# The impact of utilization of palm products on the population structure of the Vegetable Ivory Palm (Hyphaene petersiana, A....

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# The Impact of Utilization of Palm Products on the Population Structure of the Vegetable Ivory Palm (*Hyphaene petersiana*, Arecaceae) in North-Central Namibia[1]

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**Sullivan, Sian** *(Department of Anthropology, University College London, Gower Street, London WC1E 6BT, UK),* **Konstant, Tracey L.** *(4 Walker Avenue, Discovery, Roodepoort, 1707, South Africa), and* **Cunningham, Anthony B.** *(PO Box 42, Betty's Bay, 7141, South Africa).* The Impact of Utilization of Palm Products on the Population Structure of the Vegetable Ivory Palm (*Hyphaene petersiana*) in North-Central Namibia. *Economic Botany 49(4): 357–370. 1995. Indigenous trees fulfil many subsistence and economic needs in north-central Namibia.* Hyphaene petersiana *provides a range of products which contribute to most aspects of people's livelihoods. Of particular importance is its income-generating capacity through the use of palm leaves for basket production and the sale of liquor distilled from the fruits. This study investigates the population structure of* Hyphaene petersiana *in two areas of different human and livestock densities. Data were recorded for height class distribution, basal diameter of mature, stemmed individuals and sex ratios. These parameters of population structure indicate a reduction in the recruitment of mature palms and an increase in single-stemmed, vegetatively reproduced palm suckers of the smallest size class (<0.5 m). This trend is more pronounced in the site with greater human and livestock population densities. It appears to be related to high recorded levels of browsing by livestock of juvenile, unstemmed palms, despite the unpalatability of palm leaves. This acts to prevent recruitment into larger size classes and increase the compensatory growth of palm suckers, the latter being enhanced due to reduced competition through the prior removal by grazing animals of grasses and other herbaceous species. Accompanying this heavy pressure on juvenile palms are destructive uses of mature, stemmed palms, including their felling for construction purposes and tapping for palm wine. With regional human population increase, exacerbated by a recent trend to privatise land and raise pressure on remaining communal resources, it is possible that these destructive uses of mature palms will increase to unsustainable levels. Concern is thus expressed in this study regarding the long-term viability of* Hyphaene petersiana *populations in this area.*

*As árvores indigenas satisfazem muitas das necessidades de subsistência das populaçoes de Owambo. A* Hyphaene petersiana *fornece uma gama de productos que contribuem em muitos aspectos para o sustento das gentes daquela regiao. Cita-se em particular o seu papel na criação de rendimento através do uso das folhas da palmeira na confecção de cestos e da utilização dos frutos no fabrico de 'olambika' (aguardente), produtos que sao depois vendidos. Estas duas actividades sao desempenhadas quase exclusivamente por mulheres. Neste estudo manifesta-se preocupação em relação às modificaçoes operadas na população de* H. petersiana *desta regiao. A renovaçao das palmeiras é reduzida pelo pastar intensivo de rebanhos que comem os rebentos de palmeira. A isto se junta um aumento na utilização destrutiva das palmeiras maduras e de outras espécies de árvores. A exacerbar este processo cita-se a tendência recente para a privatização de terras anteriormente exploradas colectivamente. Isto deu origem a um aumento na exploração das restantes terra comunais que está a causar o colapso dos direitos tradicionais ao usufruto dos recursos vegetais.*

*Omiti dhomoshitopolwa ohadhi gwanitha po oompumbwe odhidji dhopamahupilo gaakalimo yomOwambo. Omuti gwendhina* Hyphaene petersiana *(omulunga) ohagu eta po iilikolomwa oyindji mbyoka hayi kwathele moompumbwe odhindji dhomonkalamwenyo yaantu. Omuti nguka agwa simana unene sho gahu etapo po eliko tali zi melongitho lyoombale mokutunga oontungwa, iimbamba, omashungu nuuyanambale, nokelanditho lyolambika ndjoka hayi zi moondunga. Iilikolomwa ayihe ya tumbulwa pombanda ohayi etwa po konyala kaakiintu ashike. Moshinyolwa shika omunyoli ota hołola uumbanda tau etwa po komalunduluko ogendji tagi*

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*inyenge moshitopolwa ga guma omuti nguka* H. petersiana *(omulunga). Oludhi nduka otalu shonopala unene sho iiyale hayi liwa po kiimuna manga yi li iishona. Omiti ndhika, osho wo dhilwe ndhoka hadhi longithwa momauhupilo otadhi shonopala neendelelo oshoka odha tamekwa okulongithwa komikalo dhilwe dhi ili, she etwa po keshonopalo lyomaludhi gomiti dhilwe. Omukalo omupe moshitopolwa gwokuninga evi lyaayehe lyopaumwene otagu endeleleke eshonopalo lyomiti ndhika. Iitopolwa yaayehe oya shonopalekwa nevi lyaayehe otali longithwa sha pitilila tashi fala sigo okengushukuluko lyevi.* [OSHIWAMBO]

**Key Words:** palms, *Hyphaene petersiana,* Namibia, Ovambo.

The central palm savanna of the former Ovambo region of north-central Namibia is inhabited by people whose subsistence strategy has been described as 'agro-silvipastoralist' (Krieke 1995); herding and cultivation are practised in equal amounts with local multiple-use trees making an extremely important contribution to people's livelihoods (Marsh and Seely 1992). Ovambo people inhabiting this area have long considered the vegetable ivory palm, *Hyphaene petersiana* Klotzch (known as *omulunga* in Oshiwambo), to be their most useful woody species (Rodin 1985). Like other rural areas of Africa, palms and indigenous tree species fulfil many subsistence needs, providing an important sources of food, household medicines, fuel, and raw materials for building, household utensils and a variety of local industries.

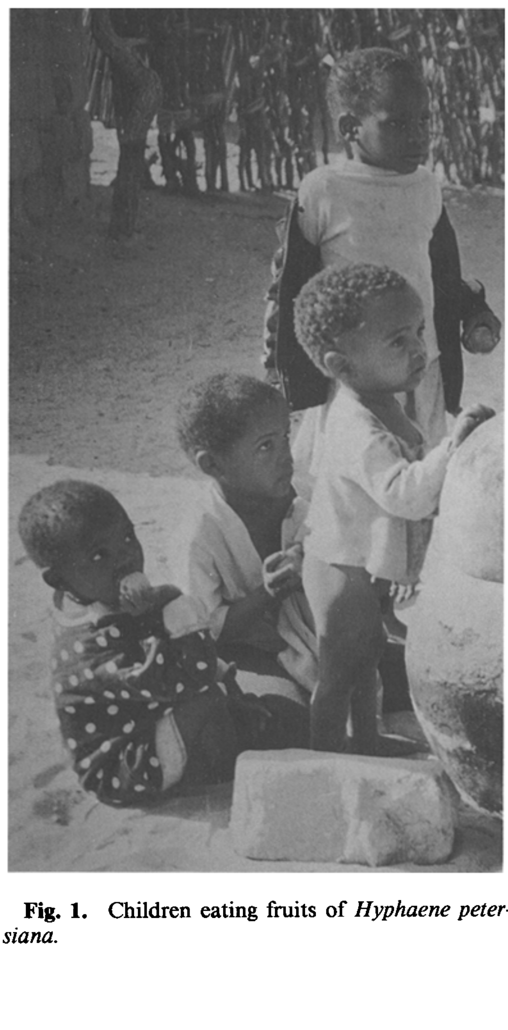


**Fig. 1.** Children eating fruits of *Hyphaene petersiana.*

In terms of its contribution to household food security, early European travellers to the region noted the important contribution that *Hyphaene* fruits made to the diet of local people (Erkkilā and Siiskonen 1992; Hahn 1928). Data collected recently confirm the dietary significance of this and other indigenous fruit species (Fig. 1). In an interview survey conducted in 1992, for example, 37 households out of 40 reported that *Hyphaene* fruits were regularly collected for home consumption in the dry season (Hamata and Cunningham in prep). The palm fruiting season peaks in September/October, coinciding with the end of the dry season before the millet harvest and at a time when wild spinaches and other indigenous fruits are not available (Marsh and Seely 1992). This timing of palm fruit production, when cultivated and other wild resources are at their scarcest, heightens their importance to rural subsistence (Campbell 1987). The terminal bud is eaten as "palm heart" and sap is tapped for palm wine (Rodin 1985). Both these products require the excision of the apical meristem which usually kills the palm stem from which they were harvested (Fig. 2). Additional contributions to household subsistence are the use of long palm petioles as fencing droppers (Fig. 3a) and fuel, and the stems of mature palms as fencing posts (Fig. 3b), building poles and water troughs for livestock.

*Hyphaene* products also fulfill an important role in the generation of cash income. The fleshy pericarp of the fruits is, for example, distilled into a spirit known in Oshiwambo as *olambika.* Distilling is a means of adding value to wild fruits

**Fig. 2.** The destructive utilization of a male *Hyphaene petersiana* through extensive removal of leaves, possibly for fencing or to prepare the palm for tapping. Male flowers were also frequently observed in palm brush fences and around felled trees, while no such palm remains were seen.

or agricultural produce and can provide an important source of revenue to the rural people of north-central Namibia, particularly when transported and sold in more affluent areas further south. Furthermore, the pliable unopened leaves of juvenile *H. petersiana* plants are the primary resource on which a thriving local basketry industry relies, producing baskets for sale as well as household use (Marsh and Seely 1992; Rodin 1985). Both distillation and basket-making are significant income-earners for households which may have limited alternative access to a cash income. Hamata and Cunningham (in prep) found that 68% of households interviewed in the palm savanna area of Ovambo regularly sold *olambika*. Similarly, le Roux (1992) states that 39 out of 56 basket-makers in Ondangwa, south-east of the region's main town of Oshakati, and 17 out of 26 basket-makers in Oshikuku to the north-west of Oshakati, produced baskets for sale. Income generation using palm products is practised mainly by women and, in view of the high proportion (more than 40%) of female-headed households in this region (Tapscott 1990), particularly important in enhancing their socio-economic position.

Finally, in the absence of alternative fodder, and despite the fibrous texture and unpalatability of palm leaves, the leaves of juvenile palms provide an important source of browse for livestock. Occasionally, the wood from inside felled mature palm stems that have been split open to provide livestock water troughs is also eaten by donkeys (Fig. 3b).

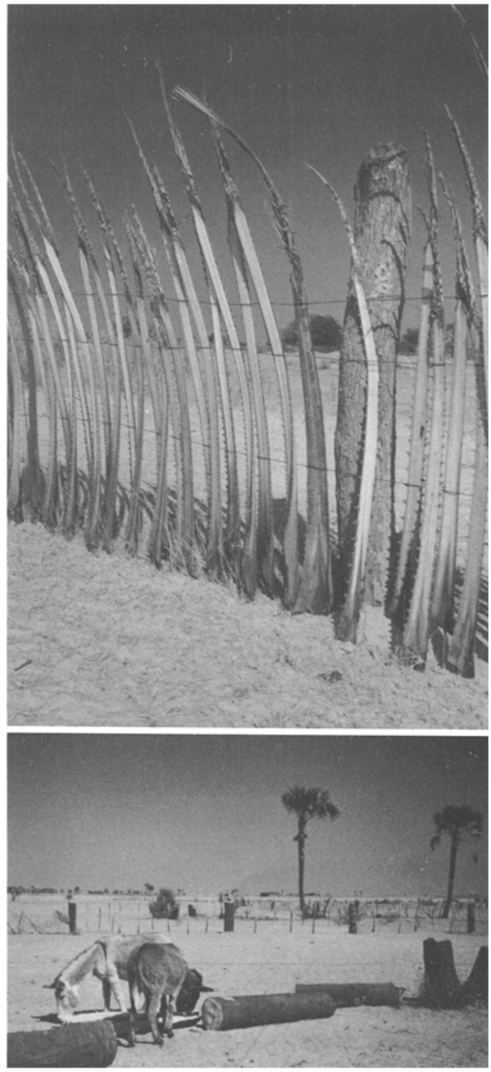


**Fig. 3a (above).** Petioles of large *Hyphaene petersiana* leaves being used as fencing droppers.

**Fig. 3b (below).** Main fence posts from trunks of mature stemmed palms, with palm leaf petioles as fencing droppers. In the foreground, the scarcity of suitable alternative fodder causes donkeys to resort to the inner wood of a recently felled *Hyphaene* plant.

The aims of this study were to assess the current status of the *H. petersiana* population in selected areas of north-central Namibi, to derive an understanding of the impact of utilization by people and livestock on its population structure, and to make some predictions as to the possible direction of change in population structure that may accompany heavy pressure on *H. petersiana* resources. With a human population increase in north-central Namibia of 4% per annum (Coghill and Kiugu 1990), accompanied by estimated overall increases in livestock numbers of 94% in cattle, 316% in goats and an astonishing 2000% increase in donkeys between 1945 and 1990 (Marsh and Seely 1992), it is inevitable that existing pressures on *H. petersiana* will increase into the future.

Baseline data concerning the status of the *H. petersiana* population and the sources of pressure on both juvenile and mature palms is therefore necessary to facilitate the future monitoring and management of this locally important species.

## Study Area

Two sampling areas in the central palm savanna of north-central Namibia were chosen to represent the effects of different densities of human and livestock populations on *H. petersiana.* The first site was in the Onayena area, northeast 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 for the juvenile palms that would have been affected by its enclosure. See Konstant, Sullivan and Cunningham (1995) for the location of these sampling areas.

## 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. These latter sites are included within the Iiheke sample for analysis concerning mature stemmed palms in this paper, as it is considered that the short period during which the Department of Forestry exclusion area had been enclosed (9 months prior to data collection) would be insufficient to exert major changes on these mature stems.

### Plant Measurements

Two objectives guided the choice of quantitative data collected for each palm individual sampled. First, to record the types and degree of utilization by humans and livestock displayed by juvenile and mature palms. Second, to indicate the current status of the *Hyphaene* population by measuring a variety of parameters of population structure. These two components of data collection were related in the analysis to suggest the degree to which features of the population structure of *H. petersiana* may be related to the intensity of different forms of utilization, and to identify possible future effects of continued or increased pressure. The measurements, and the rationale for their choice, are explained in full below.

#### *Utilization of Mature and Juvenile Palms*

Signs of utilization were recorded for each individual in the sample. With regard to mature, stemmed individuals, a number of signs of human utilization were looked for. These included the presence of cut marks in the trunk (Fig. 4) to facilitate climbing up the stem in order to reach petioles used as fencing droppers or for tapping for palm wine, the removal of petioles, and the felling of palm stems (Fig. 4). The latter is clearly distinguishable from natural mortality due the clean cut marks left on the remaining palm stump.

The utilization of juvenile palms is discussed in detail in Konstant, Sullivan, and Cunningham (1995). Broadly speaking, it fell into two categories; the cutting or spoiling of the leaves by harvesters of weaving fibre for basket production, and browsing of the leaves by livestock. Following Cunningham and Milton (1987), these types of damage were recorded for the unopened leaves and the four youngest opened leaves to provide an approximate representation of utilization during the previous year. The sharp cut marks left by human harvesters are clearly distinguishable from the ragged leaf damage causing by browsing livestock.

## Population Structure

### *Size Class Distribution*

Height and basal diameter comprised the two measures of size used as indicators of current population age structure and recruitment status. Heights were recorded for juvenile unstemmed plants by assigning each individual to one of three height classes, <0.5 m, 0.5–1 m and >1 m, and were measured for mature stemmed plants using a direct reading Suunto hypsometer. These measures were used to facilitate comparisons between the *H. petersiana* population in north-central Namibia and studies of the closely related *Hyphaene compressa* H. Wendl. in an environmentally similar area of Turkana, Kenya (Amuyunza 1991; Oba 1990). The basal diameter of each mature stemmed individual, and of dead stumps of mature palms where possible, was measured above the characteristic bulge at the base of the trunk using a calibrated diameter tape.

### *Clump Size*

The number of both live and dead juvenile and mature stems of different size classes in each clump was recorded to indicate features of clump structure in north-central Namibia, and to allow comparisons between the areas sampled in this study and similar measures recorded for *Hyphaene* populations in semi-arid areas elsewhere in Africa (Amuyunza 1991; Cunningham and Milton 1987; Hoebeke 1989; Oba 1990).

### *Sex Ratios*

It has been speculated that any increase in the destructive uses of mature palms would be aimed at male plants in preference to females palms conserved for the dietary and economic value of their fruits. Turkana pastoralists in northern Kenya have also reported differences in characteristics of the wood of male and female palms, with male trunks being more desirable as timber due to being harder, denser and heavier than those of female palms (Hoebeke 1989). Over time, consistent selective utilization of palms for either their wood quality or to conserve the fruit-bearing female palms, could be expected to lead to a skewed sex ratio in the population in the direction of leaving higher numbers of female palms relative to males. This would affect the long-term reproductive viability of the palm population by reducing the likelihood of sexual reproduction as males become scarce.

**Fig. 4.** Footholds cut into the trunk of a large *Hyphaene petersiana* plant to facilitate access to the canopy.

For this reason, the sex of mature stemmed palms was recorded wherever possible and the sex ratios compared to known ratios for *Hyphaene* populations elsewhere (Fanshawe 1967, 1966).

### *Spatial Variability*

Woody plants in arid and semi-arid environments commonly display highly dispersed and clumped distributions in response to localized water availability and favourable conditions for growth. Spatial variability in population structure and growth form has been found in *Hyphaene* in other studies (Hoebeke 1989), and is a reflection of the dependence of palms in arid environments on localized groundwater availability in areas with a high water table, along seasonal drainage lines or in poorly drained soils. Another cause of this aggregated distribution may be the dispersal of seed by humans, resulting in concentrations in refuse disposal areas and around homesteads. Clumping is also a product of the importance of vegetative reproduction through coppicing and root suckering where water is available.

The number of juvenile and mature stems per quadrat was recorded in this study as a measure of spatial variability in the distribution of *H. petersiana* in the areas sampled. Densities of palms and basal area cover were not analysed due to the high spatial variability anticipated for the distribution of this species. Future studies of such populations in dryland areas should also consider using an alternative sampling procedure based on a distance method such as point-centre-quarter or "zig-zag" transects (Leithead 1979; Moore and Chapman 1986), in order to more accurately reflect regional densities of a dispersed and clumped species.

## Analysis

The focus of the analysis was to detect significant features of the *Hyphaene* population with regard to the various parameters measured, and to relate these features to the effects of utilization at different sites. Height and basal diameter were normally distributed and analysis of variance (ANOVA) with 90% least significance difference multiple range tests were used to determine the effects of site and sex on these attributes. Of relevance to this study, for example, were questions such as whether the size parameters displayed skewed distributions and, if so, whether this could be related to sample site and its corresponding utilization pressure, or to sex of the palm individuals. Pearson product-moment correlation (PPMC) was employed to test for relationships between height, basal diameter and stem number and the Student's t-test was used to detect differences in basal diameter between dead and alive palms.

Proportions of dead stems and sex ratios of adult plants were not normally distributed and the non-parametric Mann-Whitney U-test (MWU) to test for significant differences between these attributes and sample site was used. Unless otherwise stated, results were accepted as significant at the 99% confidence level.

## Results

### Utilization of Mature and Juvenile Palms

#### *Mature Palms*

The most obvious form of utilization of tall palms was the removal of large crown leaves for fencing and building purposes. At the more densely populated Iiheke site, all the palms in the sample had nicks cut into the trunk to enable collectors to climb the palm with relative ease in order to reach the crown. These cut marks were not observed in the Onayena sample, thus indicating higher levels of utilization in the Iiheke area. The current use of petioles from mature palms as fencing droppers indicates that these cut marks reflect levels of utilization at the time of the study, rather than being solely signs of past utilization. No evidence of palm wine tapping recorded in this study, even though the practice is known to occur locally and intensively in the area, affecting large numbers of palms in limited areas.

Large number of dead stumps of felled mature palms were recorded at both sites. A much lower number of dead juvenile palms was also found, many of which appeared to have been burnt. The proportion of mature, dead stumps was lower in the Onayena sample (50% dead stumps) than in the Iiheke sample (63%), suggesting greater pressure on the mature palms in the more densely populated area (Table 1). Of the dead stumps at Onayena 59% were associated with living stems, while at Iiheke a greater number of entire groups of stems had been felled, leaving only 36% adjacent to standing palms (Table 1).

#### *Juvenile Palms*

The levels of leaf utilization of juvenile palms are described in full in Konstant, Sullivan, and Cunningham (1995). The main features relevant to this paper are as follows. First, evidence of utilization by humans and livestock was generally high, with 84% and 93% of opened leaves at Onayena and Iiheke respectively displaying signs of damage, while only 9% of unopened leaves had been damaged. Palms in the Department of Forestry exclusion area at Iiheke showed predictably lower levels of leaf damage, with only 31% of open leaves and none of the unopened leaves affected by humans or livestock. The high levels of damage to opened leaves on communal areas were largely attributable to livestock browsing, with only 10.4% of all leaves displaying signs of cutting for basket weaving fibre.

The more densely populated Iiheke site clearly showed higher levels of leaf utilization and damage relative to undamaged leaves, and this was particularly pronounced in the largest juvenile size class with significantly more open leaves over 1 m tall damaged at Iiheke (87%) than at Onayena (65%). This was despite the selection by browsing livestock for more palatable smaller, younger leaves observed in the sample as a whole, with browsing recorded on 98%, 92% and 60% of opened leaves in plants <0.5 m, 0.5–1 m and >1 m tall respectively.

TABLE 1. NUMBERS OF LIVE AND DEAD MATURE STEMMED *HYPHAENE PETERSIANA* PLANTS BY SITE AND SEX, NORTH-CENTRAL NAMIBIA.

| | Onayena | Iiheke |
|---|---|---|
| Live palms | | |
| Female | 40 | 52 |
| Male | 22 | 33 |
| Unsexed | 83 | 7 |
| Total live palms | 145 (50%) | 92 (37%) |
| Dead palms | | |
| Stumps of felled palms adjacent to living trees | | |
| Female | 33 | 25 |
| Male | 16 | 26 |
| Unsexed | 37 | 7 |
| Total | 86 (59%) | 58 (36%) |
| Stumps where all trees had been felled | | |
| Total | 59 (41%) | 101 (64%) |
| Total dead | 145 (50%) | 159 (63%) |

## POPULATION STRUCTURE

### *Size Class Distribution*

*Height.* The sample was visually and numerically dominated by small, juvenile palms, with totals of 1348 (90.2%) and 1958 (95.5%) unstemmed plants recorded at Onayena and Iiheke respectively, compared with corresponding totals of 145 (9.8%) and 92 (4.5%) stemmed plants. By comparison, the proportions of unstemmed *Hyphaene compressa* in arid Turkana, Kenya, palms display signs of heavy utilization and between 2.5 and 3.5 times as many unstemmed juvenile palms as stemmed palms were found (Hoebeke 1989). Our results for north-central Namibia also differed substantially from the height class distribution recorded for *H. compressa* in Turkana, Kenya by Amuyunza (1991) who found no individuals under 1m tall, compared with 52.7% and 54.7% of the *H. petersiana* palms sampled at Onayena and Iiheke respectively. Amuyunza (1991) also recorded that the 1–2 m height *H. compressa* size classes represented 70% of individual palms compared to only 37% at Onayena and 45.3% at Iiheke in this study. In a similar study of *H. compressa* in Turkana, the 0–2 m regeneration class represented only 52% of the palm population (Oba 1991) compared with an overall figure of 92.5% for *H. petersiana* palms sampled in north-central Namibia.

Among mature, stemmed individuals at the Namibian sites, height distribution was also skewed, displaying few palms between 1 m and 5.75 m tall, most individuals being in the 6 m to 9.75 m classes (Fig. 5a). This contrasts strongly with data recorded for Turkana *H. compressa* populations. In the Turkana studies, the 2–4 m recruitment class, corresponding roughly with our 1 m–3.75 m stem height class, contributed 18% (Amuyunza 1991) and 33% of *H. compressa* (Oba 1991) populations, compared with only 0.1% at Onayena and none in the more heavily utilized Iiheke sample in this study. Even if the abundant juvenile unstemmed individuals are excluded from this calculation, the palms in the height class indicating successful future recruitment to sexual maturity contributed only 6.8% to the population at Onayena.

Analysis of variance indicated that the stem height of mature palms within north-central Namibia differed significantly between sites and sexes. In general, palms were significantly taller at Iiheke than at Onayena (Fig. 5a) ($P = 0.005$). This was mainly due to male and non-fruiting palms being significantly taller at Iiheke than at Onayena, while there was no height difference between females at the two sites. Within the sex classes combined for both sites, however, female palms (Fig. 5b) were taller than males (Fig. 5c), and both female and male palms were taller than palms without fruits (Fig. 5d) ($P = 0.0002$). Fanshawe (1967), in his study of *H. petersiana* found that most individuals began fruiting when they

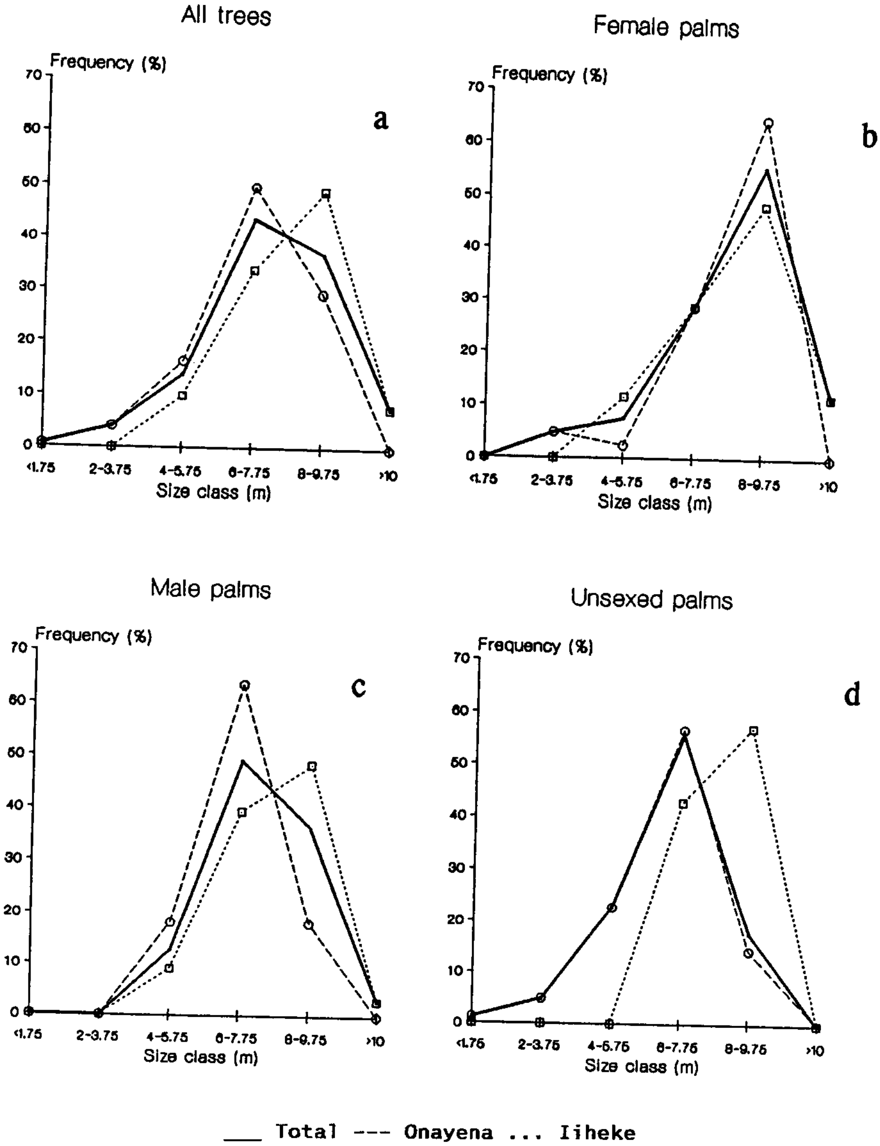



**Fig. 5.** Height class distribution of mature stemmed *Hyphaene petersiana* for a) all trees, b) female palms, c) male palms, and d) unsexed palms for the total sample and for the separate Onayena and Iiheke samples. The frequency data are presented as percentages for each sample to show the relative contribution that palms in each size class made within these samples.

were 6–7.5 m tall, and fruiting may depend on size and age of the palm. The average height of non-fruiting palms at Onayena was 6.5 m and many of these may, therefore, be too young to bear fruit. Only 7 non-fruiting palms were recorded at the more heaviliy utilized Iiheke site and these were all from the very tall height classes and were possibly senescing adults. The absence of smaller non-fruiting palms at this site suggests that younger palms are not available to replace the existing adult population.

Separate testing of the two sites revealed that differences between the heights of the male, female and unsexed palms were due primarily to significant differences within the Onayena sample, where female palms were significantly taller than males and unsexed palms ($P < 0.00001$). Analysis of variance indicated no significant dif-

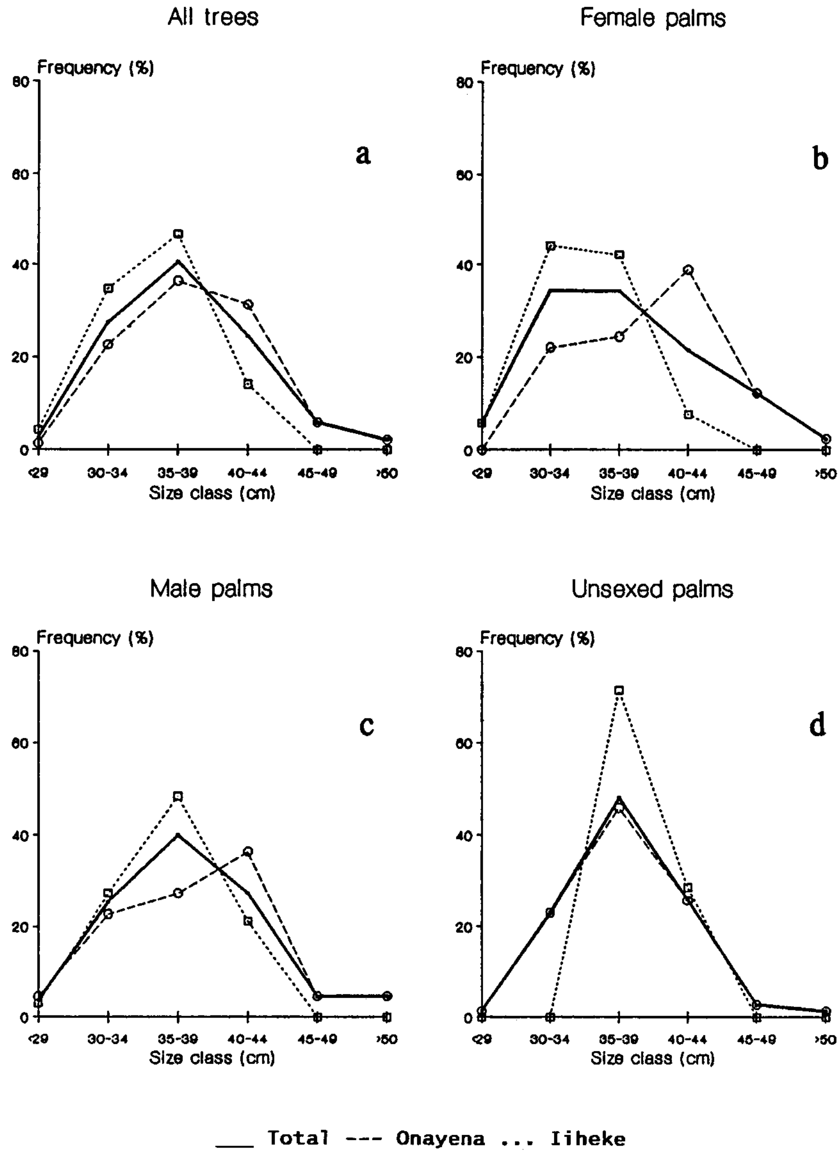
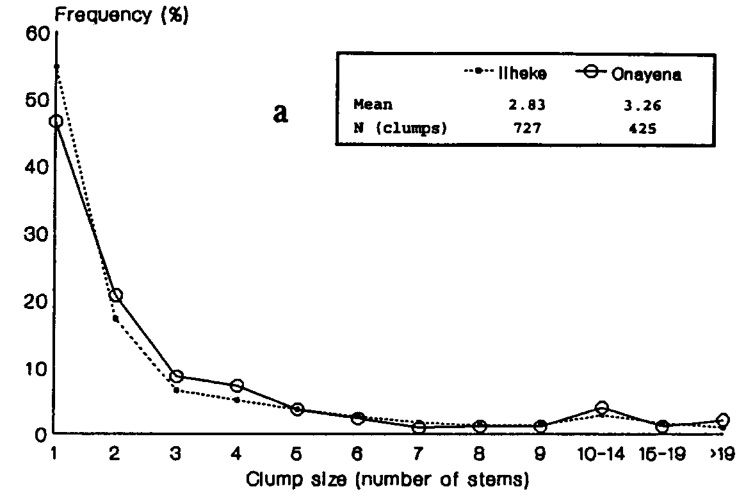



**Fig. 6.** Basal diameter class distribution of mature stemmed *Hyphaene petersiana* for a) all trees, b) female palms, c) male palms, and d) unsexed palms for the total sample and for the separate Onayena and Iiheke samples. The frequency data are presented as percentages for each sample to show the relative contribution that palms in each size class made within these samples.

ferences between the sexes of palms at Iiheke (Figs. 5b, 5c and 5d).

*Basal diameter.* Analysis of variance indicated that basal diameter was significantly larger at Onayena than Iiheke (Fig. 6a) ($P < 0.00001$), with female palms (Fig. 6b) at Onayena having the greatest girth, significantly larger than all stems at Iiheke ($P < 0.00001$) and unsexable (Fig. 6d) palms at Onayena. At Iiheke female palms (Fig. 6b) were significantly thinner than male (Fig. 6c) and unsexed (Fig. 6d) palms. Ninety of the felled palms had stumps sufficiently large and intact for the basal diameter to be measured. No significant difference in girth was found between dead and alive palms at either site implying that selection of palms for felling is not based on trunk thickness. No correlation was found between the height and basal diameter of mature, stemmed palms.

*Clump structure.* Average clump size was small



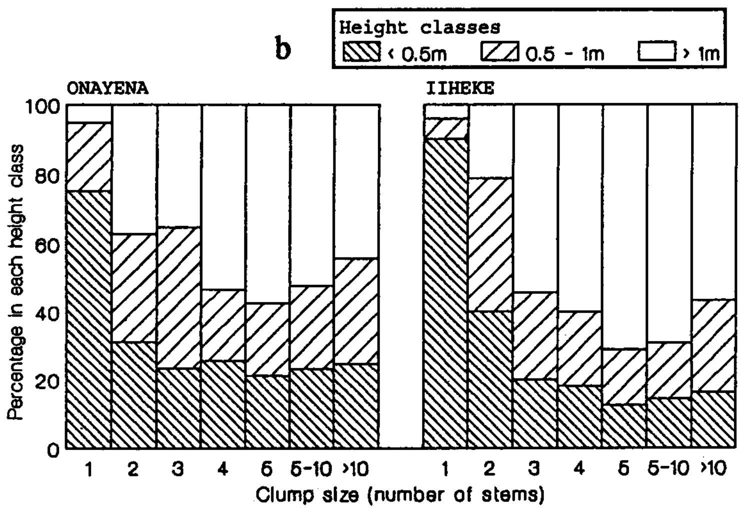




**Fig. 7a.** Clump size distribution of juvenile unstemmed *Hyphaene petersiana* at Onayena and Iiheke.
**Fig. 7b.** The proportions of juvenile *Hyphaene petersiana* plants in three height classes (<0.5 m, 0.5–1 m and >1 m) in clumps of different sizes at Onayena and Iiheke.

at both sites (Fig. 7a) and significantly smaller at Iiheke (mean = 2.83 stems/clump) than at Onayena (mean = 3.26 stems/clump) (MWU, $P$ = 0.02). This was due to large numbers of single-stemmed individuals at both sites, with 52% of clumps consisting of only 1 stem and 87% containg fewer than 6 stems. The clump sizes recorded in this study were considerably smaller than those for *H. petersiana* in Botswana palm savanna where average clump size ranged from 5 to 48 stems at different sites (Cunningham and Milton 1987). No significant difference was found between the total numbers of unstemmed palms in each juvenile size class (<0.5 m, 0.5–1 m and >1 m). Differences were found between Onayena and Iiheke, however, with 90% of the single-stemmed juvenile palms being less than 0.5m tall at liheke compared with 75% in this size class at Onayena.

With regard to the mature stemmed individuals, a significant relationship was found between the number of tall mature palms growing from a single root stock and the two size parameters (height and basal diameter) recorded for mature palms. *H. petersiana* individuals often consist of several single stems close together, and in Ovambo the number of tall stems in a clump was positively correlated with height (PPMC; $P = 0.004$) and negatively correlated with basal diameter ($P = 0.02$). In other words, the more mature stems growing from the rootstock, the taller and thinner they were. This is in contrast to figures for the closely related *H. compressa* in which clumps with several mature palms had stems shorter than those recorded for single stemmed palms (Hoebeke 1989). The latter study indicates that the resources available for the growth of each stem is negatively related to the number of stems growing in the same clump, and clumps with fewer tall stems can direct more resources to the growth of those stems. This hypothesis is not supported in this study of *H. petersiana,* however, in which the greater availability of resources for each stem thought to accompany clumps with fewer tall palms does not seem stimulate the growth of the remaining stems as might be expected.

*Sex ratios.* Drawing any conclusions regarding palm sex ratios found in this study is problematic due to the high numbers of stems which could not be sexed (35% of the complete sample of living and dead mature palms for which sex would have been possible to discern sex if the fruits were present). At both sites female palms were more common than males by almost double at Onayena and by 57% at Iiheke, suggesting the selective removal of male palms and the conservation of female palms (Table 1). A sex ratio of 2 males to each female has been reported for *H. petersiana* populations elsewhere (Fanshawe 1967), suggesting that there may have been a considerable reduction in male numbers in north-central Namibia. According to Fanshawe (1966), however, a ratio of 10 females to each male in *Hyphaene thebaica* (Del.) Mart. populations is sufficient to maintain normal pollination, in which case selectivity would have to be extremely high to cause long-term degeneration through the removal of male palms. Complicating this issue further was the fact that felled palms were evenly spread through the sample with regard to sex of the individual, with no significant difference found in the proportion of cut dead stumps from the same rootstock of live palms of different sexes (Table 1).

*Spatial variability.* The total numbers of palm individuals in each plot was highly variable, ranging between 21 and 345 palms per plot at Onayena and 74 and 491 palms per plot at Iiheke, the higher numbers at the latter site being due to the very high numbers of single-stemmed individuals in the smallest size classes recorded for this site. Numbers of mature, stemmed palms were similarly variable, ranging from none to a maximum of 37 palms in a plot.

## Discussion

The results indicate that palm resources are currently utilized for a variety of purposes in north-central Namibia, with impact of grazing and human use considerably higher in the study area with higher human and livestock population densities. This suggests that as human populations rise due to natural increase and the influx of both Angolan refugees and Namibian returning exiles since Independence in 1990, there will be a corresponding increase in pressure on *H. petersiana* in north-central Namibia. Even without human and livestock population increases, it is likely that the demand for particular *Hyphaene* resources will increase. The possibility, for example, of the more efficient marketing and commercialisation of the local basketry industry, as has been documented for centres of basket production elsewhere in Africa (Babiker 1982; Barrow 1990; Cunningham 1988a,b, 1992; Cunningham and Milton 1987; Terry 1984, 1987a,b), may introduce intense harvesting pressure on the unopened *Hyphaene* leaves.

Exacerbating this expected increase in demand for communal resources such as *H. petersiana* are observed changes in patterns of land tenure within the region. There is evidence, for example, that as north-central Namibia is drawn further into the cash economy the relatively equitable traditional land distribution system is being disrupted. This system was based on the allocation of land by traditional leaders to be used for an individual's lifespan, and unallocated land was open to anyone for grazing with usufructuary rights attached to the removal of other plant resources (Williams 1991). Today the prices paid for rights to arable land are assuming market value as demand for land increases (Tapscott 1990). The consequent land privatisation through fencing of communal areas (Fig. 8), linked to the

**Fig. 8.** Fences, with stark contrasts between the availability of grazing on each side, are becoming increasingly common in north-central Namibia through the privatisation of communal land by wealthy and influential herders.

accumulation of livestock by wealthier, often absentee, herd-owners, is concentrating large areas of land into the hands of a few individuals and forcing increased pressure on important multiple-use species such as *H. petersiana* on remaining communal land.

The primary feature of the current *H. petersiana* population structure which is almost certainly related to historic and present use pressures is its skewed height class distribution. This study records high numbers of juvenile unstemmed palms and very low numbers of stemmed individuals in the replacement height classes, thus indicating that growth of immature suckers and seedlings into mature, sexually reproductive palms is not occurring. This pattern is more pronounced in the heavily utilized Iiheke area. The palm population structure in the areas studied in north-central Namibia thus appears to be changing from stands of tall, fruit-bearing stemmed palms of various heights to short palm scrub consisting of clumped juvenile plants. Such a transformation may have significant negative implications for the future viability of the palm population. A similar change in population structure has been observed in heavily utilized *Hyphaene* populations elsewhere. In *H. petersiana* populations in north-west Botswana, for example, it has been attributed to the felling of palms for their fruits, browsing by livestock and the overutilization of unopened leaves for basketry (Cunningham 1988a; Cunningham and Milton 1987), while in *Hyphaene coriacea* Gaertn. populations in south-east Africa, recruitment of tall, reproductively mature palms is prevented by palm wine tapping (Cunningham 1990). The skewed population structure observed in this study is primarily attributable to high recorded levels of browsing by cattle, goats and donkeys, coupled with the felling of mature palms, mainly for fencing and building purposes. Livestock browsing prevents recruitment into larger size classes and probably increases the compensatory growth of palm suckers (Mendoza, Pinero, and Sarukhan 1987; Oba 1990). This latter process being enhanced due to reduced competition through the prior removal by grazing animals of grasses and other herbaceous species.

There is no evidence for the selective felling of palms on the basis of either sex or basal diameter, although trunk height, which was not correlated with basal diameter, may be an important criterion (and one which, unlike basal diameter, cannot be measured after the palm has been removed). Proximity to the homestead is probably another principal determinant.

The higher proportion of female to male palms observed at the two sites has not been satisfactorily explained as a product of human interference. This is primarily because the equal proportions of dead stems associated with both sexes suggests that the larger proportion of female palms is not a result of selective felling, although it is possible that where whole clumps of mature palms have been felled these could have been the result of selective felling of male palms.

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## Literature Cited

**Amuyunza, C. L.** 1991. Woodland resource survey in Central Turkana, Kenya. *In* C. L. Amuyunza, and G. Oba, eds., Vegetation reources of Central Turkana district, Kenya. TREMU technical report D-2, UNESCO, Nairobi, Kenya.

**Babiker, A. B.** 1992. The role of rural industries in the arid and semi-arid areas of Sudan. Geojournal 8:49–55.

**Barrow, E. G. C.** 1990. More on Doum palms. Baobab 3. Arid Lands Unit, Oxfam, UK.

**Campbell, B. M.** 1987. The use of wild fruits in Zimbabwe. Economic Botany 41:375–385.

**Coghill, B., and S. Kiugu.** 1990. Report on a survey of household health and nutrition in Katatura and selected northern areas of Namibia. UNICEF Namibia for the Ministry of Health and Social Services, Government of the Republic of Namibia, Windhoek.

**Cunningham, A. B.** 1988a. Botswana basketry resources: resource management of plants supporting the Ngamiland basket industry, 1982–1988. Unpublished report to Botswanacraft Marketing Co. (Pty) Ltd, Gaborone, Botswana.

———. 1988b. Leaf production and utilization in *Hyphaene coriacea*: management guidelines for commercial harvesting. South African Journal of Botany 54:189–195.

———. 1990. Income, sap yield and effects of sap tapping on palms in south-eastern Africa. South African Journal of Botany 56:137–144.

———. 1992. People and palms: palm cultivation evaluation and review of basketry resources management in Ngamiland, Botswana (1972–1992). Unpublished report to Botswanacraft Marketing Co. (Pty) Ltd., Gaborone, Botswana.

———**, and S. Milton.** 1987. Effects of basket-weaving industry on Mokola Palm and dye plants in northwestern Botswana. Economic Botany 41:386–402.

**Directorate of Veterinary Services.** 1990. Stock census. Ministry of Agriculture, Windhoek, Namibia.

**Erkkilä, A., and M. Siiskonen.** 1992. Forestry in Namibia 1850–1990. Silva Carelica 20. Univ. Joensuu, Finland.

**Fanshawe, D. B.** 1966. The Dum palm- *Hyphaene thebaica* (Del.) Mart. East African Agricultural and Forestry Journal 32:108–116.

———. 1967. The Vegetable Ivory Palm—*Hyphaene ventricosa* Kirk—Its ecology, silviculture and utilization. Kirkia 6:105–116.

**Hahn, C. H. L.** 1928. The Owambo. *In* The native tribes of South West Africa. Cape Times Ltd, Cape Town, South Africa.

**Hoebeke, P.** 1989. The Doumpalm (*Hyphaene compressa*) as biological resource in Turkana district, Kenya. MSc thesis, University of Trondheim, Norway.

**Konstant, T. L., S. Sullivan, and A. B. Cunningham.** 1995. The effects of utilization by people and livestock on *Hyphaene petersiana* basketry resources in the palm savanna of north-central Namibia. Economic Botany 49:345–356.

**Krieke, E. H. P. M.** 1995. The Owambo agro-silvipastoral system: traditional land use and indigenous resource management in northcentral Namibia. Forestry Publication 4. Directorate of Forestry. Ministry of Environment and Tourism, Windhoek, Namibia.

**Leithead, H. L.** 1979. Measuring the growth of trees. Rangelands 1(1):29–30.

**Le Roux, K.** 1992. Results of interview surveys conducted with basket-makers in northern Namibia. Unpublished report for the Rossing Foundation, Windhoek, Namibia.

**Marsh, A. M., and M. Seely, eds.** 1992. Oshanas: sustaining people, environment and development in Central Owambo, Namibia. DRFN and SIDA, Windhoek, Namibia.

**Mendoza., A. D, D. Pinero, and J. Sarukhan.** 1987. Effects of experimental defoliation of growth reproduction and survival of *Astrocaryum mexicanum.* Journal of Ecology 75:545–554.

**Moore, P. D., and S. B. Chapman, eds.** 1986. Methods in plant ecology. Blackwell Scientific Publications, Oxford.

**Oba, G.** 1990. Effects of wildfire on a semi-desert riparian woodland along the Turkwel river, Kenya, and management implications of Turkana pastoralists. Land Degradation and Rehabilitation 2:247–259.

———. 1991. The ecology of the floodplain woodlands of the Turkwell river, Turkana, Kenya. *In* Amayunza, C. L. and G. Oba, eds., Vegetation resources of Central Turkana district, Kenya. TREMU technical report D-2, UNESCO, Nairobi, Kenya.

**Rodin, R. J.** 1985. The ethnobotany of the Kwa-

Nyama Owambos. Monograph of the Missouri Botanical Garden 9.
**Tapscott, C.** 1990. The social economy of livestock production in the Ovambo region. NISER (Namibian Institute for Social and Economic Research) Discussion Paper 4. University of Namibia, Windhoek.
**Terry, M. E.** 1984. Botswanacraft and Hambukushu basketry: the effects of a major marketing operation on a group of African people, their traditional craft and the natural resources. Unpublished report to Botswanacraft Marketing Co. (Pty) Ltd., Gaborone, Botswana.
———. 1987a. Mokola palm experimentation and extension activities in Ngamiland, CFDA. Unpublished report to Botswanacraft Marketing Co. (Pty) Ltd., Gaborone, Botswana.
———. 1987b. Final report for the handicraft development project of Ngamiland, Botswana. Unpublished report for IVS, Inc. and Botswanacraft Marketing Co. (Pty) Ltd., Gaborone, Botswana.
**Williams, F-N.** 1991. Precolonial communities of southwestern Africa: a history of Owambo kingdoms 1600–1920. Archeia 16, National Archives of Namibia, Windhoek, Namibia.

# Book Review

**Plant Resources of South-East Asia. No. 8. Vegetables.** J. S. Siemonsma and Kasem Piluek (eds.). 1993. Pudoc Scientific Publishers, P.O. Box 4, 6700 AA, Wageningen, The Netherlands. 412 pp. (hardcover). DFL250.00; US$143.00. ISBN 90-220-1058-9.

The title of this book may fool those not especially interested in the region into avoiding the tome. You might think this is a work on plants exclusive to southeastern Asia; you are wrong if you think that! Here is a book that covers your favorite species in both temperate and tropical climes. If the plant is not in this book, it is probably in one of the others in the series (cf., species locations in all published books in Table 1, pp. 21–23).

This book is divided into four "chapters" (Introduction, Alphabetical treatment of species, Minor vegetables, Vegetable-producing plants with other primary uses), followed by Literature, Acknowledgments, Acronyms of organizations, Glossary, Sources of illustrations, Index of scientific plant names, and an Index of vernacular plant names. Finally, there is propaganda on the Prosea Foundation.

Contributions were made by almost 60 authors, largely from Asia and Europe. These manuscripts were ably edited by Siemonsma and Piluek into a reasonably even, lucid style that covers most of the information one may wish to know about the major species. This information includes, for most species, scientific name with authority, place of publication, family, chromosome number(s), vernacular names, origin and geographic distribution, uses, production and international trade, properties, description, growth and development, other botanical information, ecology, propagation and planting, husbandry, diseases and pests, harvesting, yield, handling after harvest, genetic resources, and key references. When some of these data are unavailable they are excluded. Minor species coverage is more succinct. There are line drawings for the major species that, although not detailed, are adequate for identification.

I have not read any of the other books in this series, but they have been unanimously praised by reviews in this journal. This book will take its place among the others. The collection will become the standard reference for years, supplementing and updating Purseglove's classical *Tropical Crops.* If it were not for the imminent release of the second edition of Simmond's *Evolution of Crop Plants,* that too would be supplanted (the second edition of that book was printed on 1 April 1995, and should be released before this is printed).

As with all human endeavors, there are some errors in this book, although I found scientific names to be correctly spelled and proof-reading to be high quality. Some of the individual contributors either misunderstood older literature, or had not read the originals. Errors crept into the treatments, for example, of the carrot and the beet. Still, the overall book is a pleasure to use and behold. I recommend the book heartily.

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