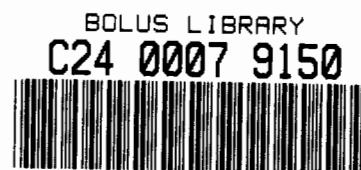


Analysis of cooking shelters in Paulshoek and the effects of harvesting on natural population of *Polymita albiflora*.

Adrian Evans, Botany department, University of Cape Town,
Rondebosch, 7700.



Abstract:

Cooking shelters are found at all the 28 stocking posts in the Paulshoek village. They are round circular structures with walls made from plant materials to provide insulation. Food is prepared and cooked inside the shelters, providing protection from the elements mainly cold and wind. These shelters also serve as social meeting and entertainment venues. Due to the poverty of the area alternatives to constructing cooking shelters are too expensive. Thus the sustainable use of plants used to construct cooking shelters will prevent both species loss and economic expense. There are three types of cooking shelters: full canopy, half canopy and open shelters. 18 shelters including all three types were measured. The volume of plant material calculated and the species composition estimated. The full canopy shelters are generally the largest and well built. These shelters are used in winter and need to be sturdy to withstand the elements and last for a number of years [15 years]. Open shelters are less permanent and built more often. As they are not required to be as sturdy a higher proportion of less desirable but more available plant species were used. However in all types the major species used was *Polymita albiflora*. This species is desirable as a construction material as it packs tightly and the dense foliage supply insulation. Although most shelters were made up of more than one species, only *Galenia africana*

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

and *Euphorbia mauritanica* are used consistently in small quantities. Both these species are common and widespread and the amounts being harvested are insufficient to cause any negative effects on the species population dynamics. However *P. albiflora* is restricted to quartzite slopes or shallow pockets in granite in Northern Namaqualand. Thus harvesting could be destructive to the natural populations. A cooking shelter was dismantled and a size class distribution of *P. albiflora* used for construction calculated. Transects were run in four separate *P. albiflora* populations and a size class distribution for all sites calculated. The majority of plants used to build cooking shelters are in the size class 0.005-0.015 m³. The size class distribution of natural populations of *P. albiflora* showed the smallest size class [<0.005 m³] to have the highest frequency. There was a decrease in the frequency for the remaining size classes. Harvesting from those size classes could cause this reduction. However it is more likely that high mortality during the establishment phase causes this decrease. A regression between volume and number of capsules showed that the plants being removed are not the only reproductively active plants. Small plants [0.001 m³] are capable of producing a few capsules each containing more than 100 seeds. Also the few large plants produce up to 300 capsules per plant. *P. albiflora* is also used as a poor quality fuelwood for baking. Baking occurs approximately once a week. However only populations within the immediate vicinity are threatened by overexploitation due to the efforts required for fetching these plants far outweighs their use as a fuelwood. This study indicates that *P. albiflora* is being harvested well within the sustainable limit. *P. albiflora* grow in dense stand and removal of plants within these will most likely be replaced by small plants or seeds of this species.

Introduction:

The consumptive use of natural resources by local inhabitants for varying purposes can pose a threat to natural plant populations. Excessive harvesting can result in at least local extinction and in some extreme cases total loss of a species. Sustainable use can be reached when the utilization of a resource is used at a rate within the plant's capacity for renewal [Goldberg 1998]. The vulnerability of plant species and their potential to be used sustainably depends on a number of factors. The first is the demand for the product. As some species are used for multiple purposes the amount needed will be large. If the plant is used for subsistence or commercial purposes also influences demand. Harvesting impact is dependant on which part of the plant is used. Plants that only have above ground organs like leaves and fruits harvested are less vulnerable than those species where the entire plant or a part that results in death to the individual is harvested. Plants that are rare, have a restricted geographic distribution or specific habitat requirement have a lower potential to be used sustainably compared to common and widespread plants species [Cunningham 2001]. Other factors that affect the potential of sustainable plant use are the frequency and intensity of harvest, growth form of the plant used and other pressures resulting from land use practises like grazing.

Studies into plant use are useful as they can illustrate species that can be used commercially for economic benefit or management options that can be recommended to lessen the impact of harvesting. A study in the semiarid Central Mexico showed that two barrel cactus species *Ferocactus histrix* and *Echinocactus platyacanthus* need habitat protection and artificial propagation to avoid extinction [Del Castillo and

Trujillo 1991]. These species are used for a variety of uses including the candy industry, medicine, as a source of food and water for goats and as ornamental plants. This study also illustrated that gathering of wild plants is still common especially where environmental stresses preclude common agricultural practises. In these regions entire rural communities depend almost completely on wild plants for their subsistence [Del Castillo and Trujillo 1991].

A study into the basket-weaving industry in Northwestern Botswana showed that commercialisation has led to detrimental changes in the population structure of the palm *Hyphaene petersiana* and dye plants have become rare [Cunningham and Milton 1987]. However controlled exploitation, diversification of the craftwork industry and a switch from natural to synthetic dyes can sustain both natural resources and the income of the village craftspeople [Cunningham and Milton 1987]. A separate study in basketry resources in north-central Namibia showed that harvesting for basketry is within a sustainable limit. However destructive browsing by domestic livestock is preventing palms from reaching suitable sizes [Konstant et al 1995]. To sustain production of the swamp palm *Nypa fruticans*, used for construction and extraction of alcohol, indigenous populations follow conservation-orientated practises in utilising the natural resource [Fong 1992]. Similarly in Sarawak, to maintain the stability of the sogo palm [*Eugeissona utilis*] felled for starch, locals rotate their extraction systematically and never cut down the entire plant to the root, as this would surely kill it [Fong 1992].

The inhabitants of Namaqualand are mostly the descendants of the Nama-speaking Khoi pastoralists and still rely on indigenous plants for some of their subsistence requirements [Archer 1994]. Although many traditional

practises have been forgotten and given way to strong western ideologies indigenous plants are still used widely for a variety of purposes [Goldberg 1998]. Plants are used in this region for medicine, fuelwood, additional food sources, grazing for livestock and construction materials. The right to utilise resources communally is dictated by 'birthright' and the tenure system is based on a communal property system [Solomon 2000]. Thus all inhabitants have the right to utilize the Paulshoek area and its resources. This tenure system consists of rules and regulations and mutual arrangements between the livestock holders of the village when using the land [Solomon 2000]. A number of studies on the use of different plant uses have been compiled for Paulshoek, a village in the Leliefontien Rural reserve, situated in central Namaqualand.

It is important to note the land use practises in the area and their effects on the vegetation. The area as a whole is not highly suitable for cultivation but some crops namely oats, wheat, rye and barley have been the main crops grown in this region over the last 100 years [Allsopp 1999]. However, only small areas of flat land have been cultivated and even after 20 years only annuals and *Galenia* shrubs have recolonised the field while uncultivated areas are dominated by *Rushia robusta* [Allsopp 1999].

Not as restricted are the effects of increased grazing on the vegetation. Stocking rates in communal areas have been maintained at approximately twice the recommended rate for the last 20 years [Todd and Hoffman 1999]. Increased grazing can lead to a decrease in species richness and a shift to assemblages dominated by toxic and spinescent woody plants. Contrasts can easily be seen on neighbouring commercial farm that have considerably more conservative stocking rates. Heavy grazing has

resulted in species tolerant of grazing such as annuals and geophytes increasing while large palatable shrub species have decreased [Todd and Hoffman 1999]. An investigation into the population processes of five shrubs species revealed that heavy grazing on the communal rangelands has resulted in reduced size of palatable shrub species, reduced flower production and seedling recruitment of palatable species while there has been increased density and recruitment of the unpalatable shrub, *Galenia africana* [Todd and Hoffman 1999]. Although there is no sign of species loss in communal rangeland there has been an altered dominance of perennials in favour of annuals. Other studies in arid and semiarid Mediterranean regions have shown heavy grazing also associated with a shift from perennials to annual vegetation [Todd and Hoffman 1999].

Goldberg [1998] compiled a comprehensive list of indigenous plants used for medicinal purposes. As the nearest doctor is 40km away and only visited by a mobile clinic, up to 70% of the population regularly use herbal remedies. The medicinal plant resources in Paulshoek seem highly resilient to harvesting pressures and land use practices as only a few used species are threatened. *Rhus undulata* and *Mentha longifolia* have shown a change in abundance and a reduction in plant fitness due to harvesting for firewood and medicinal purposes respectively. While *Sceletium emarcidum* is highly threatened and on the verge of local extinction due to a combination of intense harvesting and high grazing pressures. The high proportion of medicinal plants in Paulshoek with low vulnerable growth forms could reflect the remains of a once wider assemblage of plants used. Although there are numerous geophytes in Paulshoek none are used for a medicinal remedy. This contrasts other areas that commonly use geophytes and could reflect the local extinction of useful geophytes in the area.

As there is limited access to electricity most households rely heavily on fuelwood as an energy source [Goldberg 1998]. As woody biomass resources are very scarce in Namaqualand and limited by the harsh climatic conditions the desired fuel plants will be placed under threat. *Rhus undulata* is the most desired and heavily used fuelwood species in Paulshoek [Solomon 2000]. The threat posed to *R. undulata* appears to be alleviated by its evolved resilient characteristics, which contribute to its survival. Harvesters recognise these traits and refrain from removing green wood and live stumps. Along with an increase in alternative energy sources like electricity and gas the detrimental effect on natural populations for this species from harvesting have been lessened. However the availability of fuelwood species even those of low quality have decreased over time [Solomon 2000].

Plants harvested for construction are used to make 'matjieshuite' and cooking shelters. The most common type of dwelling was the 'matjieshuite' consisting of a rounded pole skeleton covered in reedmats [Archer 1994]. These huts were easily moved; a requirement of early Khoi pastoralists. As the requirement and ability to move decreased this shelter type has been increasingly replaced by more conventional and permanent shelters made from bricks and zinc.

However, plants harvested for construction are used mainly in building cooking shelters. Cooking shelters are circular structures found at all stockposts. These shelters provide protection from the elements mainly wind and cold. The main activity in these shelters is to prepare and cook food. These shelters are separate from the sleeping quarters due to the smoke from fires. The shelters often form the centre of social activities

[Archer 1994]. Thus these shelters form an important role in the society and lives of the farmers at stockposts. Although these structures could be replaced with synthetic materials [zinc] such materials are expensive. Also due to the distance between Paulshoek and the closest town transportation costs are high. Thus an investigation into the sustainable harvest of materials to build cooking shelters could prevent the loss of species and prevent additional cost to acquire construction materials.

There are three types of cooking shelters, full canopy, half canopy and open shelter [Fig. 1 and 2]. The open shelter is used in summer when little protection is needed from the weather. The full and half shelters are used all year but predominantly during winter for protection from the cold and wind. After a pole 'skeleton' has been made plant materials are piled on top of each other to form a wall. Most shelters have a rock base while the type of roof varies. In some, the roofs are made from vegetation while others use plastic and canvas. Open shelters have no roof. In the centre of the floor is a circular hearth on which fires are made. The poles used to make the internal structure often have short side branches. These are used to hang utensils, mugs and food out of the reach of dogs and keep them clean.



Fig. 1: Illustration of both full canopy [back] and open shelter [front] cooking shelters in Paulshoek, Namaqualand. Not some rocks are use in the base and the thick walls formed from piling *Polymiata albiflora* on itself.



Fig. 2: Illustration of a half canopy cooking shelter and an open shelter on the right side in Paulshoek, Namaqualand.

The most desired plant to build these shelters is the dwarf succulent *Polymita albiflora* known locally as 'muisoor' [Fig. 3]. This dense rounded plant is stacked upside down and packs tightly. However most shelters are made from a mixture of species mainly depicting what is available within the immediate vicinity. *P. albiflora* is restricted to growing on quartzite slopes or shallow pockets of granite in dense stands [Fig. 4]. Due to its habitat specificity this species could be vulnerable to overexploitation. This study first describes the cooking shelters of Paulshoek and their plant composition. The effects of harvesting are investigated in natural populations of *P. albiflora* to assess the effects of harvesting.

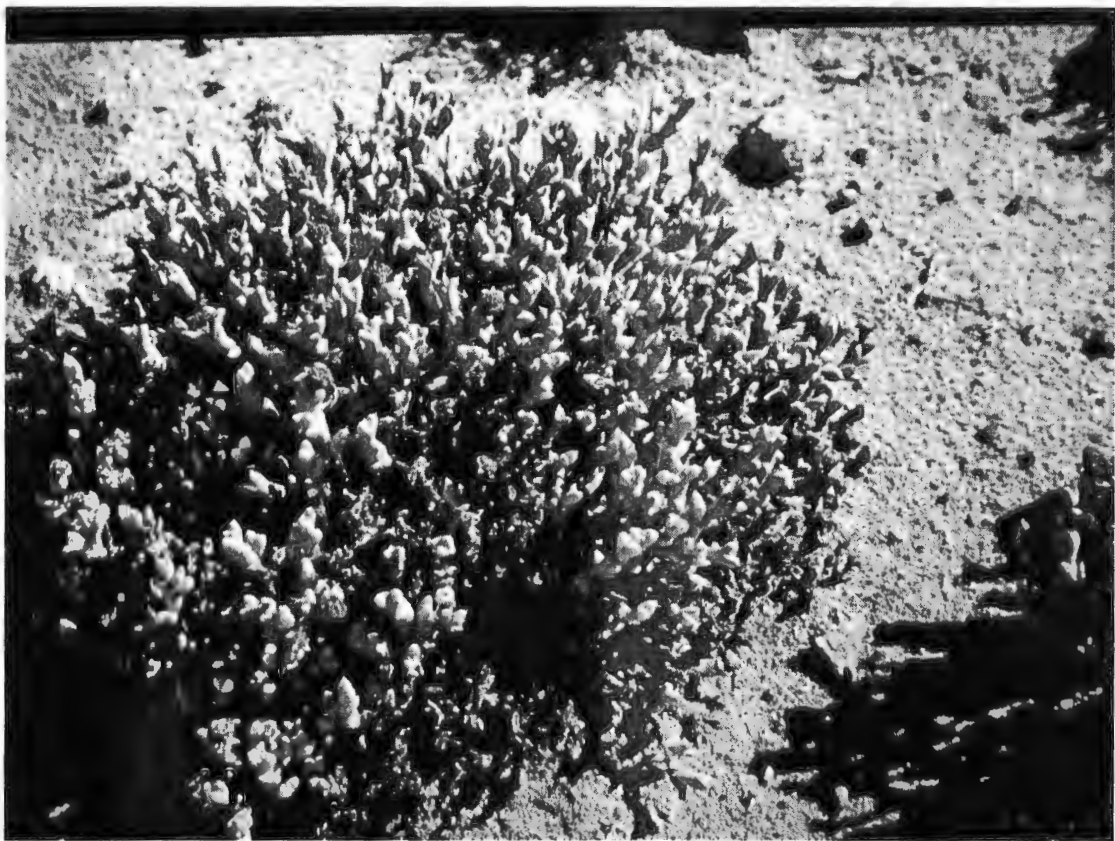


Fig. 3: A single *Polymita albiflora* plant showing the broad dense form used to construct cooking shelters.



Fig. 4: A population of *Polymita albiflora* as they occur in dense stands in Paulshoek, Namaqualand.

Study area:

This investigation was carried out in Paulshoek, a village in the Leliefontien communal reserve with approximately 800 occupants [Solomon 2000]. The village is situated on the southern part of the Kamiesberg region with an elevation between 900 and 1250m [Fig. 5 and 6]. Rainfall is unpredictable and sporadic receiving both winter rainfall in the west and summer rainfall in the east [Solomon 2000]. The dominant vegetation is Namaqualand Broken Veld [Acocks 1988]. Higher areas are comprised of more woody shrubs while the lower drier areas are comprised more of dwarf succulent shrubs [Acocks 1988]. Most inhabitants are relatively poor, depending on welfare or migrant labour remittances [Solomon 2000]. The whole reserve is used for grazing by

small stock mostly goats with some sheep. There are 28 stocking posts scattered around the reserve. Each stocking post has at least one cooking shelter with most having two a covered shelter for winter and an open shelter for summer.

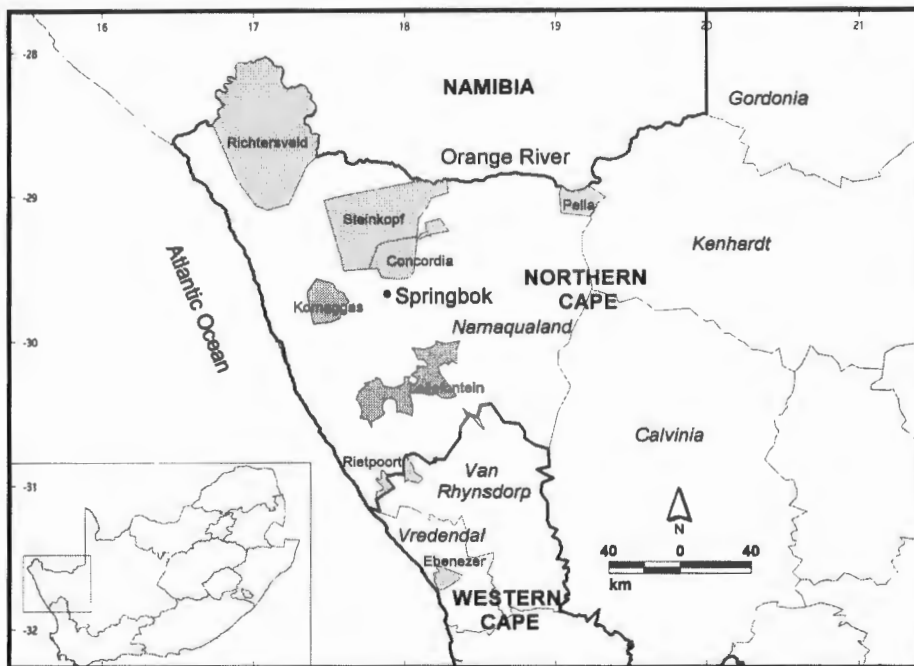


Fig 5: Map of the Leliefontein communal reserve situated in central Namaqualand.

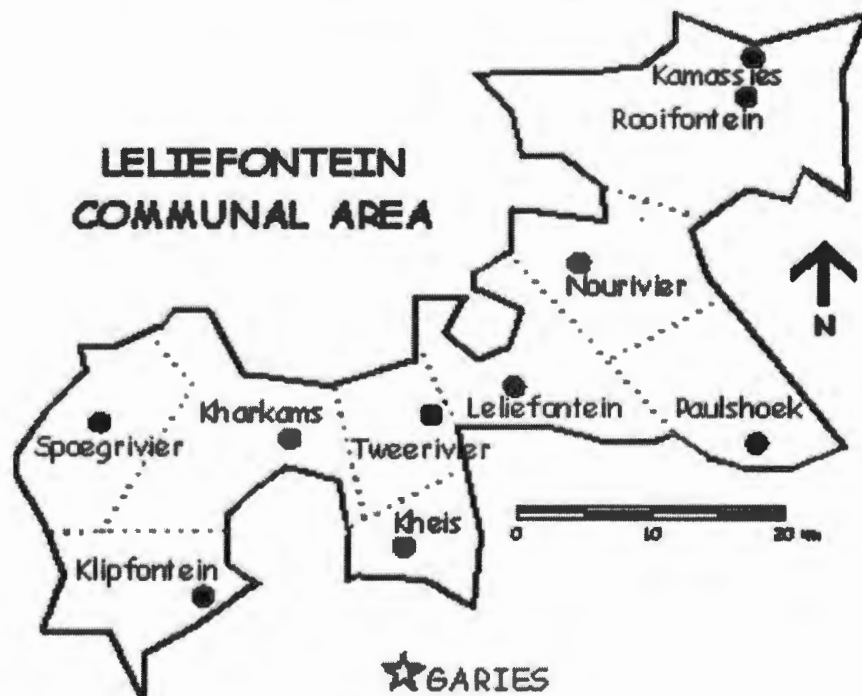


Fig. 6: Map of the Leliefontein communal area showing the position of Paulshoek.

Methods:

Description of cooking shelters

Eighteen of the twenty-eight cooking shelters in Paulshoek were measured including each of the three types: full canopy [7], half canopy [7] and open shelters [4]. For each shelter the circumference and height were measured. Wall thickness was measured by pushing a steel rod through the wall at six places around the shelter and the mean value noted. Plant species used to construct the shelter were identified and the percentage composition estimated. Other materials used were noted and at a few sites owners were asked questions about the cooking shelters and harvesting materials.

Where appropriate, average volumes of plant material used were calculated for each shelter type. A non-parametric Kruskal-Wallis H test was used to analyse the data looking for differences between shelter types [van den Honert 1997]. Total values were used to illustrate species composition and total volume of plants for each type of cooking shelter.

Analysis of a cooking shelter

With permission from the owner a half-canopy cooking shelter was measured and divided into several sections. The cooking shelter was taken apart and in three of the sections all the plants were measured and weighed. Both the long and short axis and plant height were measured and a height value. Volumes for each plant were calculated as oblate spheroids [$V = \pi A^2 B / 6$], an ellipse rotated about its minor axis [Phillips

and MacMahon 1981] where A is the smaller axis, either average diameter or height, and B the larger axis. These values were used to determine the size class of plants used to build shelters.

Polymita albiflora: Natural populations

The size class distribution of plants in four separate populations combined was calculated. Three 33m line transects were completed at each site and the closest plant at each meter measured. The height and both axis of each plant were measured and volume calculated as outlined above. All these measurements were used to construct a size class distribution of plants in their natural population. A 'health' index calculated as the percentage material alive on the plants was also estimated at all sites excluding the first. This was included in a size class distribution to illustrate the health of individuals within each size class. At the third site the number of capsules in plants of different sizes were counted. The number of capsules per plants was correlated against the volume of the plant to relate plant size to reproductive output.

Results:

Description of cooking shelters

The full canopy cooking shelter were generally the largest while the open shelters the smallest although the differences were not significant [Table 1]. Large variances and the small number of shelters measured contributed to this difference not being significant. Most shelters used rocks as a base and some had plastic or canvas roofs. Each year more plants are placed on the walls to compensate for the flattening due to the

weight of the plants. Interviews with owners of cooking shelters said that only the largest plants with mostly dead material were harvested. However most shelters contained a few small and green plants.

Table 1: Means of combined data for all cooking shelters measured including differences according to a non-parametric Kruskal-wallis H test.

Measurements:	Full	Half	Open	Statistic p [H]
N	7	7	4	-
Circumference [m]	15.1	13.2	12.4	0.15 [3.76]
Height [m]	1.7	1.3	1.1	0.23 [2.88]
Thickness [m]	0.6	0.6	0.7	0.61 [1.01]
Volume of plants used per shelter [m ³]	18.4	11.6	9.0	0.16 [3.64]
<u>% Species used:</u>				
<i>Polymita albiflora</i>	61	71	63	-
<i>Euphorbia mauritanica</i>	16	19	10	-
<i>Galenia africana</i>	4	7	27	-
<i>Rushia fredericii</i>	14	0	0	-
Other	5	3	0	-

The two oldest shelters were 15 years old and both full canopy. Only two shelters did not use *P. albiflora*. The first had none in the area while the second was the only shelter not to use any plants. The main species used was *Polymita albiflora* while *Euphorbia mauritanica* was also

consistently used. *Galenia africana* was used mostly on open canopy shelter.

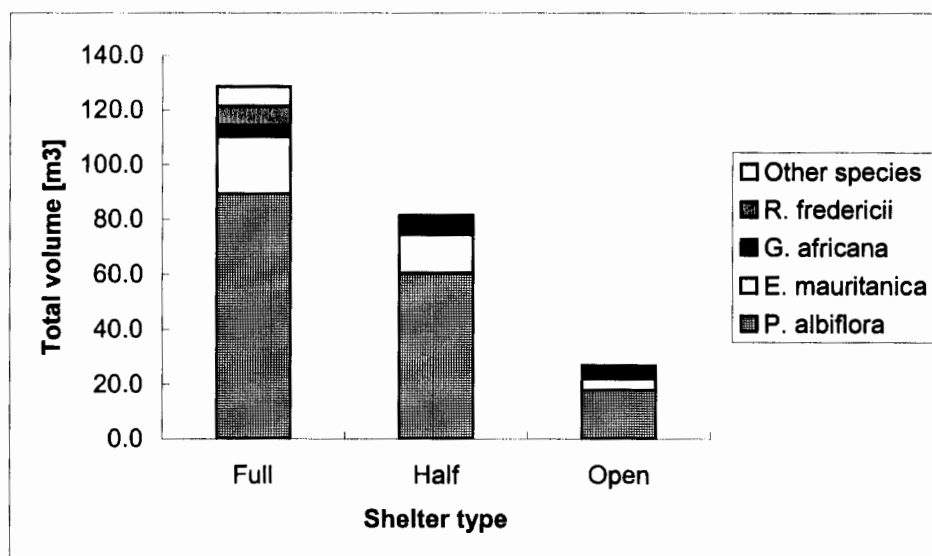


Fig. 7: Total volume of plant material used and the species compositions for each type of cooking shelter measured.

Most of the shelters used plant materials and some canvas or plastic was used mainly for roofing. Some shelters, particularly the larger ones used additional species generally reflecting what was available in the area.

The main species used for all the shelter types was *P. albiflora*. *G. africana*, *E. mauritanica* and *Rushia fredericii* were also commonly used. Other species used included *Asclepias fruticosis*, *Diospyros lycioides*, *Ruschia robusta* and *Eriocephalus ericoides*.

Analysis of a cooking shelter

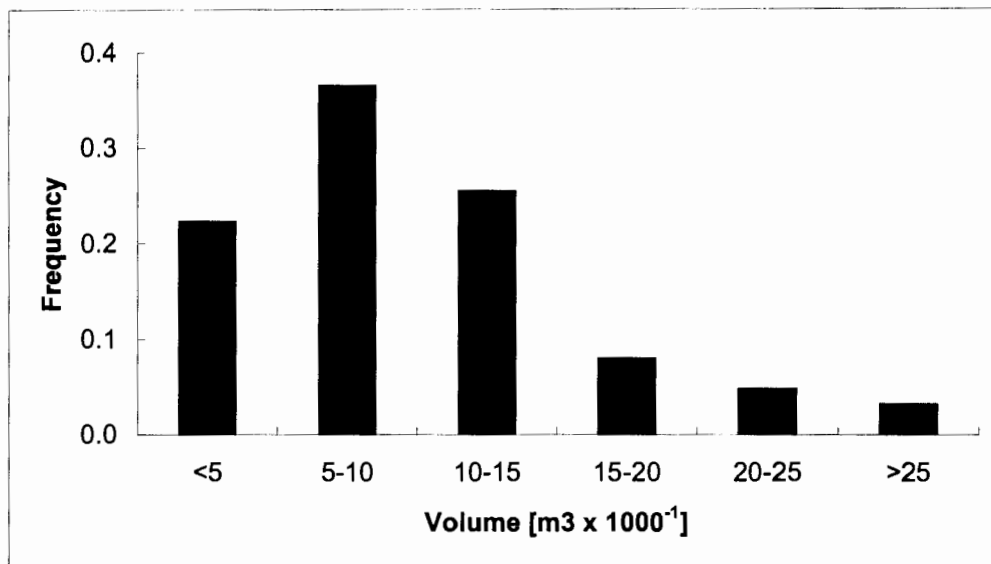


Fig. 8: Size class distribution of *Polymita albiflora* used to construct shelters.

The most commonly used size classes to construct cooking shelters were plants from 0.005 m³ to 0.015 m³. Smaller plants were also commonly used but did not contribute large amounts to the total biomass used in constructing cooking shelters.

Polymita albiflora: Natural populations

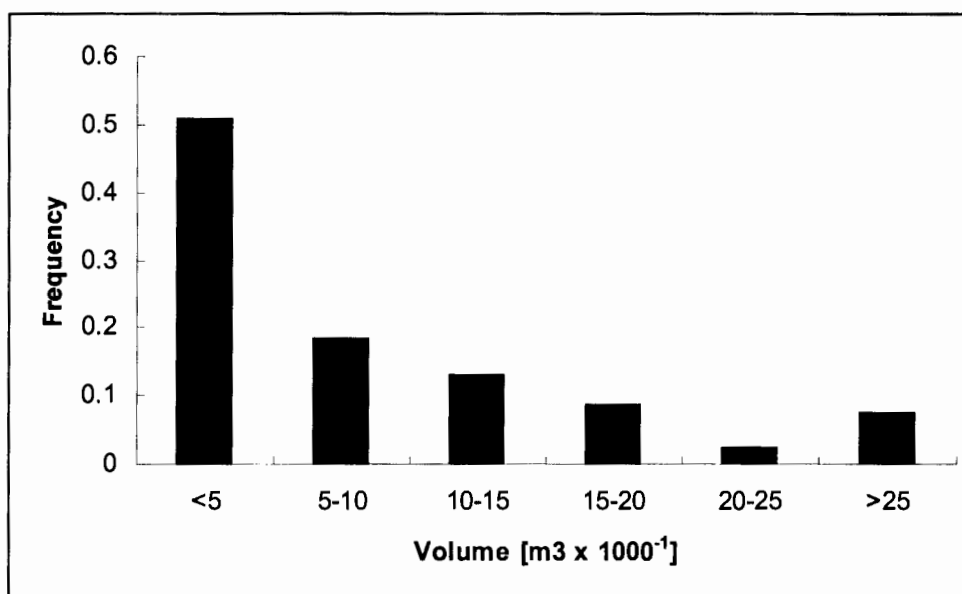


Fig. 9: Size class distribution of *Polymita albiflora* for 12 transects at 4 sites at Paulshoek.

Small plants make up a large proportion of plants in the natural populations. The next two size classes show a considerable drop in numbers a trend that is continued in all the larger size classes.

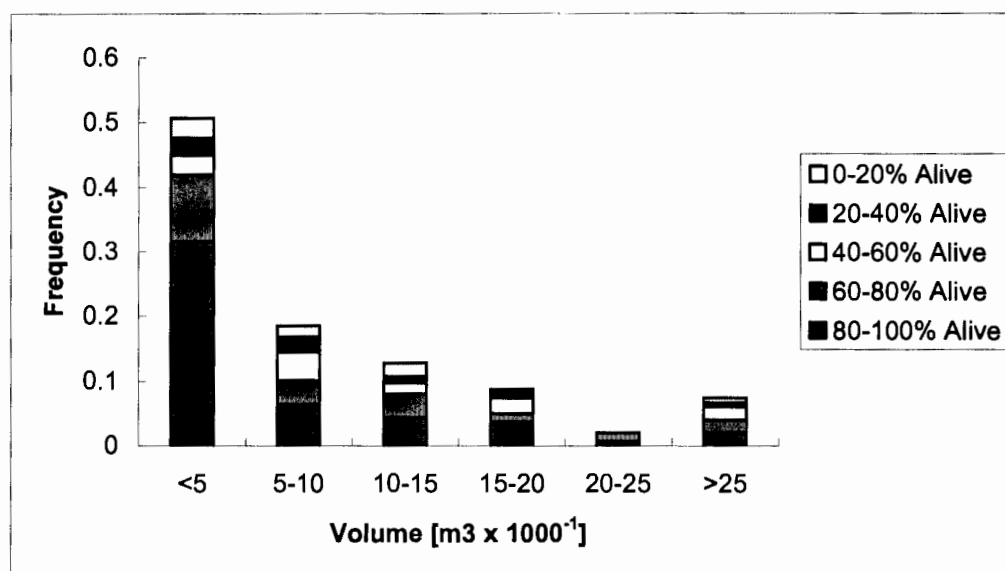


Fig 10: Size class distribution of *Polymita albiflora* including an index of health for individual plants.

A large proportion of the first size class of plants are composed of more than 60% living material. The remaining size classes generally show higher proportions of dead material on individuals in the population.

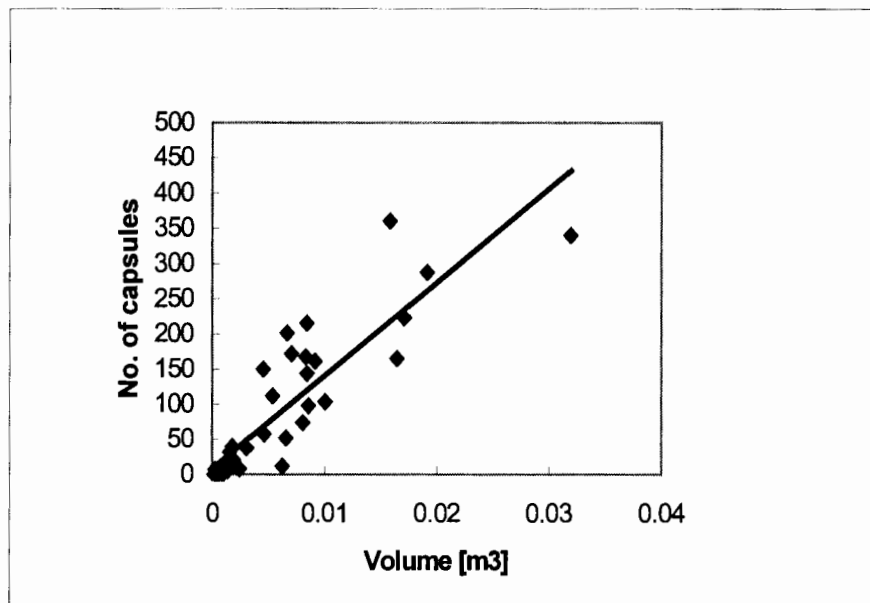


Fig 11: Regression of plant volume and number of capsules with $r^2 = 0.776$ and $p < 0.001$.

Plants have to be at least 0.001m^3 in order to produce capsules but even medium sized individuals [$0.005 - 0.015 \text{ m}^3$] are able to produce up to 200 capsules, each probably with over 100 seeds.

Discussion:

Description of cooking shelters

The largest cooking shelters measured were the full canopy shelters. Generally the full canopy shelters were well built and solid. The oldest two shelters were both full canopy and had been used for 15 years. Full

canopy shelters are used predominately in the winter and need to be well constructed to withstand the harsh elements. Open shelters are built for and used during the summer periods requiring little protection from cold but still some from wind. The open shelters, not requiring such sturdy constructions, are weaker structures and do not last as long. All the open shelters measured in this study were only a year old. These shelters are rebuilt often but don't require large effort. The highest proportion of *Galenia africana* was used in building open shelters. This species is made up of thin, weak sticks once dried and is not a solid construction material. However it is highly abundant mainly due to overgrazing [Todd and Hoffman 1999] and is used in the lower quality open shelters.

Polymita albiflora was the majority species used in all types of shelters. This illustrates the plants suitability for making shelters. The plants interlock tightly and securely. Being heavy, *P. albiflora* can be stacked on lighter species to prevent them from being blown away. The plants are also easy to harvest and handle. They do not require drying and even green plants can be used immediately. The plants grow in dense stands so a farmer only has to go to one place to fetch all the material required. *Euphorbia mauritanica* was used in small quantities for all the shelter types. A low quality construction material is used due to its availability. It is light and is stacked in layers with heavier plants placed on top. Both *G. africana* and *E. mauritanica* are locally very common and the amount being harvested for construction is highly unlikely to have a negative effect on either's population structure. However, *P. albiflora* is restricted to quartzite slopes and shallow pockets in granite [Smith et al 1998]. Thus the large quantity of *P. albiflora* being harvested could be impacting on the local populations.

Analysis of a cooking shelter

The most commonly used size classes [0.005-0.015 m³] most likely reflect the plant size easily handled and transported. Although the small size class [0-0.005 m³] has the next highest frequency it does not add large amounts of biomass. The larger size classes of plants [>0.025 m³] still contribute significant amounts of biomass but are more difficult to harvest and transport.

Polymita albiflora: Natural populations

The large drop in frequency from the first size class to the second class could be a direct influence of those size plants being harvested. Thus reducing the number of individuals above 0.005 m³ in the populations. However, the decrease from the first to second size class, could also indicate a large mortality of seedling during their establishment phase. This pattern suggests recruitment is continuous and populations are expanding under these circumstances [Cunningham 2001].

The health index on natural populations shows all the size classes to be predominantly green and healthy. The lack of dead plants [0-20% alive] above the 0.015 m³ indicates large dead plants are all harvested but not all the large plants are taken. These large plants have high numbers of capsules and supply lots of seeds.

The size classes predominantly harvested [0.005-0.015 m³] are producing large numbers of capsules [100-150 capsules]. However even small plants 0.001m³ are able to produce capsules while the few large plants produce

up to 350 capsule with each capsule containing more than 100 seeds. The high frequency of the smallest size class illustrates that recruitment is continuous. As the populations grow in dense stands the removal of plants in those stands will leave an opening most likely to be occupied by another *P. albiflora*. When plants are harvested often rootstocks are left and *P. albiflora* is capable of resprouting [Farmers, personal communications].

Currently the populations seem to be being harvested well within sustainable levels. There is no likely increase in the demand of plants as cooking shelters recycle the plant materials and only harvest small amounts each year to rebuild the walls as they sink under the weight. A new shelter is built every few years but there are sufficient plants in the smallest size class to replace the gaps. Although *P. albiflora* is also used for firewood it is a poor quality fuel, as it does not form coals. Poor fuelwood is only used for baking and this practice only occurs once a week. However due to the decrease in the availability of fuelwood, populations of *P. albiflora* within the vicinity of the village are threatened by overexploitation. However further populations are not at risk, because the effort required to fetch them far outweighs their use as a fuelwood.

Acknowledgements:

Firstly I would like to thank my supervisor. Thanks for the assistance in the field and constant feedback. It was much appreciated. To the people of Paulshoek who are always inviting, friendly and keen to pass on their knowledge.

References:

- Acocks, J. P. H. 1988. Veld types of South Africa. 3rd Edition. Memoirs of the Botanical Survey of South Africa No. 57. National Botanical Institute, Pretoria.
- Allsopp, N. 1999. Effects of grazing and cultivation on soil patterns in the Paulshoek area of Namaqualand. *Plant Ecology*. 142: 179-187.
- Archer, F. M. 1994. Ethnobotany of Namaqualand: The Richtersveld. Msc. Thesis, University of Cape Town.
- Cunningham, A. B. 2001. Applied ethnobotany: People, wild plants and conservation. Earthscan publications, London.
- Cunningham, A. B. and Milton, S. J. 1987. Effects of Basket weaving industry on Mokola palm and dye plants in Northwestern Botswana. *Economic Botany*. 41: 386-402.
- Del Castillo, R. F. and Trujillo, S. 1991. Ethnobotany of *Ferocactus histrix* and *Echinocactus platyacanthus* [Cactaceae] in the semiarid Central Mexico: Past, present and future. *Economic Botany*. 45: 495-502.
- Fong, F. W. 1992. Perspectives for sustainable resource utilization and management of Nipa vegetation. *Economic Botany*. 46: 45-54.

- Goldberg, K. 1998. Investigating the sustainability of medicinal plants and the loss of traditional knowledge in a rural community in Namaqualand. Honours thesis. University of Cape Town.
- Konstant, T. L., Sullivan, S. and Cunningham, A. B. 1995. The effects of utilization by people and livestock on *Hyphaene petersiana* [Arecaceae] basketry resources in the Palm Savanna of North-central Namibia. *Economic Botany*. 49: 345-356.
- Phillips, D. L. and MacMahon, J. A. 1981. Competition and spacing patterns in Desert shrubs. *Journal of Ecology*. 69: 97-115.
- Smith, G. F., Chesselet, P., van Jaarsveld, E. J., Hartmann, H., Hammer, S., van Wyk, B. E., Burgoyne, P., Klok, C. and Kurzweil, H. 1998. *Mesembs of the world*. Briza publications, Pretoria
- Solomon, A. M. 2000. The use and valuation of natural fuelwood resources in Paulshoek, Namaqualand and the ecological impacts on rangeland dynamics. Msc. Thesis, University of Cape Town.
- Todd, S. W. and Hoffman, M. T. 1999. A fence-line contrast reveals effects of heavy grazing on plant diversity and community composition in Namaqualand, South Africa. *Plant Ecology*. 142: 161-167.
- van den Honert, R. 1997. *Intermediate statistical methods*. University of Cape Town press, Cape Town.