORIED/POTASSIUM CHLORIDE								
DOLOMIET/DOLOMITIC KALK/LIME								
KALSITIES/CALCITIC KALK/LIME								
K.MIS of N.MIS/K.MANURE or P.MANURE								
BORAKS/BORAX								
SINKOKSIED/ZINC OXIDE								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE								
ANDER/OTHER								

* BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns. DIREKTEUR
pp. DIRECTOR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL..52071

NAAM/NAME Mr. Zinckle ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO C2 OUDERDOM/AGE SWAZILAND 2-

GEWAS/CROP Cycad

GRONDONTLEDINGS/SOIL ANALYSIS

DATUM / DATE		*		*		*		*
pH (water)	4,57							
Ohms	4300							
Ca mg/kg	160							
Mg mg/kg	53							
K mg/kg	63							
P mg/kg	1,5							
Al mg/kg	540							
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.	1258							

BLAARONTLEDINGS/LEAF ANALYSIS

	1989	*		*		*		*
N %	1,37							
P %	0,072							
K %	0,25							
Ca %	0,35							
Mg %	0,141							
Zn mg/kg	21							
Cu mg/kg	6							
Mn mg/kg	59							
Fe mg/kg	66							
B mg/kg	22							
LAB. NO.	1251							

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS Hoeveelheid/Quantity								
KAN/LAN(28%)								
UREUM/UREA(46%)								
AM.SULFAAT/AM.SULPHATE(21%)								
SUPERS(10,5%)								
CALMAFOS								
KALIUMCHLORIED/POTASSIUM CHLORIDE								
DOLOMIET/DOLOMITIC KALK/LIME								
KALSITIES/CALCITIC KALK/LIME								
K.MIS of H.MIS/K.MANURE or F.MANURE								
BORAKS/BORAX								
SINKOKSIED/ZINC OXIDE								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE								
ANDER/OTHER								

* BL = BAIE LAAG/VERY LOW
H = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

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ns. DIREKTEUR
pp. DIRECTOR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME Mr. Zünckle ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO D SWAZILAND OUDERDOM/AGE ? 1.5m GEWAS/CROP Cycad.

GRONDONTLEDINGS/SOIL ANALYSIS

DATUM / DATE	1989	*		*		*		*
pH (water)	4,71							
Ohms	3570							
Ca mg/kg	140							
Mg mg/kg	30							
K mg/kg	78							
P mg/kg	1,5							
Al mg/kg	180							
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.	1259							

BLAARONTLEDINGS/LEAF ANALYSIS

	1989	*		*		*		*
N %	1,40							
P %	0,067							
K %	0,20							
Ca %	0,25							
Mg %	0,141							
Zn mg/kg	12							
Cu mg/kg	6							
Mn mg/kg	89							
Fe mg/kg	49							
B mg/kg	19							
LAB. NO.	1252							

	A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED			T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED			
BEMESTINGSTOFFE/FERTILIZERS Hoeveelheid/Quantity							
KAN/LAN(28%)							
UREUM/UREA(46%)							
AM.SULFAAT/AM.SULPHATE(21%)							
SUPERS(10,5%)							
CALMAFOS							
KALIUMCHLORIED/POTASSIUM CHLORIDE							
DOLOMIET/DOLOMITIC KALK/LIME							
KALSITIES/CALCITIC KALK/LIME							
K.MIS of H.MIS/K.MANURE or P.MANURE							
BORAKS/BORAX							
SINKOKSIED/ZINC OXIDE							
KOPEROKSICHLORIED/COPPER OXYCHLORIDE							
ANDER/OTHER							

* BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns. DIREKTEUR
pp. DIRECTOR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME Mr. Zinckle ADRES/ADDRESS

BOORD NO/ORCHARD NO E 1(a) SWAZILAND

OUDERDOM/AGE ± 10

GEWAS/CROP Cycad

GRONDONTLEDINGS/SOIL ANALYSIS

DATUM / DATE	1989	*		*		*		*
pH (water)	4,88							
Ohms	3050							
Ca mg/kg	525							
Mg mg/kg	210							
K mg/kg	70							
P mg/kg	3,0							
Al mg/kg	200							
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.	1257							

BLAARONTLEDINGS/LEAF ANALYSIS

	'89	*		*		*		*
N %	1,40							
P %	0,062							
K %	0,15							
Ca %	0,17							
Mg %	0,151							
In mg/kg	8							
Cu mg/kg	6							
Mn mg/kg	54							
Fe mg/kg	53							
B mg/kg	41							
LAB. NO.	1249							

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

SEMESTINGSTOWWE/FERTILIZERS Hoeveelheid/Quantity								
KAN/LAN(28%)								
UREUM/UREA(46%)								
AM.SULFAAT/AM.SULPHATE(21%)								
SUPERS(10,5%)								
CALMAPOS								
KALIUMCHLORIED/POTASSIUM CHLORIDE								
DOLOMIET/DOLOMITIC KALK/LIME								
KALSITIES/CALCITIC KALK/LIME								
K.MIS of H.MIS/K.MANURE or F.MANURE								
BORAKS/BORAX								
SINKOKSIED/ZINC OXIDE								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE								
ANDER/OTHER								

* BL = BAIE LAAG/VERY LOW
M = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

Sink, boor en koper kan saam in 100 liter opgelos word en in die lente op die jong groei gespuit word.
Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

ns. DIREKTEUR
pp. DIRECTOR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME Mr. Zwinckle ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO E1(b) SWAZILAND OUDERDOM/AGE ± 10 m GEWAS/CROP Cycad

GRONDONTLEDINGS/SOIL ANALYSIS

DATUM / DATE		*		*		*		*
pH (water)								
Ohms								
Ca mg/kg								
Mg mg/kg								
K mg/kg								
P mg/kg								
Al mg/kg								
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.								

BLAARONTLEDINGS/LEAF ANALYSIS

		*		*		*
	1989					
N %	1,54					
P %	0,079					
K %	0,17					
Ca %	0,25					
Mg %	0,151					
Zn mg/kg	38					
Cu mg/kg	6					
Mn mg/kg	49					
Fe mg/kg	103					
B mg/kg	19					
LAB. NO.	1250					

BEMESTINGSTOWWE/FERTILIZERS Hoeveelheid/Quantity	A-HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED			T-HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED				
KAN/LAN(28%)								
UREUM/UREA(46%)								
AM.SULFAAT/AM.SULPHATE(21%)								
SUPERS(10,5%)								
CALMAPOS								
KALIUMCHLORIED/POTASSIUM CHLORIDE								
DOLOMIET/DOLOMITIC KALK/LIME								
KALSITIES/CALCITIC KALK/LIME								
K.MIS of N.MIS/K.MANURE or P.MANURE								
BORAKS/BORAX								
SINKOKSIED/ZINC OXIDE								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE								
ANDER/OTHER								

* BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

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OPMERKINGS/REMARKS

ns. DIREKTEUR
pp. DIRECTOR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL..52071

NAAM/NAME Mr. Zwinckle ADRES/ADDRESS Bosbou BOORD NO/ORCHARD NO E 2(a) SWAZILAND GEWAS/CROP Cycad

OUDERDOM/AGE ? 10m

GRONDONTLEDINGS/SOIL ANALYSIS

DATUM / DATE	1989	*		*		*		*
pH (water)	5,38							
Ohms	4100							
Ca mg/kg	175							
Mg mg/kg	170							
K mg/kg	93							
P mg/kg	1,5							
Al mg/kg	69							
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.	1260							

BLAARONTLEDINGS/LEAF ANALYSIS

	1989	*		*		*		
N %	1,65							
P %	0083							
K %	0,20							
Ca %	0,40							
Mg %	0,151							
Zn mg/kg	43							
Cu mg/kg	7							
Mn mg/kg	94							
Fe mg/kg	98							
B mg/kg	18							
LAB. NO.	1253							

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILIZERS Hoeveelheid/Quantity								
KAN/LAN(28%)								
UREUM/UREA(46%)								
AM.SULFAAT/AM.SULPHATE(21%)								
SUPERS(10,5%)								
CALMAPOS								
KALIUMCHLORIED/POTASSIUM CHLORIDE								
DOLOMIET/DOLOMITIC KALK/LIME								
KALSITIES/CALCITIC KALK/LIME								
K.MIS of N.MIS/K.MANURE or N.MANURE								
BORAKS/BORAX								
SINKOKSIED/ZINC OXIDE								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE								
ANDER/OTHER								

* BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
BH = BAIE HOOG/VERY HIGH

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Zinc, boron and copper may be dissolved together in 100 litre of water and must be sprayed onto the new growth during spring.

OPMERKINGS/REMARKS

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ns. DIREKTEUR
pp. DIRECTOR

DIREKTEUR,NISSV,PRIVAATSAK X11208,NELSPRUIT,1200/DIRECTOR,CSFRI,PRIVATE BAG X11208,NELSPRUIT,1200.- TEL.52071

NAAM/NAME Mr. Zünckle ADRES/ADDRESS Bosbou

BOORD NO/ORCHARD NO E2(b) Swaziland

OUDERDOM/AGE ? 10m

GEWAS/CROP Cycad

GRONDONTLEDINGS/SOIL ANALYSIS

DATUM / DATE		*		*		*		*
pH (water)								
Ohms								
Ca mg/kg								
Mg mg/kg								
K mg/kg								
P mg/kg								
Al mg/kg								
Ca/Mg								
TEKSTUUR/TEXTURE								
PROD.TON/ha								
LAB. NO.								

BLAARONTLEDINGS/LEAF ANALYSIS

		*		*		*
	1989					
N %	1,62					
P %	0,074					
K %	0,17					
Ca %	0,25					
Mg %	0,157					
Zn mg/kg	22					
Cu mg/kg	5					
Mn mg/kg	94					
Fe mg/kg	70					
B mg/kg	57					
LAB. NO.	1254					

A=HOEVEELHEID AANBEVEEL/QUANTITY RECOMMENDED T=HOEVEELHEID TOEGEDIEN/QUANTITY APPLIED

BEMESTINGSTOWWE/FERTILISERS Hoeveelheid/Quantity								
KAN/LAN(28%)								
UREUM/UREA(46%)								
AM.SULFAAT/AM.SULPHATE(21%)								
SUPERS(10,5%)								
CALMAPOS								
KALIUMCHLORIED/POTASSIUM CHLORIDE								
DOLOMIET/DOLOMITIC KALK/LIME								
KALSITIES/CALCITIC KALK/LIME								
K.MIS of N.MIS/K.MANURE or P.MANURE								
BORAKS/BORAX								
SINKOKSIED/ZINC OXIDE								
KOPEROKSICHLORIED/COPPER OXYCHLORIDE								
ANDER/OTHER								

* BL = BAIE LAAG/VERY LOW
N = NORMAAL/NORMAL
H = HOOG/HIGH
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OPMERKINGS/REMARKS

ns. DIREKTEUR
pp. DIRECTOR

APPENDIX C

DECLARATION OF THE PROHIBITION ON FIRES IN THE OPEN AIR BY THE DIRECTOR GENERAL: DEPARTMENT ENVIRONMENT AFFAIRS

DEPARTMENT OF ENVIRONMENT AFFAIRS

No. 1011 26 May 1989

PROHIBITION ON FIRES IN THE OPEN AIR.—DISTRICTS OF LYDENBURG/PILGRIM'S REST/WHITE RIVER/NELSPRUIT/WATERVAL-BOVEN/BELFAST/CAROLINA/BARBERTON

Under the powers vested in me by section 25 (1) of the Forest Act, 1984 (Act No. 122 of 1984), I hereby determine that, in the areas the boundaries of which are defined in the Schedule hereto, no person shall from 1 August 1989 up to and including 31 October 1989—

1. make or cause to be made any fire in the open air or, if such fire has been made, allow such fire to continue to burn or add fuel thereto or rekindle it, save—

1.1 fires made in those portions of KaNgwane and Lebowa situated inside the defined boundary;

1.2 fires made within a demarcated picnic or camping area or holiday resort, which should be duly licensed if they are privately owned, or which are maintained by a local authority or a Government department: Provided that such fires shall be made only at such places as have been specifically provided and prepared for that purpose;

1.3 fires made on residential stands within proclaimed townships; and

1.4 burning of sugar cane fields prior to harvesting.

W. F. VISAGIE,
Director-General: Environment Affairs.

SCHEDULE

AREA A

SOUTHERN BOUNDARY

From a point where the Machadodorp/Waterval-Boven Road intersects the southern boundary of the property Schoongezicht 347 JT; thence in a generally northern and thereafter easterly direction along the Machadodorp/Waterval-Boven/Nelspruit Road, so as to include the road reserve in the area, to the point where this road intersects the boundary between the properties Doornhoek 341 JT and Kindergoed 332 JT; thence in a generally southerly direction along the western boundaries of the properties Kindergoed 332 JT, Schoonspruit 340 JT and Elandshoek 536 JT; thence in a south-westerly direction, along the north-western boundaries of the following farms: Doornhoek 614 JT (Carolina District), Driehoek 395 JT, Ndubazi Ranch 413 JT (Waterval-Boven District), to a point where the boundary of the last-mentioned farm crosses the Machadodorp/Badplaas Road, Road P180-1, so as to include them in the area; thence in a generally south-easterly direction along the said road to where this road intersects with the Badplaas/Barberton Road, Roads P11-1 and P11-2, on the property Kees Zyn Doorns 708 JT; thence in a generally easterly direction along the Badplaas/Barberton Road, Roads P11-1 and P11-2, so as to include the road reserve in the area, to where the last-mentioned road intersects the Carolina/Barberton Magisterial District boundary; thence first in a southerly and then in a generally easterly direction along the Carolina/Barberton Magisterial District boundary to the Swaziland border; thence in a generally easterly direction to the Mozambique/Swaziland/RSA border intersection.

DEPARTEMENT VAN OMGEWINGSAKE

No. 1011 26 Mei 1989

VERBOD OP VURE IN DIE OPE LUG.—DISTRIKTE LYDENBURG/PELGRIMSRUS/WITRIVIER/NELSPRUIT/WATERVAL-BOVEN/BELFAST/CAROLINA/BARBERTON

Kragtens die bevoegdheid my verleen by artikel 25 (1) van die Boswet, 1984 (Wet No. 122 van 1984), bepaal ek hierby dat, in die gebiede waarvan die grense in die Bylae hiervan omskryf word, geen persoon vanaf 1 Augustus 1989 tot en met 31 Oktober 1989—

1. 'n vuur in die ope lug mag maak of laat maak nie, of as so 'n vuur wel gemaak is, mag toelaat dat sodanige vuur voortbrand nie of brandstof daarby mag voeg nie, of dit weer mag aansteek nie, uitgesonderd—

1.1 vure gemaak in die gedeeltes van KaNgwane en Lebowa geleë binne die omskrewe grens;

1.2 vure gemaak binne 'n afgebakende piekniek- of kampeerplek of vakansie-oord wat, indien hulle in private besit is, behoorlik gelisensieer moet wees, of wat deur 'n plaaslike owerheid of 'n Staatsdepartement in stand gehou word: Met dien verstande dat sodanige vure gemaak is op plekke wat spesifiek vir dié doel daargestel en voorberei is;

1.3 vure gemaak op woonpersele binne geproklameerde dorpsgebiede; en

1.4 die brand van suikerlande voor inoesting.

W. F. VISAGIE,
Direkteur-generaal: Omgewingsake.

BYLAE

GEBIED A

SUIDELIKE GRENS

Vanaf die punt waar die Machadodorp/Waterval-Bovenpad die suidelike grens van die plaas Schoongezicht 347 JT kruis; daarvandaan in 'n algemeen noordelike en daarna oostelike rigting met die Machadodorp/Waterval-Boven/Nelspruitpad langs sodat die padreserwe by die gebied ingesluit word, tot waar hierdie pad die grens tussen die eiendomme Doornhoek 341 JT en Kindergoed 332 JT kruis; daarvandaan in 'n algemeen suidelike rigting met die westelike grense van die eiendomme Kindergoed 332 JT, Schoonspruit 340 JT en Elandshoek 536 JT langs; daarvandaan in 'n suidwestelike rigting met die noordwestelike grens van die volgende plase langs: Doornhoek 614 JT (distrik Carolina), Driehoek 395 JT, Ndubazi Ranch 413 JT (distrik Waterval-Boven), tot by 'n punt waar laasgenoemde plaasgrens die Machadodorp/Badplaaspad, Pad P180-1, kruis, sodat die plase by die gebied ingesluit word; daarvandaan in 'n algemeen suidoostelike rigting met genoemde pad langs tot waar die pad die Badplaas/Barbertonpad, Paaie P11-1 en P11-2, op die eiendom Kees Zyn Doorns 708 JT kruis; daarvandaan in 'n algemeen oostelike rigting met die Badplaas/Barbertonpad, Paaie P11-1 en P11-2, langs tot waar laasgenoemde pad die Carolina/Barbertonlanddrosdistrikgrens kruis sodat die padreserwe by die gebied ingesluit word; daarvandaan eers in 'n suidelike en dan in 'n algemeen oostelike rigting met die Carolina/Barbertonlanddrosdistrikgrens langs tot by die Swazilandgrens; daarvandaan in 'n algemeen oostelike rigting tot by die Mosambiek/Swaziland/RSA-grenskruising.

his requirements regarding the fire belt which he wishes to clear and maintain.

(c) The time when and the manner in which the fire belt is to be cleared, the manner in which it is to be maintained, the location, length and width thereof, the nature of the assistance to be rendered by the owners, and the share of the costs in connection therewith to be borne by each, must be determined by agreement between them and, if they are unable to agree on application by either of them after 14 days' written notice to the other, by the magistrate's court within whose area of jurisdiction the land in question is situated, and that court may make such order as to costs as it may deem fit.

(d) The work involved in the clearing and maintenance of a fire belt must be done in accordance with the provisions of an agreement contemplated in paragraph *(c)*, and if one of the parties to the agreement fails to comply with such a provision, the other party may proceed to clear or maintain the fire belt and may recover the costs involved from the first-mentioned party.

(2) *(a)* Notwithstanding anything to the contrary contained in this Act, but subject to any prohibition under section 25 (3) and the provisions of this subsection, an owner of land, including State land, not situated in a fire control area, who for the protection of his land requires a fire belt on his side of the boundary between his land and any land adjoining his land, may clear and maintain a fire belt as contemplated in section 22 (1).

(b) Such an owner who intends to clear the required fire belt by burning shall in the prescribed manner give to the owner of the adjoining land in question at least 14 days before he begins with the work in connection with the clearing or maintenance of the firebelt written notice of his intention so to begin on a stated day.

(c) An owner to whom notice has so been given and who requires a fire belt on both sides of the common boundary may before that stated day in writing require the owner concerned to follow the procedure prescribed by subsection (1), and in that case the provisions of that subsection apply and the notice given is deemed to be a notice in terms of subsection (1) *(b)*.

(3) The provisions of this section do not apply in respect of—

(a) an owner of land who wishes to clear or maintain a fire belt entirely on his land in a manner other than by burning;

(b) the South African Transport Services,

and nothing in this Act contained shall be construed as prohibiting the clearing or maintenance of a fire belt in a manner other than by burning.

(4) For the purposes of this section "owner", in relation to State land or other land under the control of the State, means the officer in charge of the department of State or provincial administration exercising control over that State land or other land, or a person authorized by him.

Extraordinary precautions in times of fire hazard.

25. (1) If the director-general is of the opinion that any State forest or private forest, whether inside or outside a fire control area, is subject to an extraordinary fire hazard, he may with a view to protecting that forest, by notice in the *Gazette*, direct that in an area defined in that notice and during the period mentioned therein, no person shall make a fire in the open air or, if such a fire has been made, allow it to continue to burn or add fuel thereto, otherwise than in accordance with such conditions as he may determine in that notice.

(2) If the director-general is of the opinion that the destruction by burning of any ground cover, including slash in any tim-

ber plantation or any harvest residue, whether inside or outside a fire control area, during any period in any year can give rise to an increased fire hazard, he may by notice in the *Gazette* direct that no person shall in that manner destroy specified ground cover, slash or harvest residue inside an area defined in the notice and during a period in any year specified therein.

(3) If the director-general is of the opinion that in any area, whether inside or outside a fire control area, the clearing or maintenance of a fire belt by burning or the execution of blockburns during any period in any year could give rise to an increased fire hazard, he may, notwithstanding anything to the contrary contained in this Act, by notice in the *Gazette* prohibit the clearing and maintenance of a fire belt in that manner or the execution of blockburns in an area defined in the notice and during a period in any year specified therein.

(4) A notice in terms of this section also applies to State land in an area defined in the notice.

Fighting and extinguishing of fires.

26. (1) Any person who has reasonable grounds for believing that a fire occurring on any land may endanger life or property, may, either alone or with any other person under his control, enter upon that land or land to which the fire can spread in order to prevent the spreading of that fire or to extinguish it.

(2) Subject to the terms of any agreement in terms of section 27, any forest officer may, to the exclusion of any other person, take over control of the fighting and extinguishing of a fire occurring within 10 kilometres of the boundary of a State forest or a mountain catchment area contemplated in section 2 of the Mountain Catchment Areas Act, 1970 (Act No. 63 of 1970).

(3) Any person acting under subsection (1) or a forest officer acting under subsection (2)—

(a) may take such measures as he may consider reasonably necessary in the circumstances for the protection of life or property or for preventing the fire from spreading or to extinguish it, and may for that purpose damage or destroy trees, grass, crops or other vegetation;

(b) may give to any person present at the fire or any person present on any land to which the fire is liable to spread or any person having an interest in that land, such orders as are reasonably necessary to prevent the fire from spreading or to extinguish it;

(c) may order any person whose life may be or may become endangered or whose presence at or in the vicinity of the fire may obstruct any action in connection with the fire, to remove himself together with any vehicle or other thing under his control.

(4) No person who acted in terms of subsection (1) or who rendered assistance in the fighting or extinguishing of a fire or who performed any act or rendered any service in pursuance of an order under subsection (3), is entitled to any reward or compensation, but the director-general may pay to any person who has rendered assistance, performed any act or rendered any service in connection with a fire which threatened a State forest or a mountain catchment area, such compensation as he may, with the concurrence of the Treasury, determine.

(5) A person or forest officer who performed any act in terms of subsection (1) or (3), shall as soon as practicable report the circumstances and the steps taken to a police officer at the nearest police station.

Agreements for mutual assistance in fighting fires.

27. (1) The director-general may, with the concurrence of the Treasury, enter into an agreement with any person regarding the rendering of mutual assistance in fighting and extinguishing fires occurring on, or constituting a threat to, a State forest or moun-

APPENDIX D

CHAPTER VII OF THE NATURE CONSERVATION ORDINANCE OF THE TRANSVAAL (12 OF 1983): "INDIGENOUS PLANTS" AND SCHEDULE 12: "SPECIALLY PROTECTED PLANTS (SECTION 86(1)(b))"

DEPARTMENT OF ENVIRONMENT AFFAIRS

No. 1283 23 June 1989

AMENDMENT OF THE NOTICE OF PROHIBITION OF FIRES

The notice of prohibition of fires in the open air as published by Government Notice No. 1011 in *Government Gazette* No. 11883 dated 26 May 1989 is hereby amended to include the following subparagraph:

1.5 fires for the burning of grass for grazing, harvest residue and grass/weeds on cultivated lands, industrial purposes and fires for the preparation of food, subject to the burning prescriptions of the Department of Environment Affairs, obtainable from the Regional Director, Forestry Branch, Department of Environment Affairs at Nelspruit or Sabie.

W. F. VISAGIE,
Director-General: Environment Affairs.

DEPARTEMENT VAN OMGEWINGSAKE

No. 1283 23 Junie 1989

WYSIGING VAN BRANDVERBODSKENNISGEWING

Die verbodskennisgewing op die maak van vure in die ope lug soos gepubliseer by Goewermentskennisgewing No. 1011 in *Staatskoerant* No. 11883 van 26 Mei 1989 word hierby gewysig om die volgende subparagraaf in te sluit:

1.5 vure gemaak vir die brand van gras vir weiding, oesreste en gras/onkruid op bewerkte lande, industriële doeleindes en vure vir die voorbereiding van voedsel, onderhewig aan die brandvoorskrifte van die Departement van Omgewingsake, verkrygbaar vanaf die Streekdirekteur, Tak Boswese, Departement van Omgewingsake te Nelspruit of Sabie.

W. F. VISAGIE,
Direkteur-generaal: Omgewingsake.

CHAPTER VII

INDIGENOUS PLANTS

Protected plants and specially protected plants.

86.(1) The plants referred to —

(a) in Schedule 11 to this Ordinance shall be protected plants;

(b) in Schedule 12 to this Ordinance shall be specially protected plants.

(2) The Administrator may by notice in the *Provincial Gazette* insert in or add to or delete from Schedule 11 or Schedule 12 to this Ordinance the name of any indigenous plant.

Picking of protected plants.

87.(1) Subject to the provisions of this Ordinance, no person shall pick a protected plant, unless he is the holder of a permit which authorizes him to do so: Provided that the owner of land or a relative of his may, on the land of such owner, or the occupier of land or a relative of his may, on the land of such occupier, pick —

(a) the flower of a protected plant;

(b) a protected plant —

(i) as far as it is necessary for grazing, the making of hay or for any other *bona fide* farming purpose or by burning the veld;

(ii) on the portion of such land —

(aa) required for the cultivation, the erection of a building, the construction of a road, dam or airfield, or other development necessitating the destruction of vegetation;

(bb) set apart solely for the cultivation of such plant.

(2) Any person who contravenes or fails to comply with subsection (1) shall be guilty of an offence.

Picking of indigenous plants in nature reserve.

88.(1) No person shall pick an indigenous plant in a nature reserve, unless he is the holder of a permit which authorizes him to do so: Provided that the owner of land in a nature reserve or a relative of his may pick on such land or the occupier of land in a nature reserve or a relative of his may pick on such land —

(a) an indigenous plant which is not a protected plant or specially protected plant;

(b) a protected plant as contemplated in the proviso to section 87(1).

(2) Any person who contravenes or fails to comply with subsection (1) shall be guilty of an offence.

Picking of indigenous plants on or near public roads.

89.(1) Subject to the provisions of this Ordinance, no person shall pick an indigenous plant —

(a) on a public road;

HOOFSTUK VII

INHEEMSE PLANTE

Beskermde plante en spesiaal beskermde plante.

86.(1) Die plante genoem —

(a) in Bylae 11 by hierdie Ordonnansie is beskermde plante;

(b) in Bylae 12 by hierdie Ordonnansie is spesiaal beskermde plante.

(2) Die Administrateur kan by kennisgewing in die *Provinsiale Koerant* die naam van enige inheemse plant in Bylae 11 of Bylae 12 by hierdie Ordonnansie invoeg of daarby byvoeg of daaruit skrap.

Pluk van beskermde plante.

87.(1) Behoudens die bepalings van hierdie Ordonnansie, mag niemand 'n beskermde plant pluk nie, tensy hy die houer is van 'n permit wat hom magtig om dit te doen: Met dien verstande dat die eienaar van grond of 'n familielid van hom op die grond van daardie eienaar of die okkupant van grond of 'n familielid van hom op die grond van daardie okkupant —

(a) die blom van 'n beskermde plant kan pluk;

(b) 'n beskermde plant kan pluk —

(i) vir sover dit nodig is vir weiding, die maak van hooi, of vir enige ander *bona fide*-boerderydoeleinde of deur die veld te brand;

(ii) op die gedeelte van daardie grond —

(aa) wat benodig word vir die verbouing, die oprigting van 'n gebou, die bou van 'n pad, dam of vliegveld, of ander ontwikkeling wat die vernietiging van plantegroei noodsaak;

(bb) wat uitsluitlik vir die kweek van so 'n plant afgesonder is.

(2) Iemand wat subartikel (1) oortree of versuim om daaraan te voldoen, is aan 'n misdryf skuldig.

Pluk van inheemse plante in natuurreservate.

88.(1) Niemand mag 'n inheemse plant in 'n natuurreservaat pluk nie, tensy hy die houer is van 'n permit wat hom magtig om dit te doen: Met dien verstande dat die eienaar van grond in 'n natuurreservaat of 'n familielid van hom op daardie grond of die okkupant van grond in 'n natuurreservaat of 'n familielid van hom op daardie grond —

(a) 'n inheemse plant wat nie 'n beskermde plant of spesiaal beskermde plant is nie;

(b) 'n beskermde plant soos in die voorbehoudsbepaling by artikel 87(1) beoog,

kan pluk.

(2) Iemand wat subartikel (1) oortree of versuim om daaraan te voldoen, is aan 'n misdryf skuldig.

Pluk van inheemse plante op of naby openbare paaie.

89.(1) Behoudens die bepalings van hierdie Ordonnansie, mag niemand 'n inheemse plant —

(a) op 'n openbare pad;

(b) on land next to a public road within a distance of 100 m measured from the centre of the road,

unless he is the holder of a permit which authorizes him to do so: Provided that the owner of land contemplated in paragraph (b) or a relative of his may pick on such land or the occupier of land contemplated in paragraph (b) or a relative of his may pick on such land an indigenous plant as contemplated in the proviso to section 87(1).

(2) Any person who contravenes or fails to comply with subsection (1) shall be guilty of an offence.

Picking of indigenous plants by any person other than owner or occupier.

90.(1) No person shall pick an indigenous plant on land of which he is not the owner or occupier: Provided that —

(a) a relative of the owner of land may pick on the land of such owner;

(b) a relative of the occupier of land may pick on the land of such occupier;

(c) any person who has obtained the written permission of the owner or occupier of land beforehand and who carries it with him, may pick on the land of such owner or occupier,

such a plant.

(2) Any person who contravenes or fails to comply with subsection (1) shall be guilty of an offence.

Donation, sale, export or removal from Province of protected plants.

91.(1) Subject to the provisions of this Ordinance, no person shall donate, sell or export or remove from the Province a protected plant, unless he is the holder of a permit which authorizes him to do so: Provided that —

(a) any person —

(i) who is authorized in terms of the proviso to subsection 87(1), 88(1) or 89(1) to pick a protected plant may donate the flower thereof;

(ii) may donate a protected plant planted on land set apart solely for the cultivation thereof;

(b) a protected plant may be donated or sold by —

(i) any person who is licensed in terms of the Licences Ordinance, 1974, to sell plants and who acquired the protected plant from any person who sold it lawfully;

(ii) a botanical garden which is subject to the provisions of the Cultural Institutions Act, 1969;

(c) any person may export or remove a protected plant donated or sold in terms of paragraph (a) or (b) from the Province.

(2) Any person donating a protected plant in terms of paragraph (a)(ii) of the proviso to subsection (1) shall deliver to the donee, together with the plant, a document containing —

(a) the name and residential address of the donor;

(b) op grond langs 'n openbare pad binne 'n afstand van 100 m gemeet vanaf die middel van die pad,

pluk nie, tensy hy die houer is van 'n permit wat hom magtig om dit te doen: Met dien verstande dat die eienaar van grond in paragraaf (b) beoog of 'n familielid van hom op daardie grond of die okkupant van grond in paragraaf (b) beoog of 'n familielid van hom op daardie grond 'n inheemse plant kan pluk soos in die voorbehoudsbepaling by artikel 87(1) beoog.

(2) Iemand wat subartikel (1) oortree of versuim om daaraan te voldoen, is aan 'n misdryf skuldig.

Pluk van inheemse plante deur iemand anders as eienaar of okkupant.

90.(1) Niemand mag 'n inheemse plant op grond waarvan hy nie die eienaar of okkupant is nie, pluk nie: Met dien verstande dat —

(a) 'n familielid van die eienaar van grond op die grond van daardie eienaar;

(b) 'n familielid van die okkupant van grond op die grond van daardie okkupant;

(c) iemand wat vooraf die skriftelike toestemming van die eienaar of okkupant van grond verkry het en dit by hom dra op die grond van daardie eienaar of okkupant,

so 'n plant kan pluk.

(2) Iemand wat subartikel (1) oortree of versuim om daaraan te voldoen, is aan 'n misdryf skuldig.

Skenk, verkoop, uitvoer of wegneem uit Provinsie van beskermde plante.

91.(1) Behoudens die bepalings van hierdie Ordonnansie, mag niemand 'n beskermde plant skenk, verkoop of uit die Provinsie uitvoer of wegneem nie, tensy hy die houer is van 'n permit wat hom magtig om dit te doen: Met dien verstande dat —

(a) iemand —

(i) wat ingevolge die voorbehoudsbepaling by artikel 87(1), 88(1) of 89(1) gemagtig is om 'n beskermde plant te pluk, die blom daarvan kan skenk;

(ii) 'n beskermde plant wat aangeplant is op grond wat uitsluitlik vir die kweek daarvan afgesonder is, kan skenk;

(b) 'n beskermde plant geskenk of verkoop kan word deur —

(i) iemand wat ingevolge die Ordonnansie op Lisensies, 1974, gelisensieer is om plante te verkoop en wat die beskermde plant verkry het van iemand wat dit wettiglik verkoop het;

(ii) 'n plantetuin wat onder die bepalings van die Wet op Kulturele Inrigtings, 1969, val;

(c) iemand 'n beskermde plant wat ingevolge paragraaf (a) of (b) geskenk of verkoop is, uit die Provinsie kan uitvoer of wegneem.

(2) Iemand wat 'n beskermde plant ingevolge paragraaf (a)(ii) van die voorbehoudsbepaling by subartikel (1) skenk, oorhandig saam met die plant aan die ontvanger 'n dokument bevattende —

(a) die naam en woonadres van die skenker;

(b) a description thereof;

(c) the name and address of the donee;

(d) the date on which it is donated; and

(e) the signature of the donor.

(3) Any person receiving a protected plant in terms of paragraph (a)(ii) of the proviso to subsection (1) shall carry the document contemplated in subsection (2) with him when he conveys the plant.

(4) Any person who contravenes or fails to comply with subsection (1), (2) or (3) shall be guilty of an offence.

urchase or eceipt of rotected lants.

92.(1) No person shall purchase or receive as a donation a protected plant except from a person who sells or donates it lawfully.

(2) Any person who contravenes or fails to comply with subsection (1) shall be guilty of an offence.

nporting into nd conveyance ithin Province f protected lants.

93.(1) Subject to the provisions of this Ordinance, no person shall import into or convey within the Province a protected plant, unless he is the holder of a permit which authorizes him to do so: Provided that —

(a) any person may import into or convey within the Province a protected plant which he bought or received as a donation from any other person in any other province, the territory of South West Africa or a territory which was formerly part of the Republic, if he has documentary proof of the purchase or donation and carries it with him when he conveys the plant;

(b) any person may convey a protected plant within the Province where —

(i) he is authorized in terms of the proviso to section 87(1), 88(1) or 89(1) to pick it;

(ii) the protected plant —

(aa) has been donated or sold to him in terms of section 91(1) or by a person exempted in terms of section 94(1);

(bb) has been donated to him in terms of paragraph (a)(ii) of the proviso to section 91(1) and he carries the document contemplated in section 91(2) with him when he conveys the plant.

(2) Any person who contravenes or fails to comply with subsection (1) shall be guilty of an offence.

Exemption of owners of nurseries.

94.(1) The Administrator may, upon the written application of the owner of a nursery registered in terms of the provisions of the Plant Improvement Act, 1976 (Act 53 of 1976), exempt —

(a) the owner;

(b) any other person indicated by the owner in the application,

in writing from all or any of the provisions of this Ordinance applicable to the donation,

(b) 'n beskrywing daarvan;

(c) die naam en adres van die ontvanger;

(d) die datum waarop dit geskenk word; en

(e) die handtekening van die skenker.

(3) Iemand wat 'n beskermde plant ingevolge paragraaf (a)(ii) van die voorbehoudsbepaling by subartikel (1) ontvang, dra die dokument in subartikel (2) beoog by hom wanneer hy die plant vervoer.

(4) Iemand wat subartikel (1), (2) of (3) oortree of versuim om daaraan te voldoen, is aan 'n misdryf skuldig.

Koop of ontvangs van beskermde plante.

92.(1) Niemand mag 'n beskermde plant koop of as geskenk ontvang nie behalwe van iemand wat dit wettiglik verkoop of skenk.

(2) Iemand wat subartikel (1) oortree of versuim om daaraan te voldoen, is aan 'n misdryf skuldig.

Invoer en vervoer in Provinsie van beskermde plante.

93.(1) Behoudens die bepalings van hierdie Ordonnansie, mag niemand 'n beskermde plant in die Provinsie invoer of daarin vervoer nie, tensy hy die houer is van 'n permit wat hom magtig om dit te doen: Met dien verstande dat —

(a) iemand 'n beskermde plant wat hy van iemand anders in 'n ander provinsie, die gebied Suidwes-Afrika of 'n gebied wat voorheen deel van die Republiek was, gekoop of as geskenk ontvang het in die Provinsie kan invoer of daarin kan vervoer, indien hy dokumentêre bewys van die koop of skenking het en dit by hom dra wanneer hy die plant vervoer;

(b) iemand 'n beskermde plant in die Provinsie kan vervoer waar —

(i) hy ingevolge die voorbehoudsbepaling by artikel 87(1), 88(1) of 89(1) gemagtig is om dit te pluk;

(ii) die beskermde plant —

(aa) ingevolge artikel 91(1) of deur iemand ingevolge artikel 94(1) vrygestel, aan hom geskenk of verkoop is;

(bb) ingevolge paragraaf (a)(ii) van die voorbehoudsbepaling by artikel 91(1) aan hom geskenk is en hy die dokument in artikel 91(2) beoog by hom dra wanneer hy die plant vervoer.

(2) Iemand wat subartikel (1) oortree of versuim om daaraan te voldoen, is aan 'n misdryf skuldig.

Vrystelling van eienaars van kwekerye.

94.(1) Die Administrateur kan op skriftelike aansoek van die eienaar van 'n kwekery wat ingevolge die bepalings van die Plantverbeteringswet, 1976 (Wet 53 van 1976), geregistreer is —

(a) die eienaar;

(b) iemand anders wat die eienaar in die aansoek aanwys,

skriftelik vrystel van al of enigeen van die bepalings van hierdie Ordonnansie wat van toe-

sale, conveyance within or export or removal from the Province of a protected plant in respect of the donation, sale, conveyance within or export or removal from the Province of any species of protected plant cultivated in such a nursery.

(2) The holder of an exemption contemplated in subsection (1) may grant permission in writing to any other person to donate, to sell, to convey within the Province or to export or remove therefrom, subject to the provisions of the exemption, any species of protected plant referred to in the exemption and cultivated on the premises of the nursery referred to therein.

(3) The holder of a permission contemplated in subsection (2) may, in accordance with the particulars contained therein and subject to the provisions of the exemption contemplated in subsection (1), donate, sell, convey within the Province or export or remove therefrom the species of protected plants referred to in the permission.

Receipt, possession, acquisition or handling of protected plants.

95. Any person who —

(a) receives a protected plant knowing that it was not picked lawfully;

(b) is found in possession of a protected plant in respect of which there is a reasonable suspicion that it was not picked lawfully and is unable to give a satisfactory account of such possession;

(c) in any manner acquires or receives into his possession or handles a protected plant without having reasonable cause, proof of which shall be on him, for believing at the time of such acquisition, receipt or handling that such plant was picked lawfully,

shall be guilty of an offence.

Prohibited acts with specially protected plants.

96.(1) Subject to the provisions of this Ordinance, no person shall possess, pick, sell, purchase, donate or receive as a donation, import into or convey within the Province, export or remove from the Province a specially protected plant, unless he is the holder of a permit which authorizes him to do so: Provided that any person may possess a specially protected plant which grows in its natural habitat but which was not planted.

(2) The holder of a permit contemplated in subsection (1) who sells or donates a specially protected plant, shall deliver to the purchaser or donee, as the case may be, together with the plant, a document containing —

(a) the name and address of the seller or donor;

(b) the number of the permit;

(c) the name and address of the purchaser or donee;

(d) particulars of the species and quantity of plants sold or donated;

(e) the date of delivery of the plant; and

(f) the signature of the seller or donor.

passing is op die skenk, verkoop, vervoer in of uitvoer of wegneem uit die Provinsie van 'n beskermde plant ten opsigte van die skenk, verkoop, vervoer in of uitvoer of wegneem uit die Provinsie van enige soort beskermde plant wat in so 'n kwekery gekweek is.

(2) Die houer van 'n vrystelling in subartikel (1) beoog, kan aan iemand anders skriftelik toestemming verleen om, onderworpe aan die bepaling van die vrystelling, enige soort beskermde plant in die vrystelling genoem wat op die perseel van die kwekery daarin genoem, gekweek is, te skenk, te verkoop, in die Provinsie te vervoer of daaruit uit te voer of weg te neem.

(3) Die houer van 'n toestemming in subartikel (2) beoog, kan in ooreenstemming met die besonderhede daarin vervat en onderworpe aan die bepalings van die vrystelling in subartikel (1) beoog, die soorte beskermde plante in die toestemming genoem, skenk, verkoop, in die Provinsie vervoer of daaruit uitvoer of wegneem.

Ontvangs, besit, verkryging of hantering van beskermde plante.

95. Iemand wat —

(a) 'n beskermde plant ontvang wetende dat dit nie wettiglik gepluk is nie;

(b) in besit gevind word van 'n beskermde plant ten opsigte waarvan daar 'n redelike verdenking bestaan dat dit nie wettiglik gepluk is nie en wat nie in staat is nie om voldoende rekenskap van sodanige besit te gee;

(c) 'n beskermde plant op enige wyse verkry of in sy besit ontvang of hanteer sonder om redelike gronde, waarvan die bewyslas op hom rus, daarvoor te hê om ten tyde van die verkryging, ontvangs of hantering te glo dat daardie plant wettiglik gepluk is,

is aan 'n misdryf skuldig.

Verbode handelinge met spesiaal beskermde plante.

96.(1) Behoudens die bepalings van hierdie Ordonnansie, mag niemand 'n spesiaal beskermde plant besit, pluk, verkoop, koop, skenk of as geskenk ontvang, in die Provinsie invoer of daarin vervoer, uit die Provinsie uitvoer of wegneem nie, tensy hy die houer is van 'n permit wat hom magtig om dit te doen: Met dien verstande dat iemand 'n spesiaal beskermde plant wat in sy natuurlike groeiplek groei, maar wat nie geplant is nie, kan besit.

(2) Die houer van 'n permit in subartikel (1) beoog wat 'n spesiaal beskermde plant verkoop of skenk, oorhandig saam met die plant aan die koper of ontvanger, na gelang van die geval, 'n dokument bevattende —

(a) die naam en adres van die verkoper of skenker;

(b) die nommer van die permit;

(c) die naam en adres van die koper of ontvanger;

(d) besonderhede van die soort en hoeveelheid plante wat verkoop of geskenk word:

(e) die datum van lewering van die plant; en

(f) die handtekening van die verkoper of skenker.

(3) A document contemplated in subsection (2) authorizes the holder thereof to convey the specially protected plant sold or donated to him to his address and to possess it there for a period not exceeding 60 days.

(4) Any person who contravenes or fails to comply with subsection (1) or (2) shall be guilty of an offence and liable on conviction, in the case of a contravention of subsection (1) —

(a) where such person has not been previously convicted of a contravention of that subsection or a corresponding provision of the repealed Ordinance, to a fine not exceeding R1 000 or to imprisonment for a period not exceeding 12 months or to both such fine and such imprisonment;

(b) where such person has been previously convicted of a contravention of that subsection or a corresponding provision of the repealed Ordinance, to a fine not exceeding R1 500 or to imprisonment for a period not exceeding 18 months or to both such fine and such imprisonment.

CHAPTER VIII

ENDANGERED AND RARE SPECIES OF FAUNA AND FLORA

ndangered nd rare species f fauna and ora.

97.(1) Every species of fauna and flora referred to in —

(a) Annexure I, and any readily recognisable derivative thereof;

(b) Annexure II,

to the Convention on International Trade in Endangered Species of Wild Fauna and Flora, as amended up to 6 June 1981, shall be an endangered species or a rare species of fauna and flora respectively.

(2) After the commencement of this Ordinance the Administrator shall publish forthwith in the *Provincial Gazette* a list of the endangered species and rare species of fauna and flora contemplated in subsection (1).

(3) Where Annexure I or II to the Convention referred to in subsection (1) is amended in accordance with the provisions of that Convention, the Administrator shall amend the list contemplated in subsection (2) or substitute therefor a list in which the amendments have been effected.

rohibited acts ith ndangered pecies or rare pecies.

98.(1) No person shall import into or export or remove from the Province an endangered species or a rare species, unless he is the holder of a permit which authorizes him to do so.

(2) Subsection (1) shall not apply —

(a) where other provisions of this Ordinance are applicable to the importation into the Province or the exportation or removal therefrom of any wild animal, invertebrate, fish or indigenous plant which is an endangered species or a rare species;

(b) to the importation into the Province from or the exportation or removal therefrom

(3) 'n Dokument in subartikel (2) beoog, magtig die houer daarvan om die spesiaal beskermde plant wat aan hom verkoop of geskenk is na sy adres te vervoer en daar vir 'n tydperk van hoogstens 60 dae te besit.

(4) Iemand wat subartikel (1) of (2) oortree of versuim om daaraan te voldoen, is aan 'n misdryf skuldig en by skuldigbevinding strafbaar, in die geval van 'n oortreding van subartikel (1) —

(a) waar so iemand nie voorheen aan 'n oortreding van daardie subartikel of 'n ooreenstemmende bepaling van die herroepe Ordonnansie skuldig bevind is nie, met 'n boete van hoogstens R1 000 of met gevangenisstraf vir 'n tydperk van hoogstens 12 maande of met daardie boete sowel as daardie gevangenisstraf;

(b) waar so iemand voorheen aan 'n oortreding van daardie subartikel of 'n ooreenstemmende bepaling van die herroepe Ordonnansie skuldig bevind is, met 'n boete van hoogstens R1 500 of met gevangenisstraf vir 'n tydperk van hoogstens 18 maande of met daardie boete sowel as daardie gevangenisstraf.

HOOFSTUK VIII

BEDREIGDE EN SKAARS SOORTE FAUNA EN FLORA

Bedreigde en skaars soorte Fauna en Flora.

97.(1) Elke soort fauna en flora genoem in —

(a) Aanhangesel I, en enige geredelik herkenbare derivaat daarvan;

(b) Aanhangsel II,

by die Konvensie op Internasionale Handel in Bedreigde soorte Wilde Fauna en Flora, soos gewysig tot op 6 Junie 1981, is onderskeidelik 'n bedreigde soort of 'n skaars soort fauna en flora.

(2) Na die inwerkingtreding van hierdie Ordonnansie publiseer die Administrateur onverwyld in die *Provinsiale Koerant* 'n lys van die bedreigde soorte en skaars soorte fauna en flora in subartikel (1) beoog.

(3) Waar Aanhangsel I of II by die Konvensie in subartikel (1) genoem, ooreenkomstig die bepalings van daardie Konvensie gewysig word, wysig die Administrateur die lys in subartikel (2) beoog of vervang hy dit deur 'n lys waarin die wysigings aangebring is.

Verbode handelinge met bedreigde soorte of skaars soorte.

98.(1) Niemand mag 'n bedreigde soort of skaars soort in die Provinsie invoer of daaruit uitvoer of wegneem nie, tensy hy die houer is van 'n permit wat hom magtig om dit te doen.

(2) Subartikel (1) is nie van toepassing nie —

(a) waar ander bepalings van hierdie Ordonnansie op die invoer in die Provinsie of die uitvoer of wegneem daaruit van enige wilde dier, ongewerwelde dier, vis of inheemse plant wat 'n bedreigde soort of skaars soort is, van toepassing is;

(b) op die invoer in die Provinsie vanaf of die uitvoer of wegneem daaruit na 'n ander

Common name	Scientific name
black stinkwood	*Ocotea bullata*
stinkwood	*Ocotea kenyensis*
kiaat	*Pterocarpus angolensis*
tamboti	*Spirostachys africana*
the following euphorbias: barnardii, clivicola, grandialata, groenewaldii, knobelii, perangusta, restricta, rowlandii, tortirama and waterbergensis	the following species of the Genus Euphorbia: *E. barnardii, E. clivicola, E. grandialata, E. groenewaldii, E. knobelii, E. perangusta, E. restricta, E. rowlandii, E. tortirama and E. waterbergensis*
boabab	*Adansonia digitata*
all species of begonias	*Begonia* spp.
all species of cabbage trees	*Cussonia* spp.
the following species of ericas (heaths): alopecurus, cerinthoides and oatesii.	the following species of the Genus erica: *E. alopecurus, E. cerinthoides* and *E. oatesii*
big leaf fever tree	*Anthocleista grandiflora*
the following species of impala lilies: obesum, oleifolium and swazicum	the following species of the Genus Adenium: *A. obesum, A. oleifolium* and *A. swazicum*
kudu lily	*Pachypodium saundersii*
all species of brachystelma	*Brachystelma* spp.
all species of ceropegia	*Ceropegia* spp.
all species of riocreuxias	*Riocreuxia* spp.
all species of ghaap	*Tavaresia* spp.
all species of Huerniopsis and heurnia	*Huerniopsis* and *Huernia* spp.
all species of duvalia	*Duvalia* spp.
all species of stapeliads	*Stapelia* spp.
stapeliad	*Hoodia lugardii*
all species of orbeanthus	*Orbeanthus* spp.
all species of orbeas	Orbea spp.
all species of pachycymbiums	*Pachycymbium* spp.
all species of orbeopsis	*Orbeopsis* spp.
all species of primulas	*Streptocarpus* spp.

SCHEDULE 12

SPECIALLY PROTECTED PLANTS (SECTION 86(1)(b))

In this Schedule "seedling" means a cultivated plant of which the diameter of the trunk or bulb, either above or below the ground, does not exceed 150 mm.

Common name	Scientific name
(a) all plants, excluding seedlings, of the following cycads:	(a) all plants, excluding seedlings, of the following species of the Genus *Encephalartos:*
eugene marais	*E. eugene maraisii*
heenan	*E. heenanii*
inopinus	*E. inopinus*
laevifolius	*E. laevifolius*
lanatus	*E. lanatus*
lebombo	*E. lebomboensis*
ngoyanus	*E. ngoyanus*
paucidentatus	*E. paucidentatus*
modjadje	*E. transvenosus*
villosus	*E. villosus*
(b) all plants of the following cycads:	(b) all plants of the following species:
cupidus	*Encephalartos cupidus*
humilus	*Encephalartos humilus*

Gewone naam	Wetenskaplike naam
swartstinkhout	***Ocotea bullata***
stinkhout	***Ocotea kenyensis***
kiaat	***Pterocarpus angolensis***
tambotie	***Spirostachys africana***
die volgende soorte euphorbias: barnardii, clivicola, grandialata, groenewaldii, knobelii, perangusta, restricta, rowlandii, tortirama en waterbergensis	die volgende spesies van die Genus *Euphorbia: E. barnardii, E. clivicola, E. grandialata, E. groenewaldii, E. knobelii, E. perangusta, E. restricta, E. rowlandii, E. tortirama en E. waterbergensis*
kremetartboom	***Adansonia digitata***
alle soorte begonias	***Begonia* spp.**
alle soorte kiepersolle	***Cussonia* spp.**
die volgende soorte heide: alopecurus, cerinthoides en oatesii.	die volgende spesies van die Genus *Erica: E. alopecurus, E. cerinthoides* en *E. oatesii*
grootblaarkoorsboom	***Anthocleista grandiflora***
die volgende soorte impalalelies:	**die volgende spesies van die Genus *Adenium:***
obesum, oleifolium en swazicum	***A. obesum, A. oleifolium*** en *A. swazicum*
koedoelelie	***Pachypodium saundersii***
alle soorte brachystelmas	***Brachystelma* spp.**
alle soorte ceropegia	***Ceropegia* spp.**
alle soorte riocreuxias	***Riocreuxia* spp.**
alle soorte ghaap	***Tavaresia* spp.**
alle soorte bokhorinkies	***Huerniopsis* en *Huernia* spp.**
alle soorte hottentotstoontjies	***Duvalia* spp.**
alle soorte aasblomme	***Stapelia* spp.**
aasblom	***Hoodia lugardii***
alle soorte orbeanthusse	***Orbeanthus* spp.**
alle soorte orbeas	***Orbea* spp.**
alle soorte pachycymbiums	***Pachycymbium* spp.**
alle soorte orbeopsisse	***Orbeopsis* spp.**
alle soorte primulas	***Streptocarpus* spp.**

BYLAE 12

SPESIAAL BESKERMDE PLANTE (ARTIKEL 86(1)(b))

In hierdie Bylae beteken "saailing" 'n verboude plant waarvan die deursnee van die stam of bol, hetsy bo of onder die grond, hoogstens 150 mm is

Gewone naam	Wetenskaplike naam
(a) alle plante uitgenome saailinge van die volgende soorte broodbome:	(a) alle plante uitgenome saailinge van die volgende spesies van die Genus *Encephalartos:*
eugene marais	*E. eugene maraisii*
heenan	*E. heenanii*
inopinus	*E. inopinus*
laevifolius	*E. laevifolius*
lanatus	*E. lanatus*
lebombo	*E. lebomboensis*
ngoyanus	*E. ngoyanus*
paucidentatus	*E. paucidentatus*
modjadje	*E. transvenosus*
villosus	*E. villosus*
(b) alle plante van die volgende soorte broodbome:	(b) alle plante van die volgende spesies:
cupidus	*Encephalartos cupidus*
humilus	*Encephalartos humilus*