

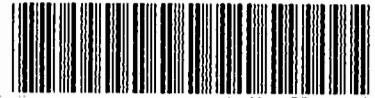
**Why is *Chasmanthe* spp. absent from the archaeological record of the south-western Cape?**



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**Abstract:**

In the archaeological record of the south-western Cape one finds corm residues in deposits mostly in the form of the netting which surrounds the corm. These plant residues seem to be a widespread feature in the archaeological record of Later Stone Age sites in Southern Africa. Corm residues have been identified as mainly representative of the Iridaceae family. The most common geophyte corms identified are those of *Watsonia*, *Babiana*, *Hexaglottis*, *Moreae* and *Gladiolus*. Interestingly, *Chasmanthe* spp. commonly found growing on the west coast, have not been found in archaeological deposits of this area. The carbohydrate-rich corms follow seasonal growth patterns and mainly flowering in spring and early summer and growing during the winter months. Hunter-gatherers must have been familiar with their growth patterns and their palatability so that they could exploit these plants when corms were at their optimum and harvest them before the stored carbohydrates were used up by the plant. Utility plant indices for varying plant-resource components and mineral content analysis for N, P and total non-structural carbohydrates of the corms were calculated. From the results it appears that the reason for *Chasmanthe* spp. not appearing in the archaeological record is due to choices made by foragers regarding field processing of low utility plant parts (i.e. plant waste), rather than its relative importance or more precisely lack thereof, in the diets of early foragers.

**Cover plate:** Botanical drawings of *Chasmanthe* spp. [a = *C. floribunda*; b = *C. floribunda* var. *duckittii*; c = *C. aethiopica*; d = *C. bicolor*] (Jeppe 1989:93).

## **1. Introduction:**

What tempted the palate of early foragers? Rootstocks were undoubtedly a major component of diet. Many early commentators on hunters and herders referred to 'uintjies' (onions); 'uintjiesok' (onion stick) and 'uintjiesak' (onion sack). These corms were probably roasted before being eaten, as the common name for *Watsonia*, Hottentotsbrood (Hottentot's bread), indicates. (Smith 1966; Archer 1982).

In the cave sites of De Hangen, Elands Bay Cave, Diepkloof, Andriesgrond and Renbaan (all located in the south-western Cape), plant remains are a regular feature taking the form of bedding or Iridaceae patches, mostly dating from the last 2000 years (Liengme 1987). Of all geophyte residues most are in the form of corms and corm casings (Liengme 1987; Parkington 1972; Parkington & Poggenpoel 1971; Smith 1999) (Fig. 1 & Table 1).

The fynbos biome has an abundance of geophytes especially the many edible corms from the Iridaceae family. They generally flower in the spring and early summer (Innes 1985; Jeppe 1989; Kidd 1996) resulting in seasonal corm development patterns (Parkington and Poggenpoel 1971).

What becomes apparent is that the *Babiana*, *Moraea*, *Gladiolus*, *Hexaglottis* and *Watsonia* (all belonging to the Iridaceae family) are the most common genera and their corm casings form a common feature amongst the five sites mentioned above. *Babiana* corm tunics were found at all of the five sites, *Gladiolus* at 80% of the sites, *Hexaglottis* at 40% of the sites and *Watsonia* at 60% of the sites. What is also interesting is the fact that *Chasmanthe* sp. was only found at one of the sites, namely De Hangen (Liengme 1987).

Dietary reconstruction of interrelationships between people and plants, is a subject that has received scant attention. Associated with this type of reconstruction are many interpretative problems. The biggest being partial and biased representation of total food

intake due: to poor excavation methods, partial preservation of plant materials or due to some foods just not leaving any traces (Buchanan 1987; Thomas 1989).

The main objective in this project is to obtain a greater understanding of corm gathering in the archaeological record and try to understand why the genus *Chasmanthe* has not been identified in the archaeological record to the same degree as some of the other genera mentioned above. Is its absence from the archaeological record a true reflection <sup>?</sup> could there be other reasons for it not leaving any traces site deposits? <sup>^</sup>

My project involves two hypotheses:

1. The intra-site patterning of these corm residues is largely related to field processing, which is the removal of waste or low utility parts from resources at the location of procurement, as is stated in the model by Metcalfe and Barlow (1992). The model goes on to describe the trade-off between field processing and transport of resources (more on this model is discussed later). Differences in types and quantities of plant remains in archaeological sites may reflect variations in the amount of time people spent removing low utility, but archaeologically visible plant parts prior to the transportation to the home base and not their relative importance in past diets. Do some species have more low utility parts than others and, if so, would they have been more likely to have been field processed before returning to the home base, thereby resulting in certain patterns within a spatial dimension of the site. Can this account for *Chasmanthe* being absent in the archaeological record? This research project will be used to assess the changes in types and quantities of inedible plant-waste associated with different stages of field processing based on the assumption that foragers should have removed different components of resources between the time of procurement and returning to the home base.
2. In the archaeological record certain genera are identified more often than others. Could it be that *Chasmanthe* spp. had such a low nutritional content that perhaps people of the Later Stone Age made a conscious decision not to collect them as a

food resource? Research will be conducted to assess the nutritional content of Chasmanthe, namely nitrogen, phosphorus and total non-structural carbohydrates, relative to some of the more common genera and to determine if the levels of these nutrients are exceptionally low compared with the more common species. If so, perhaps this could account for the fact that Chasmanthe is not a common feature in sites of the south-western Cape.

In this study I have collected specimens from three genera: *Babiana disticha*, *Watsonia borbonica* and two species of Chasmanthe: *Chasmanthe floribunda* and *Chasmanthe aethiopica*. The *Watsonia* and *Babiana* species were chosen as they are the most representative genera in the archaeological deposits of the five sites mentioned above, and so would be a good comparison against which Chasmanthe can be analysed. Plates 1, 2 and the cover page depict the species under investigation.





Plate 1. Botanical drawings of *Babiana* spp. *Babiana disticha* is represented in 'h'. [a = *B. angustifolia*; b = *B. spathacea*; c = *B. leipoldtii*; d = *B. villosa*; e = *B. rubrocyanea*; f = *B. sambucina*; g = *B. tubulosa* var. *tubiflora*] (Jeppe 1989:105)



Plate 2. Botanical drawings of *Watsonia* spp. *Watsonia borbonica* is represented in 'a'. [b = *W. tubularis*; c = *W. meriana*; d = *W. roseoalba*] (Jeppe 1989:85).



## **2. Background information on the species under investigation:**

### *Babiana disticha* (= *B. plicata*):

Commonly this species is known as 'Bobbejaantjie', 'Bobbejaanuitjie', or 'Bloubobbejaantjie' (the generic title was derived from 'babaner' meaning baboon, as baboons supposedly enjoy eating these corms). The inflorescence can be branched or simple overtopping the leaves. The flowers are fragrant and colours can vary from pale blue to lilac to purple with occasional white forms. The leaves are broad, appearing folded and the plant can attain heights of 15-30 cm in length. It has a cormous rootstock more or less rounded with tough fibrous/membranous tunics with the inner layers often being unbroken. This species flowers July to September. It's distribution varies from Springbok to the Cape Peninsula and east to George but, locally, is commonly located on Signal Hill and the northern slopes of Table Mountain (Innes 1985; Jeppe 1989; Kidd 1996).

### *Watsonia borbonica* (= *W. pyramidata*; *W. ardernei*):

*Watsonia borbonica* is commonly known as 'Suurkanol', 'Suurknol' or 'Witkanol'. This species grows in large colonies on mountain slopes and hillsides, often in damp, sandy places. The inflorescence is usually branched with numerous flowers being white and pink to rose-pink on a long spike. The leaves are glossy, 2-4 cm in width and the plant can attain a height of 1-2.2 m. The corm is 3-4 cm in diameter covered by tough, grey-brown membranous tunics with the inner layers often intact. Their flowering time is from September to November. It's distribution is from Tulbagh to the Cape Peninsula and as far as George (Goldblatt 1989; Innes 1985; Jeppe 1989; Kidd 1996).

### *Chasmanthe floribunda* (= *Petamenes floribunda*):

*Chasmanthe floribunda* is commonly known as 'Piempie', 'Rooipypie' or 'Suurkanol'. Plants form small colonies and grow in damp, rocky places near streams on lower mountain slopes. The inflorescence can reach 1 m with numerous flowers of 25-30 arranged in two ranks on a spike. They are bright orange in colour. The corms are

somewhat flattened with papery rather than membranous tunics. Their flowering time is from June to September with a distribution from Vanrhynsdorp to the Peninsula and east to Knysna (Innes 1985; Jeppe 1989; Kidd 1996).

*Chasmanthe aethiopica* (= *Petamenes aethiopica*; *Antholyza aethiopica*):

This species is commonly known as 'Suurkanolpypie' or 'Suurkanol'. The plants grow in small groups in damp, shady places among rocks on lower mountain slopes. The inflorescence reaches 70 cm with about 10 orange-scarlet flowers. The corms are also flattened with papery rather than membranous tunics. Their flowering time is from May to August with a distribution which is mainly coastal ranging from the Cape Peninsula to the eastern Cape (Innes 1985; Jeppe 1989; Kidd 1996).

### **3. Materials and Methods:**

#### **3.1 Study site:**

For the analysis, 23 individuals were collected of *B. disticha* from Camps Bay. Plants of *W. borbonica* were collected from two populations: Kenilworth and Table Mountain. 17 individuals were collected from Kenilworth and 13 individuals were collected from Table Mountain (a total of 30 individuals for this species). Specimens of *C. floribunda* were also collected from two populations: Clovelly and Table Mountain. 12 plants were collected from Clovelly while 13 plants were collected from Table Mountain (a total of 25 specimens for this species). Finally 10 plants were collected for *C. aethiopica* from Fish Hoek. All the plants were collected between the beginning of July and the end of August using a trowel to excavate each plant. It should be noted that individual plants from each species were at different stages of flowering and fruiting. 16/23 of *B. disticha* plants were fruiting from the Camps Bay sample; none of the *W. borbonica* plants were either fruiting or flowering from either of the two populations; 1/13 plants were flowering from the Table Mountain population and 2/12 plants from the Clovelly population were flowering for *C. floribunda*. None of the plants collected for *C. aethiopica* were either flowering or fruiting.

#### **3.2 Preparation of plant material:**

The plants were brought back to the laboratory where fresh and dry masses were taken for the different plant components, namely the roots, leaves, corms and corm casings. The width and height of each corm was recorded to determine its dimensions. Depth of the corm below the soil surface was also recorded as well as whether the plant bore fruit or flowers and the length of the leaves for each individual plant.

All plant material except for the corms were placed into a convection oven at 60° C until dry. The corms were placed into a convection oven first at 100° C for one hour to halt all biological processes, then at 60° C for approximately 24 hours or until the corms were

dry. The corms were then ground up until they were reduced to powder. This ground corm material was used for the determination of mineral nutrients N, P and carbohydrates.

### **3.3 Total N, total P, and total non-structural carbohydrate analysis of Iridaceae corm material:**

13 representative plants for *B. disticha*, collected from Camps Bay, 13 representative plants for *C. floribunda*, collected from the Table Mountain population, and 13 plants collected from Table Mountain for *W. borbonica* were used to determine total N, total P and total non-structural carbohydrates.

#### **(i) Total N Determination:**

Total N was determined by the Kjeldahl digestion method where organic N in the sample under analysis is converted to  $\text{NH}_4^+$ -N by digestion with concentrated  $\text{H}_2\text{SO}_4$  containing 34 g  $\text{L}^{-1}$  salicylic acid. 0.1g aliquots of plant material was measured out and placed into long, thick-walled boiling tubes with 1 ml of distilled water. 3 ml of concentrated  $\text{H}_2\text{SO}_4$  containing salicylic acid was added together with a small spatula tip of sodium thiosulphate crystals and one selenium kjeldahl-catalyst tablet. The salicylic acid and sodium thiosulphate was included to adopt nitrate and nitrite in the assay (Bremner 1965). The tubes were placed on an aluminium-block digester and heated at the following temperatures and times:

150° C for a minimum for 2 hours

180° C for 30 minutes

220° C for 1 hour

250° C for 1 hour

280° C for 1 hour

300° C for 1 hour

350° C for 2-4 hours until the digest is clear.

After this, the tubes were cooled to 150° C and those which contained dark pink splattered material on the inside of the tubes were carefully rolled so as to rinse the residue back into the acid solution. The heating sequence above, was repeated, this time using 30 minute intervals for the lower temperatures, and 1-2 hours for the highest temperature until the digest was clear again. After cooling again at 150° C, 5 ml distilled water was added to each tube. Each sample was then made up to 50 ml with distilled water.

The N content was determined by a phenyl-hypochlorite colourmetric method (Allen 1989) and absorbance was read at 635 nm on the SPECTRONIC 20 GENESYS. Digest solution of 0.5 ml aliquot was pipetted out to which 25 ml EDTA-Na<sub>2</sub> (0.12% w/v) was added. 2 ml Reagent A and 3.5 ml reagent B was added after which the volume was adjusted to 50 ml by adding the appropriate volume of distilled water. Each assay was mixed thoroughly and allowed to stand for 1 hour so that the blue colour could develop before the absorbance was read. [Reagent A is made up of (i) 0.5% w/v sodium nitroprusside & (ii) 10% phenol in 95% ethanol. Mix (i) and (ii) in equal volumes to make up Reagent A. Reagent B is made up of (iii) alkaline phosphate buffer where 6.93 g Na<sub>2</sub>HPO<sub>4</sub> and 20.65 g NaOH are dissolved separately and mixed together in volume of 1L & (iv) 1.5% sodium hypochlorite. Mix four parts of (iii) and one part of (iv) to make up Reagent B]. Standard reference material was included to check the digestion and analytical procedures.

Nitrogen concentrations for each sample were extrapolated from the standard curve and converted to mg/g dry weight.

#### **(ii) Total P Determination:**

Total P was determined by the triacid digestion method. 0.1 g aliquots of corm material was placed into long, thick-walled boiling tubes, after which 1 ml of concentrated nitric acid was added to each tube. The tubes were placed in an aluminium digestion block at



160° C until the samples were almost dry. At that stage 1 ml triacid mix (10 HNO<sub>3</sub>:1 HClO<sub>4</sub>:1 H<sub>2</sub>SO<sub>4</sub>) was added to each tube and was allowed to digest for a further 1 hour at 180° C until the white perchloric fumes had dissipated and the solution was white to yellowish and viscous. After cooling the tubes were diluted to 25 ml using distilled water (Grimshaw 1987).

The P content was determined by a molybdenum-blue colourmetric procedure, as described by Allen (1989) and absorbance was read at 882 nm on the SPECTRONIC 20 GENESYS after one hour had elapsed to ensure the development of the blue colour of the assay. 10 ml aliquots of digest solution was pipetted out to which 25 ml distilled water was added to dilute the acidity of the sample and 8 ml of Murphy and Riley was added to each, then each sample was diluted to 50 ml and mixed thoroughly. [The Murphy and Riley reagent is made up of 2.5M H<sub>2</sub>SO<sub>4</sub>; ascorbic acid; ammonium molybdate and Antimony potassium each added in the appropriate amounts]. Standard reference material was included to check the digestion and analytical procedures.

Phosphorus concentrations were extrapolated from a standard curve and subsequently converted to mg/g dry weight using the following equation:

### **(iii) Total non-structural carbohydrate determination:**

Total non-structural carbohydrates (TNC) are made up of starch and sugars. TNC was determined by weighing out 50 mg of ground corm material. Extraction using 10 ml of 80/20 (v/v) ethanol/distilled water mixture, was repeated three times, centrifuging after each extraction. The extracts were combined and diluted to 50 ml with the above ethanol/distilled water mixture. This extraction was for sugar determination. The remaining pellet was washed with 10 ml absolute ethanol and centrifuged. The supernatant was discarded and 5 ml 3% HCL was added to each sample and placed into a water bath for 3 hours at 100°C. A marble was placed on top of each tube containing the

samples. After the 3 hours the sample was diluted to 50 ml with 5 ml distilled water and 40 ml absolute ethanol. This extraction was for starch determination (Stephen 1995).

Starch and sugars were determined using a phenol/sulphuric acid assay (Stephen 1995). The assay contained 1 ml of the sugar or starch extract, to which 1 ml of 28% phenol in 80% ethanol was added. Immediately thereafter 5 ml concentrated H<sub>2</sub>SO<sub>4</sub> was added. The solutions were mixed thoroughly and allowed to stand for 15 minutes. Absorbance was read at 490 nm on the SPECTRONIC 20 GENESYS. Standard reference material was included to check the analytical procedures and when dilution were needed to be made the correct dilution factor was applied in the calculations below. Sugar and starch concentrations were extrapolated from the same standard curve.

Sugar and starch concentrations were extrapolated from the standard curve and subsequently converted to ug/g dry weight.

TNC was calculated in the following manner:

$$\text{TNC} = \text{Sugar} + \text{Starch}.$$

#### **4. The Field Processing/Transport Model:**

Metcalf and Barlow (1992) addressed the problem of the differential utility and transport of resource components of plants. They developed an optimality model derived from evolutionary ecology principles.

Fundamental to interpretations made by archaeologists on patterned variations in the types and quantities of refuse (i.e. inedible plant parts) recovered from sites, is the assumption that some of this variation is associated with processing at or near the site of procurement of the resource in order to eliminate low utility parts thereby improving the quality of the transported load which is considered to have high utility. This definition of field processing is associated with three important points (Metcalf & Barlow 1992):

1. Resources are procured as packages consisting of two or more parts. For corm plants the plant can be divided into three parts: the leaves or aerial above ground parts; the corm casings and the corms themselves.
2. The components of a resource package are likely to vary in utility. In the case of corm plants the leaves and corm casings are of little use, therefore have zero utility, while the corm itself is a valuable commodity, therefore has a high utility.
3. The definition emphasises the relationship between field processing and transport.

Foragers must decide whether field processing the corms at the resource site would be more efficient than transporting the whole plant back to the home base. The advantage of field processing would imply a load of high quality and high-utility with little of the load wasted on transporting waste material of zero utility. Which strategy is the most efficient in terms of the morphology of the resource and the distance it is to be transported. The model they proposed implicates the time required to make a trip to and from the resource site and the relationship between time spent field processing and increase in the utility of the transported load. This model demonstrates the importance of the trade-off between

field processing and transport and how it varies among resources (Barlow & Metcalfe 1996; Metcalfe & Barlow 1992).

There are a number of assumptions underlying the model (Metcalfe & Barlow 1992):

1. The home base and resource site are not in the same location and the forager has decided to procure the resource for home consumption.
2. Foragers will make field-processing and transporting decisions that are both economic and efficient, i.e. foragers will try and maximise the resource load home relative to time spent procuring, field processing and transporting. In addition there is the assumption that field processing at the camp has no cost or that no field processing in the camp is needed prior to consumption/use. In the simplest case processing in the camp may be less time consuming than in the field as it can be delegated to others; there are additional persons to participate in processing thereby sharing the cost of processing.
3. Foragers are not limited in time spent procuring, field processing or transporting (this does not always hold in all environments/populations).
4. The field processing/transport model does not predict 'mixed loads' ever to be transported. Therefore, the resource load will be uniformly processed or unprocessed. (But "mixed loads" may be expected if there is a limit on the length of time available for procurement and transport).
5. The optimal load size for transportation < resources available.
6. The energy cost per unit time is the same for transporting and field processing. This assumption is incorrect in most cases and so can be relaxed.

It is necessary to understand the morphology of the resource under investigation as this is important in the decision making for field processing options. Metcalfe and Barlow (1992) recommend distinguishing 'structured' from 'unstructured' resources. 'Structured' resources are those where the morphology of the package dictates the order in which various resource components must be removed. 'Unstructured' resources on the other hand do not dictate how various components must be removed. In the case of the

corm plants, the morphology of the plant dictates it as a 'structured' resource. To get to the desired corm-meat one first has to remove the leaves then the corm casing inside which the corm is situated.

This model is extremely important for archaeologists as it predicts and potentially explains variation in the types of resource components transported by central place foragers and it predicts the presence or absence of low utility and high utility components. The high utility component is mostly used or consumed or will decay if abandoned. If low utility components are present the model adds little to conventional interpretations. However, when they are absent archaeologists are not able to determine whether their absence indicates that the resource was never utilised.

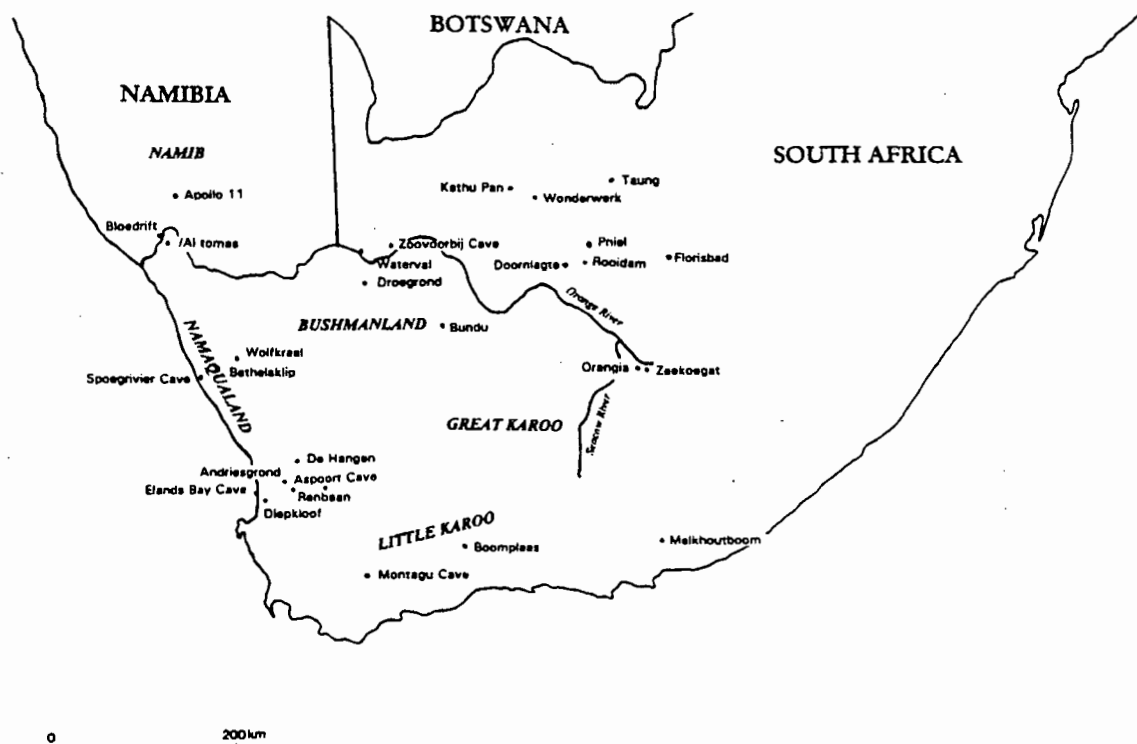


Fig. 1. Map of South Africa showing the location of the sites mentioned in this text (Smith 1999:248).



## **5. Results:**

### Growth of plants

All the plants were separated into different plant components as seen in Table 2. Plates 3-5 show what the plants look like once removed from the ground. From the table it becomes evident that *W. borbonica* leaves grow to an average of 95.54 cm from the Table Mountain population, closely followed by 89.00 cm for *C. aethiopica* from Fish Hoek, while *B. disticha* leaves only grow to a length of 21.60 cm. The fresh mass of leaves is highest in *C. aethiopica* from Fish Hoek with 54.413 g followed by the *W. borbonica* plants from both populations with 35.048 and 34.067 g. *C. floribunda* fits between these two with 30.427 and 24.164 g from Table Mountain and Clovelly respectively. *B. disticha* has the lowest leaf fresh weight at only 1.508 g. Differences amongst the same species in different populations occurs, this is likely to be a result of natural variation within individuals among populations.

The mass of corm casings for the different species gave interesting results. *W. borbonica* had the most corm casing surrounding the corm with 28.820 g from Table Mountain and 40.529 g from Kenilworth. *B. disticha* had the second highest with 5.613 g followed by the *Chasmanthe* species. It was interesting to notice that *C. floribunda* had very little corm casing surrounding the corm. What was immediately evident was how different the texture of the casings of *Chasmanthe* spp. were to the *Watsonia* or *Babiana* species. *Chasmanthe floribunda* had very thin and papery tunic not at all tough and membranous as with *Watsonia*, while *Babiana* had more fibrous corm casings (refer to plate 6). *Watsonia borbonica* tunics were very difficult to remove even when using scissors. *Chasmanthe floribunda* and *Chasmanthe aethiopica* tunics could easily be removed by simply pulling the papery layer off. When looking at the fresh mass of the corms it is surprising to notice that *C. aethiopica* has the largest corm mass of 15.930 g yet it has very little corm casing to protect the corms, as with *C. floribunda*. *W. borbonica* on the other hand seems to invest a lot of corm casing to protect their corms which has a mass of 9.501 g from Table Mountain and 11.159 g from Kenilworth. *B. disticha* seems to

Table 2. Mean values and standard deviations for different plant components for each of the species at each of the population sites

Species	Plant components											
	Root fresh mass (g)	Root dry mass (g)	Corm fresh mass (g)	Corm dry mass (g)	Corm tunic fresh mass (g)	Corm tunic dry mass (g)	Leaves fresh mass (g)	Leaves dry mass (g)	Length of leaves (cm)	Height of corm (cm)	Width of corm (cm)	Depth of corm below soil surface (cm)
<i>Babiana disticha</i> (Camps Bay)	0.057 ± 0.042	0.040 ± 0.028	1.431 ± 0.685	0.640 ± 0.319	5.613 ± 1.929	2.986 ± 1.038	1.508 ± 0.317	0.476 ± 0.775	21.60 ± 4.28	1.05 ± 0.26	1.55 ± 0.33	8.44 ± 2.83
<i>Watsonia borbonica</i> (Table Mountain)	0.754 ± 0.430	0.194 ± 0.121	9.501 ± 6.229	3.206 ± 1.701	28.820 ± 28.000	16.121 ± 15.863	35.048 ± 16.531	5.951 ± 2.787	95.54 ± 12.95	1.61 ± 0.29	4.29 ± 0.91	7.85 ± 1.67
<i>Watsonia borbonica</i> (Kenilworth)	1.146 ± 1.105	0.480 ± 0.464	11.159 ± 4.917	3.788 ± 2.028	40.529 ± 40.788	21.014 ± 19.383	34.067 ± 16.006	5.888 ± 2.671	70.17 ± 8.59	1.79 ± 0.57	4.68 ± 0.71	9.22 ± 2.18
<i>Chasmanthe floribunda</i> (Clovelly)	0.351 ± 0.387	0.128 ± 0.108	8.618 ± 0.275	2.028 ± 1.389	0.220 ± 0.106	0.136 ± 0.178	30.427 ± 12.652	3.935 ± 1.463	71.83 ± 16.21	1.19 ± 0.36	4.45 ± 0.97	7.33 ± 2.14
<i>Chasmanthe floribunda</i> (Table Mountain)	0.307 ± 0.239	0.056 ± 0.048	4.766 ± 6.614	0.693 ± 0.800	0.324 ± 0.262	0.113 ± 0.090	24.164 ± 17.181	3.247 ± 3.218	79.38 ± 13.96	1.25 ± 0.39	3.59 ± 1.34	12.38 ± 2.21
<i>Chasmanthe aethiopica</i> (Fish Hoek)	0.578 ± 0.478	0.237 ± 0.175	15.93 ± 9.882	4.468 ± 2.664	2.673 ± 2.629	2.023 ± 1.931	54.413 ± 26.811	7.577 ± 3.984	89.00 ± 5.40	none	none	9.83 ± 2.63

have a very consistent amount of corm tunics surrounding their corms with a mass of 1.431 g.



Plate 3. A photograph of *B. disticha* once removed from the ground showing corm tunics and leaves still attached.



Plate 4. A photograph of *C. floribunda* with leaves and corm tunics still attached.



Plate 5. A photograph of *Watsonia borbonica* showing the 'structured' morphology of these corm-plants.



Plate 6. A comparison of the tunics amongst the three different species. From left to right: the papery corm casings of *C. floribunda*, followed by the fibrous tunics representative of *B. disticha*, and finally the tough, membranous corm tunics of *W. borbonica*.

Table 1. Geophyte plant species identified from archaeological deposits for 5 sites in the western Cape (Smith 1999:248).

Geophyte sp. recovered	Elands Bay Cave	Diepkloof	Andriesgrond	De Hangen	Renbaan
Antholyza plicata	×				
Babiana sp.	×	×	×	×	×
Boophane sp.	×	×			
Chasmanthe sp.				×	
Cyanella sp.				×	
Dioscorea elephantipes				×	×
Gladiolus sp.	×	×		×	×
Hexaglottis sp.			×		×
Homeria sp.				×	
Hypoxia sp.					
Ledebouria sp.				×	
Moraea cf. fugax	×		×	×	
Oxalis sp.	×		×	×	
Romulea sp.				×	
Veltheimia glauca	×			×	
Watsonia sp.	×	×		×	

#### Degrees of utility for different processing stages

Considering that corms and corm casings were the plant parts recovered in majority of the archaeological deposits (Parkington & Poggenpoel 1971) of the five sites mentioned above, the assumption will be made that processing of the resources did not take place in the field but rather occurred at the home base. The morphology and structure of these corm species dictated that the plants would have under gone three processing stages: first the plant would have to be procured, then the leaves would be removed, then the corm casings would be removed leaving the corm itself which was the final product for consumption. Tables 3(a)-(d) shows the ratio of corm by weight for the three processing stages involved and the remaining waste components after each stage. In the final processing stage of removing the corm tunics the roots were also included, as it was discovered that when the corm casings were removed majority of the roots were removed with it.

When comparing the ratio of corm by weight for the first processing stage, *W. borbonica* has the most units of waste per unit of corm with 7.903 followed by *C. floribunda* with



6.910, then *B. disticha* with 6.712 and finally *C. aethiopica* with 4.851. For the second processing stage *B. disticha* has the highest ratio of waste per unit corm at 5.292. This is due to the relatively small corm in relation to the amount of corm casing. This is followed by *W. borbonica* at 4.159 as a result of the larger corm mass and larger amount of corm casing. *C. floribunda* and *C. aethiopica* have the lowest ratios of waste at 1.1 and 1.253 respectively, because they both have very small amounts of corm casing.

Table 3(a). *Babiana disticha* processing stages and ratio of corm to inedible components (n = 23)

Processing stage	Remaining waste component	Ratio corm by weight
(i) Collect whole plant	Leaves, corm casing and roots	6.712
(ii) Remove leaves	Corm casing and roots	5.292
(iii) Remove corm tunics & roots	None	1

Table 3(b). *Watsonia borbonica* processing stages and ratio of corm to inedible components (n = 30)

Processing stage	Remaining waste component	Ratio corm by weight
(i) Collect whole plant	Leaves, corm casing and roots	7.903
(ii) Remove leaves	Corm casing and roots	4.159
(iii) Remove corm tunics & roots	None	1

Table 3(c). *Chasmanthe floribunda* processing stages and ratio of corm to inedible components (n = 25)

Processing stage	Remaining waste component	Ratio corm by weight
(i) Collect whole plant	Leaves, corm casing and roots	6.910
(ii) Remove leaves	Corm casing and roots	1.100
(iii) Remove corm tunics & roots	None	1

Table 3(d). *Chasmanthe aethiopica* processing stages and ratio of corm to inedible components (n = 10)

Processing stage	Remaining waste component	Ratio corm by weight
(i) Collect whole plant	Leaves, corm casing and roots	4.851
(ii) Remove leaves	Corm casing and roots	1.253
(iii) Remove corm tunics & roots	None	1

### Percentage of mineral nutrients in corms

Total N content (mg/g) amongst the three different species is shown in Fig. 2. *Chasmanthe floribunda* has the highest total N content (a mean of  $20.055 \pm 11.432$  with a range of 6.900 to 37.230), followed by *W. borbonica* (a mean of  $12.156 \pm 5.455$  with a range of 4.812 to 20.225) and *B. disticha* (a mean total N content of  $7.281 \pm 3.053$  with a range of 4.55 to 15.813). There is no significant difference between the three species for total nitrogen content.

Total P content (mg/g) among the three species is shown in Fig. 3. Here *B. disticha* has the highest P levels (a mean of  $2.577 \pm 1.146$  with values ranging from 1.031 - 4.012) followed by *C. floribunda* (with a mean of  $1.080 \pm 0.622$  ranging from 0.066 - 2.206) and *W. borbonica* with the lowest P content (with a mean of  $0.500 \pm 0.184$  with a range of 0.194 - 0.324). There is no significant difference between *C. floribunda* and *B. disticha* or *W. borbonica* but there is a significant difference between *W. borbonica* and *B. disticha*.

For the total non-structural carbohydrates (ug/g), shown in Fig. 4. *B. disticha* has a significantly higher TNC content with a mean of  $178577.103 \pm 35310.664$ , *W. borbonica* has the lowest (a mean of  $40418.971 \pm 5361.743$ ) with *C. floribunda* as the intermediate with a mean of  $44872.32 \pm 9876.806$ . *B. disticha* is significantly different from both *C. floribunda* and *W. borbonica*, but *C. floribunda* is not significantly different from *W. borbonica*.

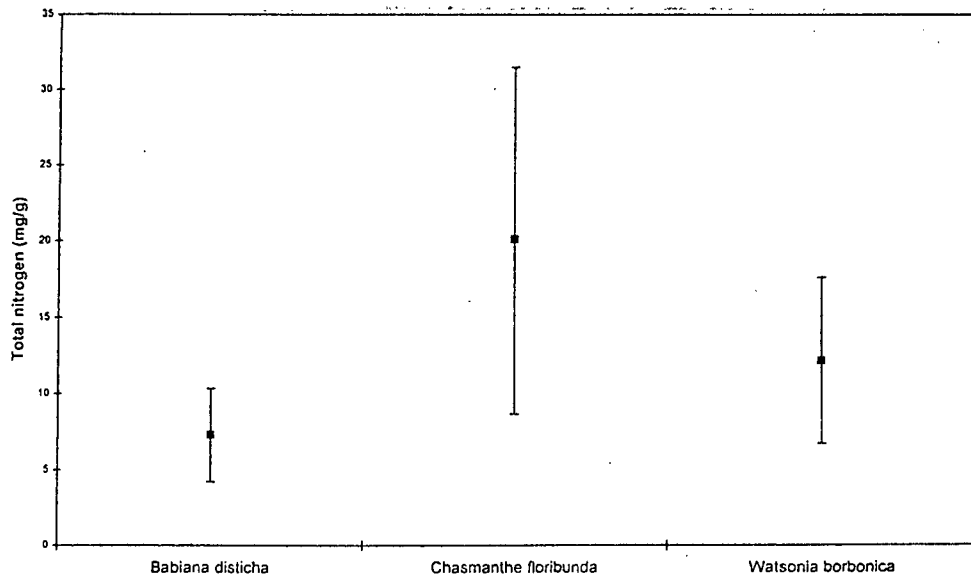


Fig. 2. Comparative levels of total N (mg/g) between *Babiana disticha*, *Chasmanthe floribunda* and *Watsonia borbonica*.

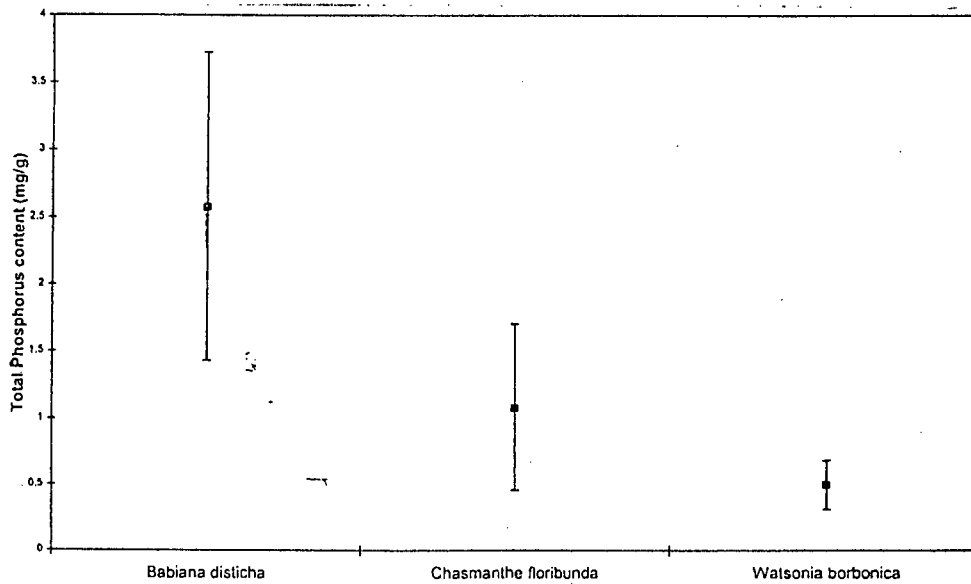


Fig. 3. Total P levels (mg/g) amongst *Babiana disticha*, *Chasmanthe floribunda* and *Watsonia borbonica*.

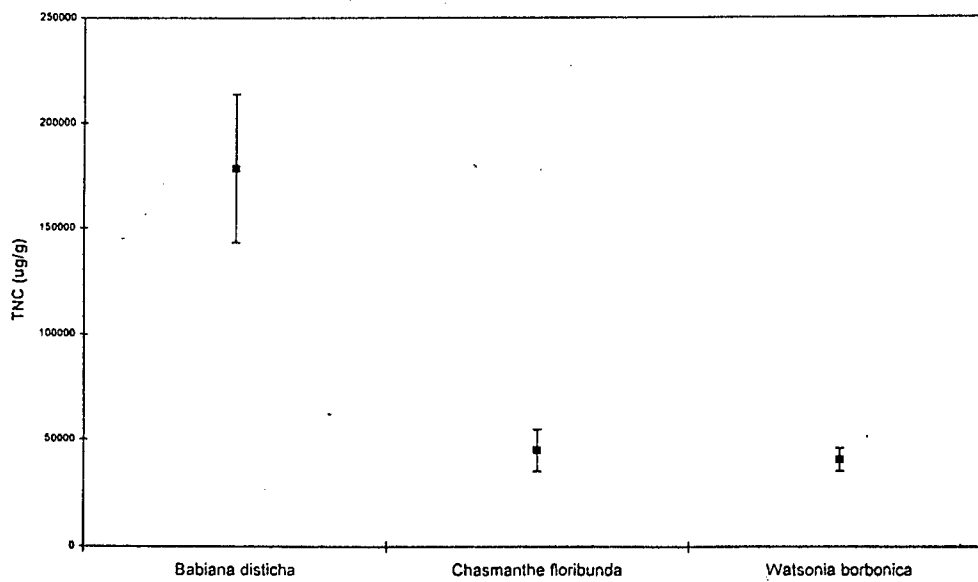


Fig. 4. Allocation of total non-structural carbohydrates ( $\mu\text{g/g}$ ) between *B. disticha*, *C. floribunda* and *Watsonia borbonica*.

## **6. Discussion:**

When looking at Table 2 it becomes apparent that the total leaf fresh mass for *Watsonia* and *Chasmanthe* constitute a considerably large portion by weight of the total plant mass. Leaf lengths are also quite dramatic, ranging from approximately 70 to 95 cm for *W. borbonica* and 70 to 90 cm for *Chasmanthe* spp. Logic would dictate that if foragers were to procure these plants it would be cumbersome and restricting to carry bunches of these plants with leaves ranging from 0.7 to 1 m, so as to get to the corms that only have dimensions of approximately 2 cm × 5 cm for *W. borbonica* and 1 cm × 5 cm for *C. floribunda*. When collecting these plants I found it extremely cumbersome to carry them whilst the leaves were still attached and it greatly increased the weight of the load. The leaves are low utility parts and reduce the quality of the transported load. As Metcalfe and Barlow (1992) stated in their transport model, foragers would make field-processing decisions economically and efficiently. Foragers would try to maximise the resource load relative to the time spent procuring, field processing and transporting. Taking this into account it seems extremely viable to remove the leaves as the plants are procured. The leaves join together at the base in a bulb shape that is in turn attached to the corm. The leaves simply snap off and can be discarded quickly and easily. By doing this the resource load weight will be reduced and the quality of the resource will increase due to the proportion of high utility parts increasing in the load. With the practicality of this procedure and supporting data, indicating that the leaves account for a large portion of the total plant mass, one can assume that this processing stage, i.e. the removal of leaves, occurred in the field, most likely at the site of procurement. It is the most energy efficient strategy. If this was the case, then the archaeological record verifies this as most of the plant remains found are of corms and corm casings.

For *B. disticha* a slightly different strategy might have been employed as in this case the corm and corm tunics constitute most of the plant mass, not the leaves. So the removal of the leaves (which have a mean leaf length of approximately 20 cm ) in the field at the site of procurement for *B. disticha* might have been relaxed, but necessary. Corm plants have

a structured morphology dictating how the plant should be processed. The leaves would have to be removed first and then the husks so as to get to the corm. Perhaps the removal of the leaves took place in the field or perhaps at the camp site. This would depend on other factors such as distance of the resource to the base camp, etc. However, if it took place in the field the quality and quantity of the resource load would be increased.

The ratios for corm tunic fresh masses to corm fresh masses (shown in Tables 3a-d) are greatest for *W. borbonica* and *B. disticha*. *Chasmanthe* spp. proved to have very little corm casings relative to corm weight. From this information alone one would be tempted to assume that the removal of the corm casings for *W. borbonica* and *B. disticha* would also take place in the field, this would be the most cost effective strategy in terms of energy expenditure by the foragers. *Chasmanthe* spp., having so little corm casings would probably be taken back as is, as there is already so little that needs to be removed. The implications is that at archaeological sites *Chasmanthe* spp. are likely to leave the most archaeologically visible residues (under optimal preservation conditions) relative to *B. disticha* or *W. borbonica*. However, what we actually find in the archaeological record is just the opposite. The most prominent corm plant residues recovered from archaeological sites are corms and corm casings. At De Hangen archaeological site *Watsonia*, *Babiana* and *Gladiolus* are the three most common corm tunics respectively. At Diepkloof the order is *Gladiolus*, *Watsonia* and then *Babiana*. *Chasmanthe* spp. tunic remains were only found at De Hangen and at no other sites (Liengme 1987). One has to assume then that the removal of the corm casings, did not take place in the field but rather at the home base which would account for their presence in the deposits. A possible reason for this could be that it was in fact more cost effective for foragers to return to the home base with corms and tunics still intact. One way in which this could be true is if the resources were readily available in large quantities very close to the base camp. All three of these genera, *Babiana*, *Watsonia* and *Chasmanthe* commonly occur in the south-western Cape region today (Innes 1985; Goldblatt 1989; Jeppe 1989; Kidd 1996). *Watsonia* usually grow together in large stands as do *Chasmanthe* (Innes 1985; Goldblatt 1989; Jeppe 1989; Kidd 1996). It is highly probable that these plants literally grew on their door-steps, ripe



for the picking. *Babiana* plants do not grow in dense stands/colonies as do the others, but they still occur in patches on the landscape with individual plants being in close proximity to each other.

If this were the case, then it would imply that *Babiana* and *Watsonia* would be more visible in the archaeological record, under optimal preservation conditions, as is the case. This trend could also be associated with the nature of these corm tunics. The high utility components, corms, were consumed or if left would, more often than not, decompose. The low utility components such as corm tunics are more likely to survive if conditions are favourable. In the case of the three species under investigation, *Babiana* and *Watsonia* have tough fibrous and tough membranous tunics, respectively, while *Chasmanthe* has papery tunics. This would suggest that *Chasmanthe* tunics are less likely to survive the archaeological record and so would be less representative of the species.

*Chasmanthe floribunda* was found to be significantly different from *B. disticha*, but not *W. borbonica* with regard to total non-structural carbohydrates (Fig. 4). This significant difference could be related to the fact that *B. disticha* plants had already begun to set seed at the time of their collection. For N and P content (Fig. 2 & 3) *C. floribunda* was not significantly different from either *B. disticha* or *W. borbonica*. The mineral content of corms in terms of nitrogen and phosphorous showed that there was no real significance between the three species. In this case, mineral content did not appear to be an indicator of relative dietary importance (potentially explaining *Chasmanthe* spp. absence in the archaeological record).

There seems to be no reason to indicate that *C. floribunda* was not collected and utilised by early foragers. *C. floribunda*, like *W. borbonica*, grow in large stands. This means that foragers would be able to collect large quantities of corms from one colony, reducing their energy expenditure of walking around the landscape trying to locate corm plants, which is more likely to occur with *B. disticha* as these plants do not grow together in stands. Secondly, when looking at the corm dimensions of the three species, one notices

that *C. floribunda* corm as very similar to those of *W. borbonica* in size, but considerably larger than those of *B. disticha*. There would be no reason to suggest that *C. floribunda* was not collected on this basis. Thirdly, the mineral content of *C. floribunda* was very similar to that of *W. borbonica*. The mineral content of *Watsonia* and *Babiana* must have been sufficient for foragers to have collected their corms. On this basis the same should apply to *C. floribunda*. Caloric values from previous studies indicate that *Babiana* spp. were extremely similar to *Watsonia* spp. *Babiana dregei* and *Babiana hypogea* received values of 16.54 and 16.45 kJ/g respectively. *Watsonia* spp. were found to give values of 16.31. These values are even higher than potatoes with 15,73 kJ/g (Archer 1982). I think that if *Chasmanthe* spp. were to be tested the caloric values would be rather similar to that of *Watsonia* and *Babiana*.

It seems then that the intra-site patterning of these corms, amongst the different genera, is related to field processing and field processing decisions made by the foragers. Differences in the types and quantities of plant remains in archaeological sites may reflect variations in the amount of time people spent removing low utility, but archaeologically visible plant parts (as well as the preservation potential of these low utility parts). From the little data that has been documented in this report it appears that the three species have different quantities of low utility parts and in different ratios, which in turn would be more likely to result in certain patterns within an archaeological record. For *W. borbonica* the ratio of total leaves and bulk corm tunics are present in equal amounts. For *C. floribunda* plants there is a higher ratio of leaves by mass and a small ratio of corm casings, while, *B. disticha* plants have a large ratio of corm tunics and a small ratio of total leaves relative to the mass of the plant.

At this stage all that can be said is that processing and processing-decisions provide the best possible reason why *Chasmanthe* spp. plant remains are absent from the archaeological record and there seems to be no reason at this early stage to suggest that *C. floribunda* would not have been harvested for their corms. There seems to be a trend between utility indices, field processing and the intra-site patterning seen in sites today.

To achieve more precise predictions of field processing and its potential effects on intra-site patterning of *Chasmanthe* spp., changes in utilities associated with processing time for the resources should be developed and utility functions of caloric values of these resources at different processing stages should be calculated. Growth and nutrients should be more closely monitored more closely throughout the life-cycle of the plants and any experimentation done should take place at the same life-cycle stages between and within species. Another area that should be addressed is the relative palatability of these corm as there have been some indications, historically, that this potentially affected decision-making for preference of one species over another.

## **7. Conclusion:**

What was most marked in this investigation was how different the utility indices were between the three species of *Babiana disticha*, *Watsonia borbonica* and *Chasmanthe floribunda*. From this alone one would expect different intra-site patterns resulting between *Watsonia borbonica*, *Babiana disticha* and that of *Chasmanthe floribunda* as each would leave different quantities of plant waste in archaeological deposits. Low utility indices are able to predict the presence or absence of low utility components of plant resources. Predictions can now be made for plant resources which are absent from the archaeological record or that leave no visible traces, as their utilities can still be measured. Utility indices for *B. disticha* and *W. borbonica* do seem to correlate to some degree with the intra-site patterning of plant residues at Elands Bay Cave, Andriesgrond, Diepkloof, Renbaan and De Hangen. More precise investigation need to be tackled before any real results can used and inferences made for *Chasmanthe floribunda* or other *Chasmanthe* species.

## **References:**

1. Allen, S.E. (edt). 1989. Chemical analysis of ecological materials. Oxford: Blackwell Scientific.
2. Archer, M. F. 1982. 'n Voorstudie in verband met die eetbare plante van die Kamiesberge. *Jl S. Afr. Bot* 48(4):433-449.
3. Barlow, K.R. and Metcalfe, D. 1996. Plant utility indices: Two Great Basin examples. *Journal of Archaeological Science* 23: 351-371.
4. Buchanan, W.F. 1987. pp:192-211. Calories in prehistory IN: Parkington, J. and Mall, M. (eds). Papers in the prehistory of the western Cape, South Africa. Part I, Bar International Series 332: Great Britain.
5. Bremner, J.M. 1965. Total nitrogen. IN: Black, C.A (edt). Methods of soil Analysis, American Society of Agronomy. Madison: Wisconsin.
6. Bremner, J.M. & Mulvaney, C.S. 1982. Chap. 31. Total nitrogen. IN: Page, A.L., Miller, R.H. & Keeney, D.R. (eds). Methods of soil analysis, Part 2 (second edition). Madison: Wisconsin USA.
7. Goldblatt, P. 1989. The genus *Watsonia*. National Botanic Gardens: Cape Town
8. Grimshaw, H.M. 1987. pp:92-95. The determination of total phosphorus in soils by acid digestion. IN: Rowland, A.P. (edt). Chemical analysis in environmental research. Institute of Terrestrial Ecology: Huntingdon.
9. Innes, C. 1985. The world of iridaceae. Holly Gate International Ltd.: Great Britain.
10. Jeppe, B. 1989. Spring and Winter flowering bulbs of the Cape. Oxford University Press: Cape Town.
11. Kidd, M.M. 1996. Cape Peninsula. Botanical Society of South Africa: Kirstenbosch.
12. Liengme, C. 1987. pp:237-263. Botanical remains from archaeological sites in the western Cape. IN: Parkington, J.E. and Hall, M. (eds). Papers in the prehistory of the western Cape, South Africa. Part I, Bar International Series 332: Great Britain.
13. Metcalfe, D. and Barlow, K.R. 1992. A model for exploiting the optimal trade-off between field processing and transport. *American Anthropologist* 94: 340-356.
14. Parkington, J.E. 1972. Seasonal mobility in the Late Stone Age. *African Studies* 31: 223-243.

15. Parkington, J.E. and Poggenpoel, C. 1971. Excavations at De Hangen, 1968. South African Archaeological Bulletin 26: 3-36.
16. Smith, A.B. 1999. pp:243-256. Hunters and herders in the Karoo landscape. IN: Dean, W.R.J. & Milton, S.J. (eds). The Karoo, ecological patterns and processes. Cambridge University Press: UK.
17. Smith, C.A. 1966. Common names of South African plants. Pretoria, Dept. of Agricultural Technical Services.
18. Stephen, A.M. 1995. Food Polysaccharides and their application. Marcel Dekker: New York.
19. Thomas, D.H. 1989. Archaeology. Holt, Rinehart and Winston, INC: USA.

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