THE EFFECTS OF UTILIZATION BY PEOPLE AND LIVESTOCK ON *HYPHAENE PETERSIANA* (ARECACEAE) BASKETRY RESOURCES IN THE PALM SAVANNA OF NORTH-CENTRAL NAMIBIA[1]

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Konstant, Tracey L. *(4 Walker Avenue, Discovery, Roodepoort, 1707, South Africa),* **Sullivan, Sian** *(Department of Anthropology, University College London, Gower Street, London WC1E 6BT, UK), and* **Cunningham, Anthony B.** *(PO Box 42, Betty's Bay, 7141, South Africa).* THE EFFECTS OF UTILIZATION BY PEOPLE AND LIVESTOCK ON *HYPHAENE PETERSIANA* BASKETRY RESOURCES IN THE PALM SAVANNA OF NORTH-CENTRAL NAMIBIA. *Economic Botany 49(4):345–356. 1995.* *Basketry production is an important informal sector activity in the palm savanna of north-central Namibia, particularly for women. This study assesses the comparative impact of utilization by basket makers and browsing livestock in areas of different human and livestock population pressures on the source of weaving fibre, leaves from juvenile individuals of the vegetable ivory palm,* Hyphaene petersiana. *Mature individuals of this species are an important source of edible fruit. Destructive uses of mature individuals such as tapping for palm wine and the cutting of stems for construction purposes are also practised, even though they are forbidden by customary law. Unlike other centres of basket production in southern Africa, the level of leaf utilization for basketry is low and there is potential for greater use of this resource. Despite the unpalatability of this species, a cause for concern, however, is the intensity of browsing by domestic livestock on young palms, which may affect the future structure and viability of the palm population in north-central Namibia. This predicted degradation of a multiple-use species such as* H. petersiana *represents the gradual erosion of an important buffer against rural poverty, loss of income and reduction in food security.*

Etungo lyimbale olyi li omahupilo goomeme yamwe mboka yeli moshitopolwa shopokati shaWambo. Oshinyolwa shika otashi konaakona oshilanduli sheindjipalo lyaakalimo nolyi-itungwa komuti gwedhina Hyphaene petersiana *(omulunga), ngoka ogwo onza yiitungitho yii-likolomwa ya tumbulwa pombanda. Pakuyelaka nomahala gamwe muAfrika lyokuumbugantu moka hamu tungwa oontungwa, elongitho lyoombale mOwambo olyi li pevi, nelongitho lyolunza nduka otashi vulika li nenepalekwe. Unanapelo woondoongi, iikombo noongombe kiiyale otau eta omalimbililo notashi vulika u ete po omukundu gwopamahupilo komeho. Ehanagulo po lyomiti dhiiyimati ngaashi* Hyphaene petersiana *otaili shonopaleke oshikandekitho sholuhepo notashi vulika shi fale sigo omekanitho lyiikulya miitopolwa yomomikunda.* [OSHIWAMBO] *A produção de centos e outros artigos de vime é uma actividade importante do sector nao-convencional em Owambo, no norte da Namibia, particularmente para as mulheres. Este estudo investiga o impacto da produção de cestos e da exploração por parte de população humana na planta que fornece as fibras, a palmeira Marfim Vegetal ou* Hyphaene petersiana. *Contráriamente ao que se verifica em outros centros de produção de cestos na Africa Austral, o grau de utilização da folha da palmeira nao é elevado e a potencialidade existe para o uso mais intensivo deste recurso vegetal. É no entanto motivo de preocupação o pastar intenso de gado bovino, de cabras e de burros que comem as palmeiras jovens o que provávelmente afectará a estrutura e a via-bilidade da população de palmeiras no futuro. A degradação de plantas produtoras de frutos comestiveis como a* Hyphaene *representa o esgotamento de uma defesa importante contra a pobreza das populaçoes rurais.*

Key Words: *Hyphaene petersiana*; vegetable ivory palm; basketry; Namibia.

[1] Received 16 August 1993; accepted 3 March 1995.

Fig. 1. Owambo basket-maker using strips of the young leaves of *Hyphaene petersiana*.

Basketry in the former Owambo region of northern Namibia is an important rural industry practised mainly by women, providing both important household utensils and a means of generating income (Fig. 1). The primary resource on which this industry relies is the pliable unopened leaf of juvenile individuals of the palm *Hyphaene petersiana* Klotzsch, known as *omulunga* in Oshiwambo. In addition to using the leaves for multipurpose fibre, the mature palms are a source of fruits with an edible pericarp which can also be fermented to make an alcoholic beverage (termed *olambika*), sap for palm wine, edible terminal shoots (palm hearts), long petioles for fence droppers, and stems from felled palms for fencing posts, building poles, and water troughs (Rodin 1985). In the absence of alternative fodder sources, the young palms are also browsed by domestic cattle, goats and donkeys, despite the fibrous texture and unpalatability of the palm leaves (Fig. 2). *Hyphaene* palms and a few other multiple-use species such as *Colophospermum mopane* (Kirk ex Benth.) Kirk ex J. Léonard, *Berchemia discolor* (Klotsch) Hemsley, *Diospyros mespiliformis* Hochst. ex A. DC., *Ficus sycomorus* L., and *Grewia* spp., dominate the anthropogenic landscape of the recently delineated Oshana, Omusati and north-eastern Oshikoto Regions of the former Owambo region. Subsistence farmers in this area have been decribed as agro-silvipastoralists (Krieke 1995), a term which emphasises the dominant contribution that indigenous tree species make to rural livelihoods.

Rural industry such as basketry is an important form of self-employment in Africa, providing a supplement, particularly for women, to income from subsistence agriculture and, through diversifying labour input and productive output, spreading risk and increasing chances of survival in times of vulnerability such as drought years (Colson 1979). The development of organized marketing of products reliant on a naturally renewable resource, as is likely when such products assume commercial value is, however, potentially harmful in the long-term, particularly when not coupled with development of the industry's resource base. This is especially so in arid and semi-arid areas where plant growth rate and standing biomass are inherently low and variable, and in areas such as north-central Namibia where considerable degradation of natural resources has already occurred (Erkkilä and Siiskonen 1992).

Initially, the availability of raw materials is usually the most important factor determining the establishment of such industries, more so than access to markets or transportation (Kabuye 1988). Once established, however, the industries tend to survive, despite local resource depletion, thereby stimulating the importation of raw material from elsewhere and the continued intensive utilization of any remaining or renewed local supplies (Babiker 1982). While the encouragement of such industry can be beneficial to rural people in need of alternative income, development of this kind should be coupled with the monitoring of resource availability and resource management, particularly at community level, in order to ensure the sustainability of such activities into the future. The reinforcement of traditional property rights concerning important tree species, combined with rotational harvesting of stems and leaves, and encouragement of seed planting by community leaders, has, for example, proved successful in the management of *Hyphaene compressa* H. Wendl. resources in Turkana, Kenya (Barrow 1990).

The aim of this project was, therefore, to assess the status, relative to other African centres of

Fig. 2. A high number of cattle, goats and donkeys were relying on palms for fodder at the time of the study.

basket production, of *H. petersiana* basketry resources in two areas of different human and livestock population densities within the palm savanna of north-central Namibia. Similar work indicates that basketry resource depletion has occurred in Botswana (Cunningham 1988a, 1992; Cunningham and Milton 1987; Terry 1984, 1987a,b), South Africa (Cunningham 1988b), East Africa (Barrow 1990) and Sudan (Babiker 1982), despite the relatively high natural productivity and resilience to damage of the species concerned (Oba 1990). This has been attributed largely to human population increase and commercialisation of the basketry industry resulting in the unsustainable frequency and intensity of palm use for basketry, accompanied by non-selective (see below), cutting of palm leaves. Ideally, palm leaves for basketry are selectively cut through the petiole using a sharp knife without damaging the meristem, open leaves or other young leaves (Terry 1987a), with the recommendation that sustainable leaf harvesting be limited to 30% of annual leaf production (Cunningham 1988a).

At the time of this study, basket-makers in north-central Namibia produced almost entirely for a local or regional market (Fig. 3). Given the human population growth rate in Owambo of 4% per annum (Coghill and Kiugu 1990), however, harvesting pressure on basketry resources can be expected to increase substantially, even without an increase in the commercial market for baskets. Careful monitoring of the basket-making industry, and of other pressures on its resource base, is, therefore, necessary in order to prevent the depletion of basketry resources in this area, and the consequent undermining of a handcraft activity which, through its income-generating capacity, has the potential to improve the livelihoods of many rural people.

Study Area

Two sampling areas in the palm savanna of north-central Namibia were chosen to represent the effects of differing densities of human and livestock populations on *H. petersiana*. The first site was in the Onayena area, north-east Oshikoto Region, a relatively rural area approximately 30 km east of the small town of Ondangwa and the main road north through north-central Namibia. The second site was located in the Iiheke area within 15 km of Oshakati, the largest town and greatest concentration of human population in the central Oshana Region of north-central Namibia. Only palms growing on communal land were included in the sampling of these sites. Within the Iiheke area, a Department of Forestry exclusion area, fenced since October 1991 to prevent access by livestock or people, was sampled as a third site and partial control. Figure 4 shows the location of these sampling areas.

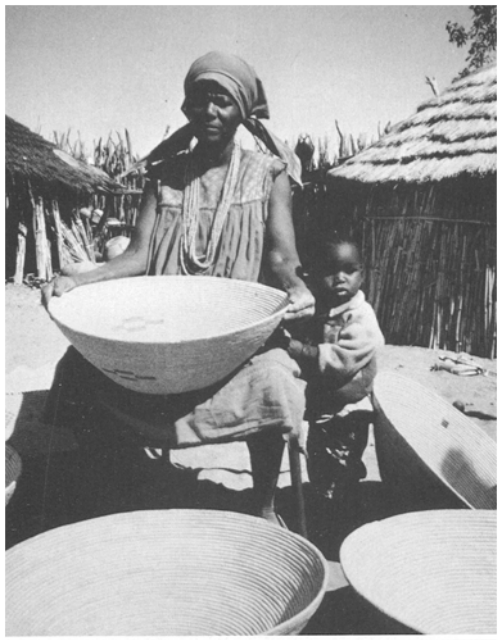


Fig. 3a (above). Strong, functional baskets made from *Hyphaene petersiana* for home use. They are finely woven with few, simple designs.

Fig. 3b (below). *Hyphaene* baskets for sale to tourists are made more quickly than those intended for household use, are not as robust although sometimes very large, and often contain more dyed fibre.

Methods

Sampling Strategy

Palms were sampled using a series of 100 m × 100 m quadrats, placed systematically in lines of 2–3 at 100 m intervals. Each of these transects was situated approximately 1 km apart in areas of palm savanna. In some instances the placement of the quadrats was modified slightly due to the location of homesteads, cultivated fields or fenced, privatised land. Data were collected from a total of 10 quadrats at each of the sites on communal land, while 2 quadrats comprised the sample located in the Department of Forestry exclusion area at Iiheke.

Plant Measurements

A variety of quantitative plant measurements were chosen as the focus for data collection in this study in an attempt to fulfill two aims. First, to describe the type and intensity of use of palm leaves by both humans for weaving fibre and livestock for browse. Second, to analyse the type of impact that such utilization may be having on these resources by relating use measures to a range of indicators of plant vigour. These measures were made on all juvenile (i.e., unstemmed) individuals and are described in full below.

Leaf Utilization and Damage

Each palm stem produces a succession of leaves in a rosette around the apical meristem, with leaves produced throughout the year and annual production increasing with age of the plant. Estimates of leaf production rates for juvenile unstemmed plants range from between 6 leaves/year in *H. petersiana* (Fanshawe 1967) to 1 leaf/year in *Hyphaene coriacea* Gaertn. (Moll 1972). Leaf production in these juvenile palms appears to vary with age in proportion to the average leaf length of the leaf blades of individual plants. Cunningham (1988b), in a more recent study of leaf production in *H. coriacea* in Natal, South Africa, recorded annual leaf production rates of 3.15 leaves/year in palm stems with leaf blades 80–99 cm long, and of 3.79 leaves/year in stems with leaf blades 100–119 cm long. Cunningham and Milton (1987), in their study of basket resource utilization in Botswana, assumed, therefore, an annual leaf production in juvenile *H. petersiana* plants of 3–5 leaves/year in the section of the population utilized by basket weavers. Subsequent work on this species in north-western Botswana has confirmed this leaf production rate (Cunningham 1988a).

Following Cunningham and Milton (1987), therefore, damage to the unopened leaves and the four youngest opened leaves was recorded in this study to provide an estimate of leaf utilization during the previous year. Each of these

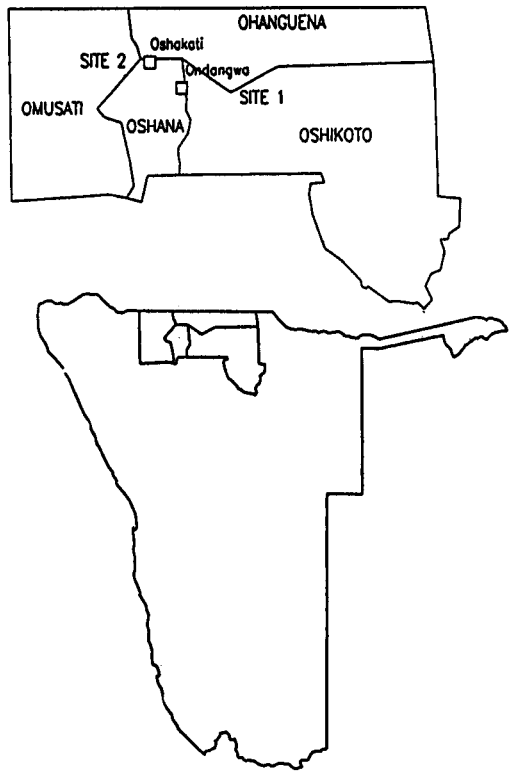


Fig. 4. Location of study region in and the location of the study sites within north-central Namibia. Site 1 is in the Onayena area and site 2 is in the Iiheke area.

leaves was classified according to type of utilization as follows: **undamaged**, no damage by humans or livestock; **cut**, the entire leaf removed leaving a clean-cut petiole (Fig. 5a); **spoiled**, leaflets cut through the leaf blade, either prior to the opening of the leaf thus damaging the unopened leaf used for basketry, while trying to reach the unopened leaf, or for the use of individual leaflets for twine (Fig. 5a); **browsed**, this category was not recorded by Cunningham and Milton (1987) but in north-central Namibia, where browsing livestock are abundant and alternative feed may be periodically unavailable, this was considered to be of possible significance in affecting palm productivity and community structure (Fig. 5b).

Spoiling of leaves by cutting (Fig. 5 above) is clearly distinguishable from the ragged damaged causing by browsing livestock (Fig. 5 below).

Fig. 5a (above). Leaves of *Hyphaene petersiana* removed by cutting through the petiole (cut) or damaged by cutting through the leaf blade (spoiled), making them unusable for basketry.

Fig. 5b (below). The ragged damage to palm leaves caused by browsing livestock (browsed).

Plant Vigour and Productivity

Leaf Emergence

The number of emerging unopened leaves was recorded for each stem. Similar work in Botswana demonstrates that the emergence of new unopened leaves is sensitive to the intensity of utilization. Cunningham and Milton (1987) and Cunningham (1988a), for example, recorded averages of 0.6 and 0.5 unopened leaves per palm

sucker in areas of heavy pressure on this resource, and means of 0.98 and 1.3 unopened leaves per sucker in the least utilized areas.

Leaf Length

One of the primary criteria for the suitability of palm leaves for basket weaving is the length of the unopened leaf, on which the strength and durability of the baskets depend (Cunningham and Milton 1987). Leaf length has also been found to be affected by heavy utilization in *H. petersiana* populations in Ngamiland, Botswana (Cunningham 1988a). In Natal, where leaves are relatively easily available, the average size used for basketry is at least 80 cm (Cunningham 1988b), while in the more depleted areas of basket production in Botswana leaves of 50–60 cm are used if necessary (Cunningham 1988a). Where levels of damage and the degree of emergence of unopened leaves permitted, the lengths of unopened and opened leaves were measured, therefore, to reflect local availability of weaving material of a suitable size and the possible impact of heavy utilization by harvesters for basketry and browsing livestock. Following Cunningham and Milton (1987), measurements were taken from the lowest point of the leaf base to the tip of the middle leaflet.

Clump Structure and Height Classes

The number of stems in each clump was recorded together with the height of each stem, as a measure of plant size, in one of three height categories; <0.5 m, 0.5–1 m and >1 m. These measures were used to indicate changes in the structure of the juvenile palm community which may be attributed to type and degree of utilization and affect the future availability of basketry and other palm resources.

Analysis

The leaf utilization data and the plant vigour measures of leaf emergence, clump structure and size class were not normally distributed and the non-parametric Mann-Whitney U-test (MWU) was used to indicate differences in the degree and type of utilization, and its effects, at and between each site. Unless otherwise stated, differences were accepted as significant when the probability of exceeding the test statistic Z was less than 0.01.

Leaf length was normally distributed and the effects of site and plant size were analysed using multiway analysis of variance and 90% least significant difference multiple range tests. Relationships between the average leaf length of each clump and the degree of each type of leaf utilization and damage recorded for that clump were tested using Pearson product-moment correlations. In this way it was possible to test for whether basket producers were selecting for leaves of a particular size, or whether plants with the greatest indication of damage were producing smaller leaves. The effect of the number of stems in the clump on average leaf size was determined in the same way.

Results

Leaf Utilization and Damage

Leaf utilization and damage data are presented for all three sites in Fig. 6. A total of 84% and 93% of opened leaves on communal land at Onayena and Iiheke respectively were recorded as damaged, primarily by browsing livestock (Fig. 6). In contrast only 9% of all unopened leaves in these sites had been damaged. In both opened and unopened leaves overall damage was greater in the smaller stems. Totals of 98.5%, 95.5% and 76% of open leaves were damaged in the <0.5 m, 0.5–1 m and >1 m size classes respectively, and corresponding figures for unopened leaves were 17% for plants <0.5 m high and 2.5% for those >1 m high.

The effect of higher human and livestock population densities was greatest in plants above 1m, with significantly more open leaves damaged at Iiheke (87%) than at Onayena (65%). The fenced area at Iiheke, which had been protected from human and livestock utilization for 9 months prior to data collection for this study, displayed predictably lower levels of damage with only 31% of open leaves and none of the unopened leaves recorded as cut, spoiled or browsed.

Despite the high levels of total damage recorded, only 10.4% of all leaves had been cut for weaving fibre or spoiled by non-selective harvesting. This is much lower than that recorded for heavily utilized areas of Botswana, for example, where damage by harvesters affected 42% and 46% of leaves (Cunningham and Milton 1987). These indicators of human utilization were most frequent in the current study in plants more than 1m high (16%) than in the intermediate or smallest size classes (3.5% and 0.9% of leaves respectively). Less damage by harvesters was recorded on communal land at Onayena than Iih-

eke, with significantly more undamaged than cut leaves in all except the smallest size class (<0.5 m) at Onayena, and no significant difference between numbers of undamaged and cut leaves in any of the size classes at the more densely populated Iiheke site. In no instance was there any difference between the numbers of cut and spoiled leaves, suggesting the sacrifice of about an equal number of leaves to those harvested.

Levels of human utilization were thus minimal compared to damage caused by browsing livestock, the latter being responsible for damage to some 98% of opened leaves in plants <0.5 m high, and to 92% and 60% of opened leaves in the 0.5–1 m and >1 m size class respectively. Levels of browse on unopened leaves were much lower, the emerging unopened leaf being protected by the spines of open leaves surrounding it and by its hard, tightly folded, compact nature. Browse on unopened leaves was 11.5% more frequent in the smallest sized palms than in either of the size classes above 0.5 m. This selection for the smaller, younger leaves of plants of the smallest size class is probably accounted for by the greater fibrous texture and unpalatability of larger leaves.

Plant Vigour and Productivity

Leaf Emergence

The number of new unopened leaves ranged from 0 to 3 per individual palm sucker and was significantly higher at Onayena than Iiheke in all size classes with averages of 0.92 and 0.75 per sucker recorded respectively (Fig. 7). This reflects reduced vigour in the more densely populated Iiheke area. Palms in this area still demonstrated moderate productivity, however, when compared with palms surveyed in intensely utilized areas of Botswana (see above).

Leaf Length

No significant difference in leaf length between Onayena and Iiheke was found in palm plants in the 0.5–1 m and >1 m size classes (Fig. 7). In the <0.5 m size class none of the leaves of plants at Iiheke could be measured because of heavy browsing and comparisons within this size class were therefore impossible. Palms in the Department of Forestry exclusion area at Iiheke produced significantly smaller leaves than recorded for the communal areas at either Onayena or Iiheke in the two larger size classes (>0.5 m). This reduction in leaf length following protection

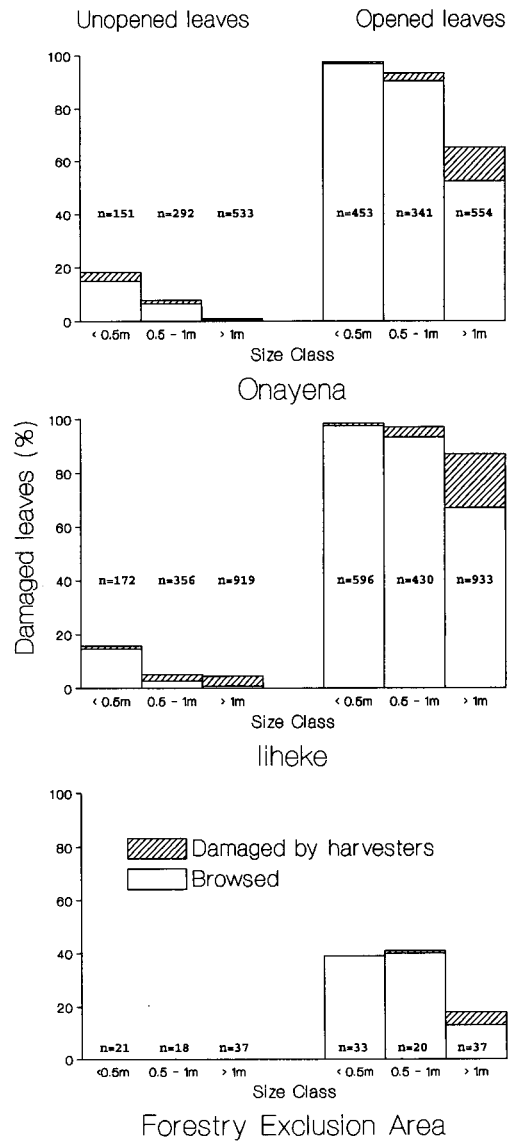


Fig. 6. The degree of utilization by humans and livestock, of the unopened leaves and the four youngest opened leaves of unstemmed *Hyphaene petersiana* in three size classes at three sites: the moderately populated Onayena area, the densely populated Iiheke area, and the Department of Forestry exclusion area in Iiheke.

was probably due to competition for water by rapidly colonizing grass species which may outweigh the benefits of alleviated disturbance following the removal of grazing livestock. It is likely that larger leaves will be produced once the grass sward has been established and herbaceous growth rates decrease. This emphasizes findings elsewhere that while palms are relatively tolerant

of utilization (Cunningham 1988b; Oba 1990), and perhaps grow more vigorously to compensate for the resulting leaf damage, they are sensitive to water availability and survive in semi-arid and arid areas only where high water tables or restricted drainage permit (Tomlinson 1979). *H. compressa* in Turkana, Kenya, for example, was found to produce fewer smaller leaves when growing further from river-beds than individuals beside rivers (Hoebeke 1989).

As has been observed in other populations (Cunningham 1988b), larger plants were found to produce larger leaves with means of 95 cm, 63 cm and 50 cm recorded for plants in the >1 m, 0.5–1 m and <5 m size classes respectively (Fig. 7). The number of stems in a clump was found to have no effect on the average leaf length of the clump, suggesting that close proximity of shoots neither inhibits or enhances individual leaf production.

The effects of harvesting for weaving fibre and livestock browsing on leaf length were determined by testing for significant correlation between the mean percentage of each type of damage in a clump and the mean leaf length of that clump. Total damage was found to have no significant relationship with leaf length at Iiheke, while at Onayena a positive correlation between damage and smaller leaf size was found ($P < 0.05$). This could largely be attributed to the effects of browsing which was found to be highly positively correlated with smaller leaf length ($P < 0.0001$), particularly at Onayena. This is to be expected since browsing was found to be heaviest in the smallest palms, the size class which produced the smallest leaves. The greater selectivity of smaller leaves in the Onayena sample indicates lower overall pressure than in the more densely populated Iiheke area, where less palatable and more fibrous larger leaves were also heavily browsed by livestock.

In contrast to livestock browsing, leaves cut and spoiled by humans were positively correlated with larger leaf sizes ($P < 0.0001$) with selection for larger leaves taking place at both sites. This relationship was more pronounced at Iiheke, even though there was no difference in the mean leaf lengths available at the two sites. More than 30% of stems producing leaves longer than an average of 110 cm were harvested, while stems bearing leaves of an average length of less than 90cm were hardly touched. The average leaf length of the clumps showing signs of utilization for basketry was 98 cm at Onayena and 102 cm at Iiheke. When compared with figures for Natal (Cunningham 1988b) and Botswana (Cunningham 1988a) (see above) these results suggest that large leaves are still in good supply, and productivity is healthy, in the areas sampled in north-central Namibia.

Juvenile Clump Structure

The clump structure of the palm population in this area is discussed in more detail in Sullivan, Konstant, and Cunningham (1995). The main features relevant to the juvenile palms which supply leaves utilized for basketry include the following.

First, the palm community of the areas studied was dominated by individuals in the non-reproductive, unstemmed juvenile height classes which produce leaves suitable for weaving fibre, with nine and ten times as many juvenile palms as tall stemmed individuals recorded in the Onayena and Iiheke samples respectively. This is much greater than the proportions of unstemmed individuals found in *Hyphaene compressa* populations in semi-arid Turkana, Kenya (Amuyunza 1991; Oba 1991; Hoebeke 1989).

Second, clump size was small at both sites (Fig. 8a above), and significantly smaller at Iiheke (MWU, $P = 0.02$), due to large numbers of single-stemmed individuals, with 52% of clumps consisting of only 1 stem and 87% containing fewer than 6 stems. These clump sizes are considerably smaller than those recorded in a similar study of *H. petersiana* in Botswana palm savanna (Cunningham and Milton 1987).

Finally, most of the single-stemmed, juvenile palms found in this study were from the smallest height class (<0.5 m) (Fig. 8b below), with 90% and 75% recorded for this height class at Iiheke and Onayena respectively.

Discussion

The findings of this study suggest that the impact of basketry on its resource base is low in the area sampled, especially compared with other centres of basket production such as those in Botswana, Zimbabwe and South Africa, where rural commmunities produce export quality baskets for an international market (Babiker 1982; Cunningham 1988a; Cunningham and Milton 1987). The total level of utilization recorded in this study of 10.4% of leaves harvested as weaving fibre is also much lower than the potential

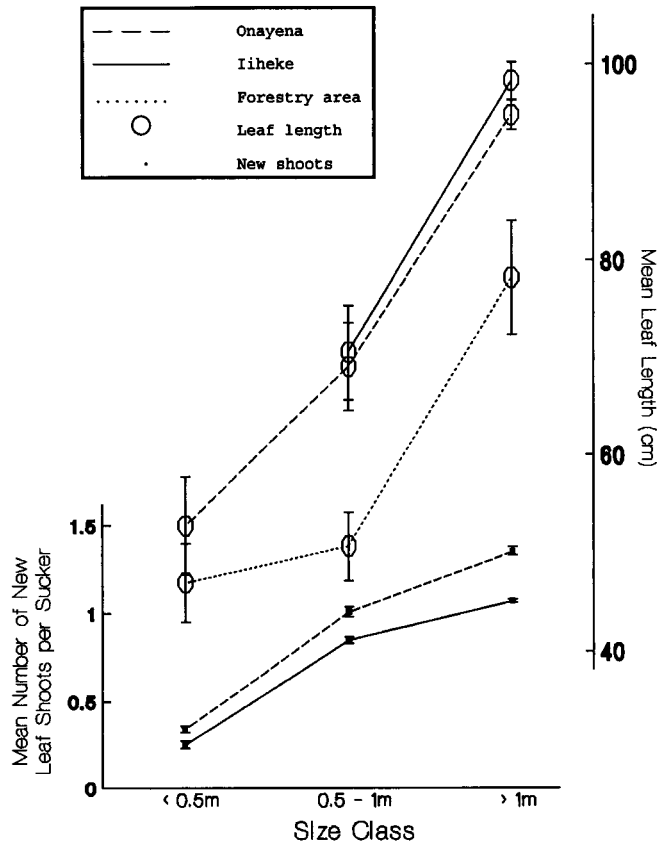


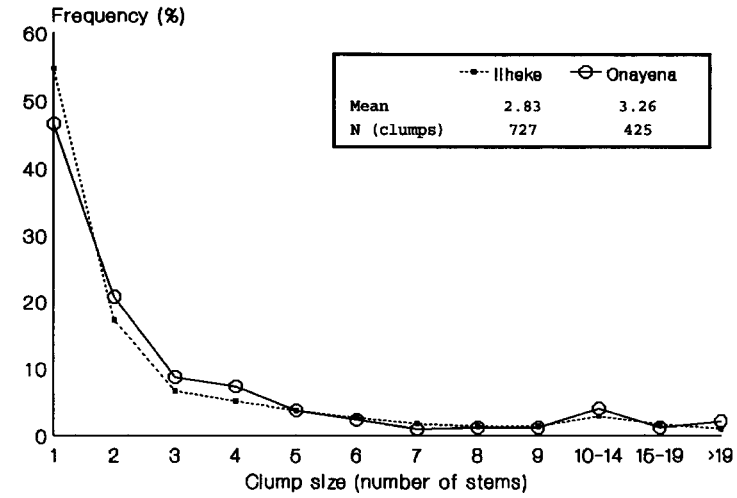
Fig. 7. Mean leaf length and the number of emerging leaves per sucker in three size classes of juvenile unstemmed *Hyphaene petersiana*. None of the palms below 0.5 m tall sampled on communal land at Iiheke had measurable leaves.

annual offtake level of 30% of leaves recommended for *H. petersiana* in Botswana (Cunningham 1988a), and for *H. coriacea* in Natal (Cunningham 1988b). This suggests that the impact of harvesters for basketry in these areas of north-central Namibia are within sustainable limits.

In common with other basket producing areas of southern Africa however, leaf harvesting is not evenly spread, but is concentrated on the palms most accessible from basket making villages. An unpublished survey by le Roux (1992) for example indicates that a priority area could be that immediately surrounding the town of Ondangwa where an average of 25 baskets were made annually by each respondent (n = 41), of which an average of 21 were sold by 39 respondents. Further investigation is necessary, therefore, in known areas of high basket production, where baskets are consistently produced for commercial sale.

Despite the low level of utilization of palm leaves for basketry in the areas surveyed in this study, the *Hyphaene* population in north-central Namibia is subject to more intense, and possibly unsustainable, browsing by livestock than in other southern African basket production centres. While livestock numbers throughout Namibia display substantial fluctuations in response to rainfall-determined primary productivity, regional records from 1945 to 1990 indicate overall increases in cattle numbers of 94%, a 316% increase goat numbers and a 2000% increase in donkeys (Marsh and Seely 1992; Directorate of Veterinary Services 1990; Tapscott 1990).

It is probable that the prevalence of small single-stemmed shoots, and the high numbers of juvenile, unstemmed palms relative to mature, stemmed palms recorded for this area (Sullivan, Konstant and Cunningham 1995), are the result of compensatory root productivity in response to severe defoliation by browsing. This is sup-



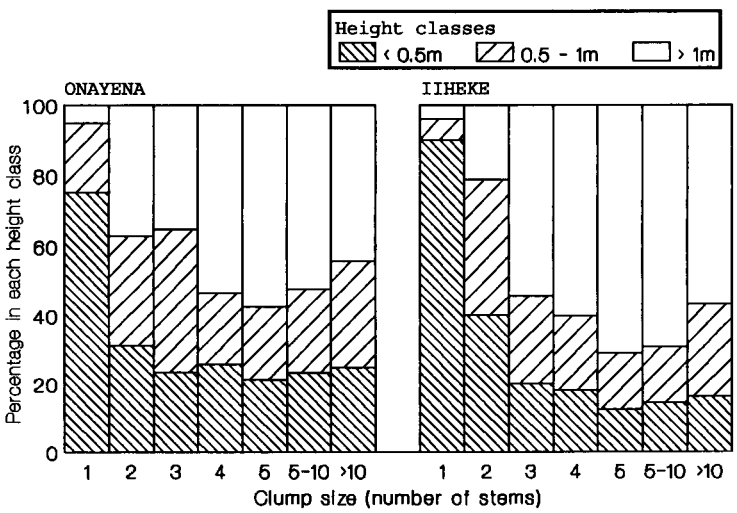


Fig. 8a (above). Clump size distribution of juvenile unstemmed *Hyphaene petersiana* at two sites.
Fig. 8b (below). The proportions of *Hyphaene* shoots in three height classes in clumps of different sizes at Onayena and Iiheke.

ported by findings elsewhere by Oba (1990) that, following defoliation by fire, the density and number of sucker shoots in coppice clumps in *H. compressa* increased, and by Mendoza, Pinero, and Sarukhan (1987) that defoliation stimulates productivity. This is borne out by the relatively low proportion of palm suckers in the area at Iiheke protected from defoliation by livestock.

Differences in livestock population density between the areas surveyed emphasize the effects of livestock, with the palm population at the more densely populated Iiheke site displaying greater levels of total damage in larger plants, lower rates of new shoot emergence, less selective browsing and more single stemmed suckers. Of serious concern is the likelihood that the impact of increasing numbers of browsing livestock in the absence of alternative fodder resources may produce major changes in the palm population structure (Sullivan, Konstant, and Cunningham 1995).

The intense browsing by livestock observed in this study, particularly on small plants, is considered likely to reduce the rate of replacement of sexually productive adult palms and thereby cause a change in the overall population structure from stands of mature palms to short palm scrub reliant on vegetative reproduction. While such a relative abundance of juvenile palms, as recorded in this study, would appear to bode well for the future production of weaving material, continued heavy browsing may prevent small plants from reaching the size class (>1 m) which produces leaves suitable for basketry. It may also reduce the length of leaves produced by these larger plants. Furthermore, it is likely that a change in the physiognomy of the palm population due to browsing will be exacerbated by an increase in destructive uses of mature palms as other less desirable woody species are removed to supply household timber requirements. The overall effect of such combined pressures may be reduced genetic diversity and long-term decline in the viability of the palm population in this area.

While the low impact of harvesting for basketry recorded in this study is encouraging for the predicted increase in demand for weaving material it should, therefore, be placed in the context of other factors influencing long-term resource availability. The many indicators of vegetation degradation in the north-central Namibia, including the destructive use of mature *H. petersiana* palms and the heavy browsing by livestock of this normally unpalatable species, suggest intense pressure on this important multiple-use species and a need for appropriate resource management measures which keep both the palm resource base and traditional basketry skills alive.

Acknowledgments

Financial support for this project was received from the Norwegian Embassy through the Namibian Nature Foundation (NNF) and the Research Bureau, University of Namibia. Our thanks go to Joseph Hailwa (District Forestry Officer, Ondangwa) and the Regional Commissioner's office for permission to conduct the study, to Theophilus Ananias and to Emmanuelle Alexander for field assiatnce and interpretation. We are also grateful to Karen le Roux for access to unpublished data collected by the Rossing Foundation.

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Book Review

Principles and Practice of Plant Conservation. David R. Given. 1994. Timber Press, Inc., 133 SW Second Avenue, Suite 450, Portland, OR 97204-3527. viii & 292 pp. (hardcover). $39.93 plus $6.50 shipping and handling. ISBN 0-88192-249-8.

Appeals by conservation organizations for funds to protect biodiversity typically utilize photos of rare and endangered megafauna; the "big brown eyes" appeal. Biologists recognize that a myriad of other, less conspicuous species, many of which are also threatened, also deserve protection; included are invertebrates, microorganisms, and plants.

This book, commissioned by the World Wide Fund for Nature and the World Conservation Union, is, to my knowledge, the first to treat all aspects of plant conservation. The book's scope is indicated by the chapter headings: 1. "Reasons for Conserving Plant Diversity" 2. "How Plants Became Threatened or Extinct" 3. "Documentation and Databases for Plant Conservation" 4. "Plant Population Management" 5. "Plant Conservation in Protected Natural Areas" 6. "Off-site Plant Conservation" 7. "Plant Conservation in Modified Landscapes" 8. "Awareness and Education" 9. "Conservation Legislation" 10. "Economics and Plant Conservation," and 11. "Putting It Together: Integrated Conservation."

The major principles of conservation are illustrated both visually (black and white photos and figures) and in narrative from Given's worldwide experiences: North America, Europe, Asia, Africa, Australia, and New Zealand. Each chapter includes several "case studies"—abstracted publications, most from the 1980's, in conservation biology. The ample bibliography is cosmopolitan in its coverage. Like other books from Timber Press that I have seen, this one is quite attractive.

An examination of this book would make most any botanist who teaches in the area of conservation biology wish that he or she were teaching a plant conservation course. This book would be an ideal text for that course. *Principles and Practice of Plant Conservation* should be equally useful as a major reference for other conservation courses at the upper division/graduate level. For botanists involved in field conservation studies, it is highly recommended as a handbook.

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