

2011

BOLUS LIBRARY

C31 0000 1201



*Preliminary analysis of charcoal deposits from Spitzkloof Rockshelter,
Richtersveld - South Africa, in relation to current vegetation of the area*

Kirsten Packer

Supervisors: Timm Hoffman, Edmund February

Dissertation presented in partial fulfilment of the requirements for the degree of Bachelor of Science
(Honours) in the Department of Botany, UCT, December 2011.

KD PACK

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.

Abstract

Spitzkloof Rockshelter, located in the desert Richtersveld, is currently being excavated by the AMEMSA (Adaptations to Marginal Environments in the Middle Stone Age) archaeological team as part of a larger investigation. An abundance of charcoal was found during the excavation. The aim of this project was to analyse the charcoal deposits to determine what the main genera found in the excavated charcoal were and if the charcoal deposits relate to modern species composition in areas surrounding Spitzkloof Rockshelter. Charcoal fragments from context/layer 1 and 2 of the excavation were sampled, 100 fragments and 34 fragments respectively. To identify the fossil charcoal fragments, a modern reference collection was established by collecting wood from species surrounding the rockshelter, charring this wood and creating transverse sections by a manual fracturing method. Fossil charcoal fragments were microscopically compared to the modern references by observing wood anatomical features. An abundance ranking was given to species currently found at the site, relative to *Zygophyllum* sp., as it was the most abundant species. Context 1 contained five species that were present at Spitzkloof currently (*Zygophyllum*, *Stoeberia*, *Euclea*, *Acacia* and *Solanum*). *Zygophyllum* was the most abundant species, comprising 26%. Context 2 contained five species that were currently present at Spitzkloof (*Zygophyllum*, *Stoeberia*, *Euclea*, *Acacia* and *Lycium*). Interestingly, *Stoeberia* was the most abundant species comprising 48%. Context 1 contained six charcoal types that did not match any of the modern reference charcoal, while context 2 contained five unknown types. Species composition of context 2 may be different to context 1 either due to a long period between the depositions (accurate dating needed), allowing for environmental change to affect the vegetation, or may be the signature of a 'hearth' feature. As many of the 'unknown' types were somewhat similar to the modern references, it is suggested that for further investigations, large branches and small twigs are sampled for the modern reference, as well as wood from different individuals and different localities, to be able to evaluate variability of wood anatomy within a species.

Introduction

Spitzkloof Rockshelter, located in the coastal desert region of the Richtersveld, is currently being excavated by the AMEMSA (Adaptations to Marginal Environments in the Middle Stone Age¹) archaeological team as part of a larger investigation. The AMEMSA project was developed to explore how early modern humans adapted to marginal environments (characterised by spatially and temporally unpredictable or variable resources) especially during the ecologically challenging Upper Pleistocene, ± 126 thousand years ago (Dewar and Stewart 2011). The project is focused on two regions in southern Africa: the desert Richtersveld and the Lesotho highlands, where rockshelters with Upper Pleistocene sequences have been identified, Spitzkloof Rockshelter being one of them (Dewar and Stewart 2011). Previous investigations into the development of behaviourally modern humans have been geographically biased, focusing on the coastal Fynbos area which is not a marginal environment, and so this project hopes to correct this bias (Dewar and Stewart 2011). Regarding the Spitzkloof excavation, the AMEMSA team aims to reconstruct the environmental conditions under which early modern human foragers were able to colonise the Richtersveld (Dewar and Stewart 2011). They will begin to interpret what subsistence, settlement, technological and social strategies used to adapt to stresses of living in this marginal environment. During the excavation of Spitzkloof Rockshelter, an abundance of charcoal was found and it is hoped that these fragments could play a role in the larger investigation.

Charcoal deposits are common/abundant in most southern African archaeological sites and so represent an important source of information on vegetation surrounding the archaeological sites (Tusenius 1986). These charcoal deposits are derived from the collection of wood for fire by the inhabitants of the site. Inhabitants may choose the wood randomly or for specific purposes such as light, cooking or warmth. The wood is most likely collected from a general area surrounding the site and so naturally, the fossil charcoal remains should reflect the composition of the woody vegetation surrounding the site, to an extent. As the fossil charcoal remains are usually deposited in stratigraphic layers, changes in the relative abundance of certain taxa across these layers should reflect changes in the woody vegetation surrounding the site. In other words regional climatic changes are bound to affect the ecological requirements of plants surrounding the site, leading to certain species being less or more abundant and available for collection. Therefore, the main aim of fossil charcoal analysis is to obtain data on vegetation history and climatic change of the specific archaeological site.

Modern wood samples are needed to provide reference/comparative material for the identification of fossil charcoal (Tusenius 1986). Information on the current distribution and ecological requirements of the species is also necessary. Charcoal is identified by microscopically analysing wood anatomical features which are distinctively combined in different species. These distinct patterns can be observed on either the transverse/cross section or on the longitudinal section as there are two anatomical cell systems in wood – axial (vertical) and radial (horizontal), in terms of the orientation of the long axis of a cell. Vessels and tracheids, which are part of the axial system, conduct water and dissolved mineral salts

from the roots to the leaves. Fibres, also part of the axial system, provide mechanical support for the plant. Parenchyma tissue can either be axial or radial (otherwise known as 'rays') and mainly function in the storage of food reserves. Ultimately fossil charcoal is compared and matched to modern wood charcoal.

Charcoal analysis is not without faults; certain factors may affect the abundance of species in the charcoal deposit and interpretation of palaeoclimate (Tusenius 1986). As previously mentioned, inhabitants of a site may preferentially choose wood for certain burning properties. This could obviously lead to an overestimation of the relative abundance of certain species and an underestimation of other species. Wood of different species may preserve dissimilarly over time. Hardwoods may preserve for much longer than very brittle, soft wood species, again leading to an overabundance of the better preserved species, and an underestimation of soft wood species. Furthermore, a single piece of charcoal under pressure from above layers may fragment into smaller pieces, leading to a seemingly 'greater' abundance of this species. Charcoal analysis is, however, definitely feasible within certain boundaries of precision. The analysis needs to focus on gross changes in woody vegetation and environmental/climatic changes over thousands, not hundreds, of years. Also, the use of independent proxy evidence from the same site, such as mammal fauna bones or pollen, greatly increases the reliability of a charcoal analysis.

The use of proxies, such as charcoal analysis, to determine palaeoclimates and environments is crucial especially to the winter rainfall zone (WRZ) of southern Africa, an area that is likely to be sensitive to climate change (Cowling *et al.* 1999). Proxy evidence of past environmental changes may guide estimations of future environmental changes – vital in terms of the region's unique biodiversity (Chase and Meadows 2007). Also, the region was a probable hotspot for human evolution, so archaeological projects exploring this, such as the AMEMSA project, will benefit from data on past environmental changes. Reconstructions of past environments within the WRZ have been hindered by the semi-arid climate coupled with strong seasonality, which has prevented the preservation of most organic material used as proxies (Chase and Meadows 2007). The Namib Desert and Namaqualand/Richtersveld are thought to have been established 10 to 7 million years ago due to the formation of the Benguela upwelling system. The Namib Desert has maintained arid characteristics since its formation, only varying between semi and hyper-arid (Dewar and Stewart 2011). But have environmental changes occurred across Namaqualand and the Richtersveld, especially during the last glacial? It is well-known WRZ temperatures during the last glacial were cooler (opposed to warmer interglacials), but moisture levels across the region may have increased, in contrast to the general global decrease in moisture (Chase and Meadows 2007). It is proposed that an equatorial shift in mid-latitude cyclone systems, due to the expansion of the Antarctic ice shelf during the last glacial, could have lead to a larger distribution and higher frequency of cold fronts/rainfall over the WRZ (Chase and Meadows 2007). The question is how far northwards did this increased moisture extend, in relation to Namaqualand and the Richtersveld?

Pollen and charcoal evidence from Elands Bay Cave (West Coast) indicate that conditions during the last glacial period were wetter and cooler (Cowling *et al.* 1999; Parkington *et al.* 2000). The records show a

dominance of afromontane forest elements and some fynbos elements during the last glacial, compared to current xeric karroid and strandveld vegetation. Pollen evidence from Pakhuis Pass (N. Cederberg) also suggests a wetter last glacial, where mountain fynbos existed compared to a mosaic of fynbos, thicket and succulent vegetation currently (Scott and Woodborne 2007a, 2007b). Interestingly, pollen records from the high mountains of the central Cederberg are stable across the last glacial/interglacial boundary, consistently indicating mountain fynbos (Quick et al. 2011; Meadows and Sugden 1991). It is suggested the mountainous region is climatically stable and most likely received constant rainfall across the glacial/interglacial boundary. At Boegoeberg (N. West Coast), the identification of bones belonging to blue wildebeest and southern reedbuck is indicative of a moister climate because these species require more dense vegetation than is currently present (Klein *et al.* 1999). Although this evidence is unquestionable, the site could not be dated accurately to a particular cold period, therefore may be of older origin than the last glacial maximum. Although studies of macro-faunal remains at Apollo 11 (S. Namibia) show few changes in species since the last glacial (except the key disappearance of the 'large zebra' *Equus capensis*), a measure of 'mean ungulate body mass' indicates that the carrying capacity (therefore primary productivity) was higher during the last glacial (Thackeray 1979). Clearly more palaeo-evidence from the Namaqualand/Richtersveld area is needed.

The aim of this project was to analyse charcoal deposits from the Spitzkloof Rockshelter, by comparing fossil charcoal to modern charred wood and identifying to genus level. We aimed to determine what the main genera found in the excavated charcoal were and if the charcoal deposits relate to modern species composition in areas surrounding Spitzkloof Rockshelter.

Methods and Materials

Study Area

Spitzkloof Rockshelter (28° 51' 47.4" S; 17° 04' 39.162" E) is located in the Richtersveld, Northern Cape of South Africa, roughly 30 kilometres inland from the Atlantic Ocean and 30km south of the Orange River (Figure 1) (Dewar and Stewart 2011). The landscape around the rockshelter is desolate; composed of quartz gravel plains, Pleistocene-derived red sand sheets or dunes and rocky gorges or hills (Mucina and Rutherford 2006; Dewar and Stewart 2011). The actual rockshelter is one of three consecutive dome-shaped hollows that have been eroded out of an outcrop of folded quartzite (Dewar and Stewart 2011) (Figure 2).

The rockshelter directly overlooks a perennial tributary of the Holgat River. Most perennial rivers in the area only flow once a decade at most, unless an unusual amount of rainfall is received. The defining factor of this arid region is precipitation. The mean annual precipitation ranges between 60mm and 120mm, falling predominantly in winter (Mucina and Rutherford 2006). Coastal fogs, although not as frequent as along the coast, can extend 90km inland, up to the escarpment, and are a crucial form of hydration for desert fauna and flora (Mucina and Rutherford 2006; Dewar and Stewart 2011). Average maximum temperatures exceed 30°C during summer, while contrastingly winter minimums are below 0°C (Dewar and Stewart 2011).

The Richtersveld in general is part of the diverse Succulent Karoo biome. Spitzkloof Rockshelter is located in an area/vegetation unit of the Succulent Karoo biome defined as 'Lekkersing Succulent Shrubland' by Mucina and Rutherford (2006). The landscape surrounding the rockshelter is dominated by leaf-succulent dwarf shrublands, similar to those found at low altitudes on the Richtersveld central mountains (Mucina and Rutherford 2006). Within the 'Lekkersing Succulent Shrubland' vegetation unit, coastal vegetation elements can be found, such as *Stoeberia beetzii*, while *Zygophyllum* species can be dominant in disturbed areas (Mucina and Rutherford 2006). At the Spitzkloof Rockshelter, it was noted that a *Stoeberia* species was dominant on the slopes just below and next to the rockshelter, while a *Zygophyllum* species was dominant in and along the tributary river bed – a place of disturbance. Larger species such as *Acacia karroo* are only found along river beds, including the tributary river below Spitzkloof Rockshelter (Dewar and Stewart 2011).

Figure 1: The location of Spitzkloof Rockshelter in relation to South Africa (left), the Richtersveld (defined by the Orange River) and the closest settlement Lekkersing (far left). The satellite image below shows the desolate nature of the landscape surrounding the rockshelter, and the proximity of the rockshelter to a perennial tributary river.

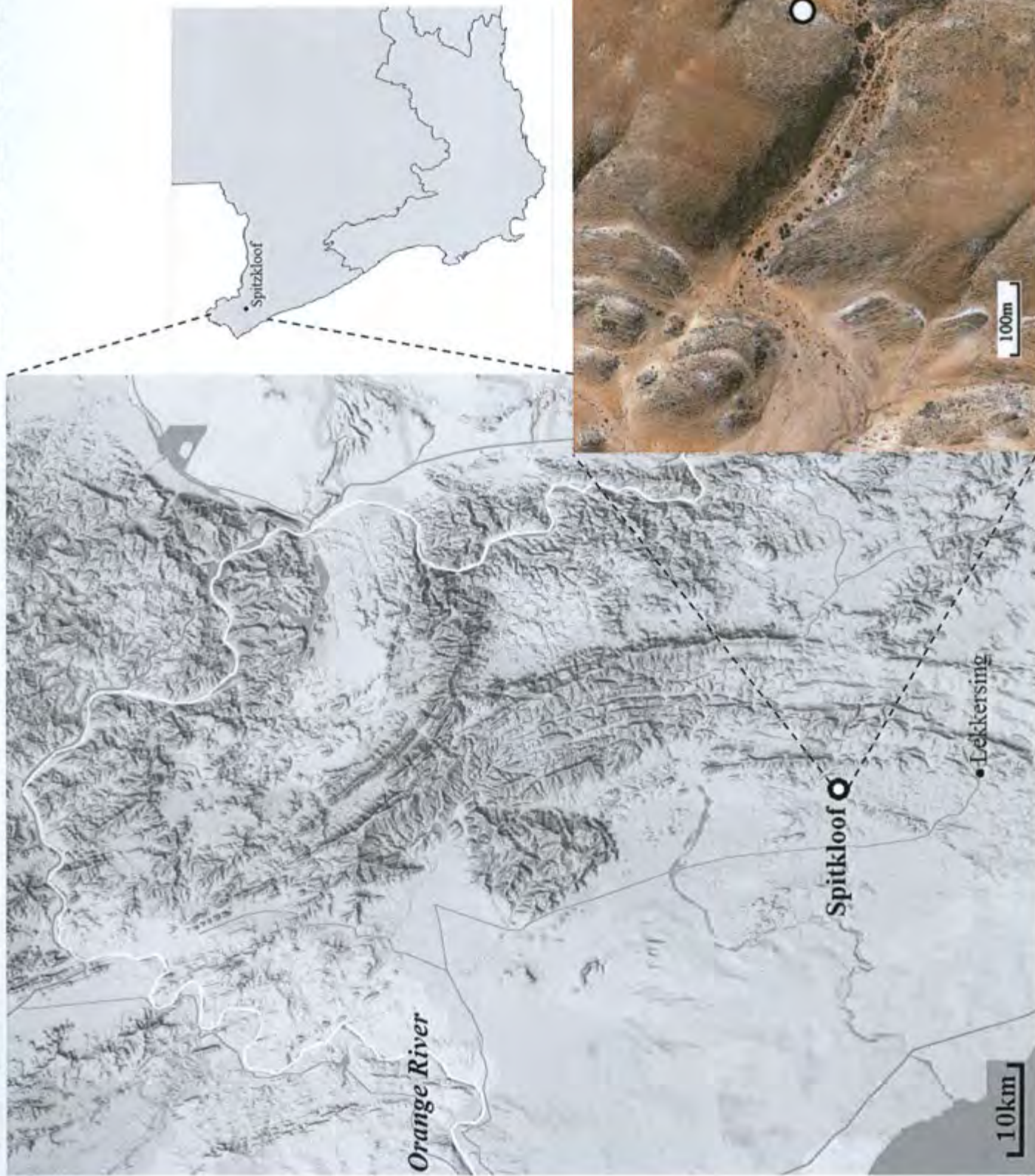




Figure 2: Photograph of the front of Spitzkloof Rockshelter showing the three consecutive dome-shaped hollows and dry river bed. The excavation took place in the largest, dome, closest to the river (Dewar and Stewart 2001).

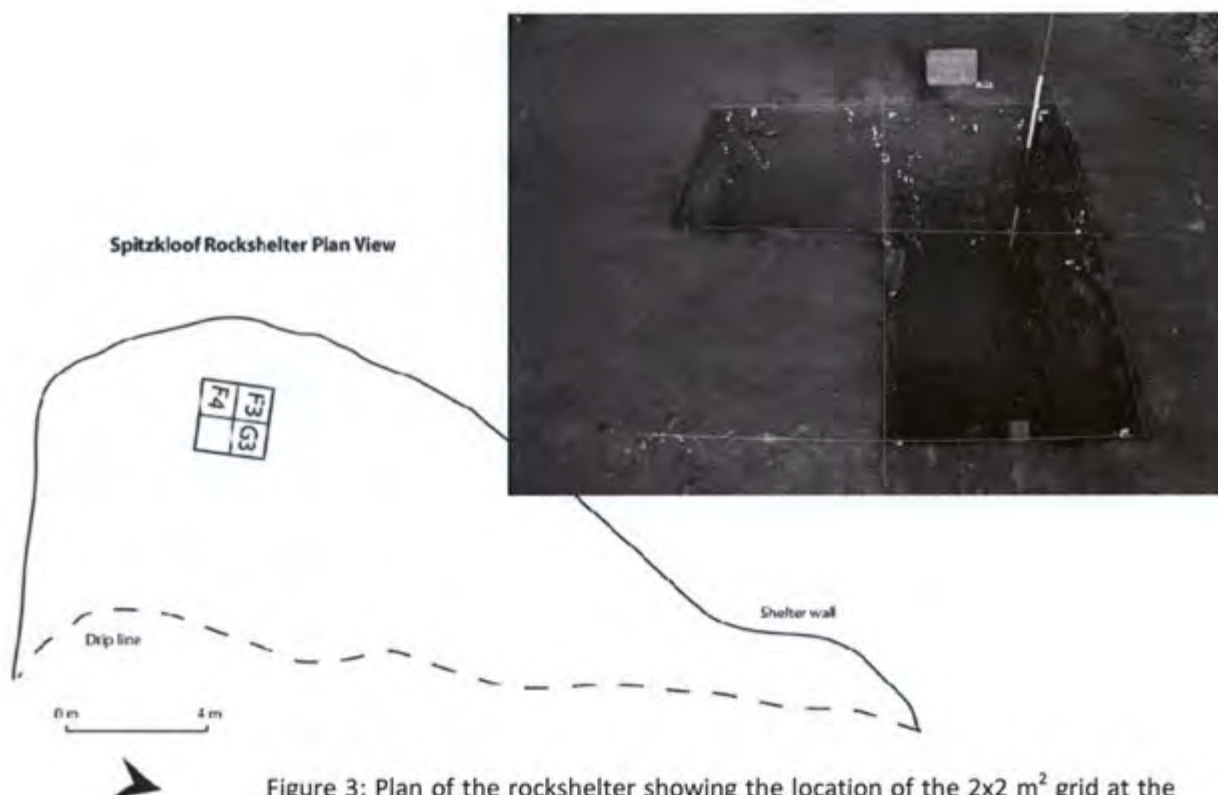


Figure 3: Plan of the rockshelter showing the location of the 2x2 m² grid at the back of the cave, with a photograph showing the 3 square meters that were excavated (Dewar and Stewart 2001).

Excavation of Spitzkloof Rockshelter (Dewar and Stewart 2011)

The excavation of Spitzkloof Rockshelter A began in April 2010. A 2x2 m² grid was established at the back of the cave, avoiding all remains of modern camping fires. Three square meters were excavated from this grid using 'standard archaeological methods' (Figure 3). The sediment collected was sieved through 3mm and 1mm mesh to collect the smallest artefacts, which were bagged on site. In archaeological terms, 9 layers were sampled in which 20 'context changes' were noted; thicker 'contexts' being divided into 'spits' (further divisions). These context changes are identified by a change in the texture or colour of the sediment as well as by artefact inclusions.

Reference Charcoal Collection

To identify the fossil charcoal from the Spitzkloof excavation, a reference/comparative collection of modern wood was needed. Branches from all of the woody taxa surrounding the rockshelter were collected and identified to genus or species level. Each species collected was given an abundance ranking (out of 10) to indicate how the modern vegetation around the rockshelter is structured.

Once collected, the 'modern' wood samples then needed to be charred so that this reference collection could be compared and hopefully matched with the excavated fossil charcoal. A first attempt at charring the modern wood was performed over an open fire. Branches were held over the open fire until assumed to be burnt through. This method, however, was problematic as the wood either tended to form ash immediately or was not entirely burnt through. A further problem encountered was that the wood tended to split, as it was not charred in entirely anoxic conditions, and this splitting caused the distortion or disappearance of the wood anatomical patterns needed for identification (Figure 4). The second attempt at charring the modern wood followed a set method for charcoal studies. Short pieces of branch wood (up to 70mm in length) from each species collected were wrapped in tin foil. The wood samples were then placed in a muffle furnace and charred at 400°C for an hour and a half.

It was decided for this project to only examine the cross-section or transverse section of the wood anatomy. Sections of each specimen were obtained by a manual fracturing method. A shallow ring was scored around the outside of the charred branches using a razor blade (to initiate the break) and the wood was snapped with fingers to expose the transverse surface in a clean break. The razor blade was never used to cut through the entire transverse section as the cells of the wood anatomy would have been damaged. Each genus was examined firstly under a dissecting microscope (light field incident illumination) to examine broad details and then under a dark field microscope to examine finer details. Each genus was defined by unique/diagnostic arrangement and combinations of the cells which make up the wood anatomy system. The specific features looked at were: vessel size, shape and arrangement (single or combined; diffused or ring porous), axial parenchyma and ray parenchyma (Figure 5). The sections of each species were photographed under a Nikon Stereoscopic Zoom Microscope with a Nikon DS Camera head (highest total magnification – 112.5x with a camera resolution of 2560 x 1920).

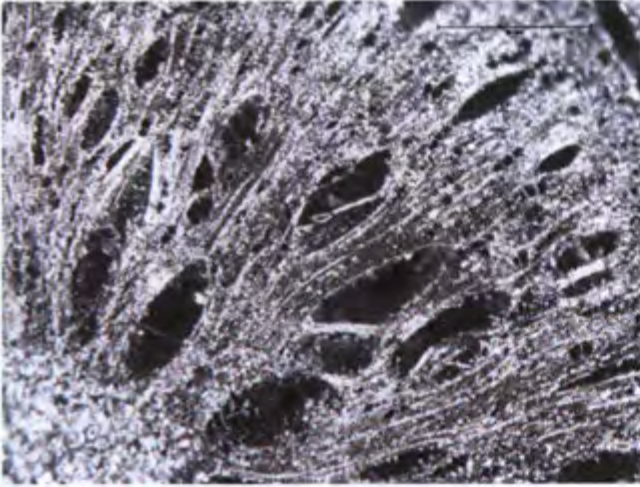


Figure 4: The first attempt at charring the modern wood samples over an open fire lead to the wood splitting, and causing the distortion or disappearance of the wood anatomical patterns needed for identification.

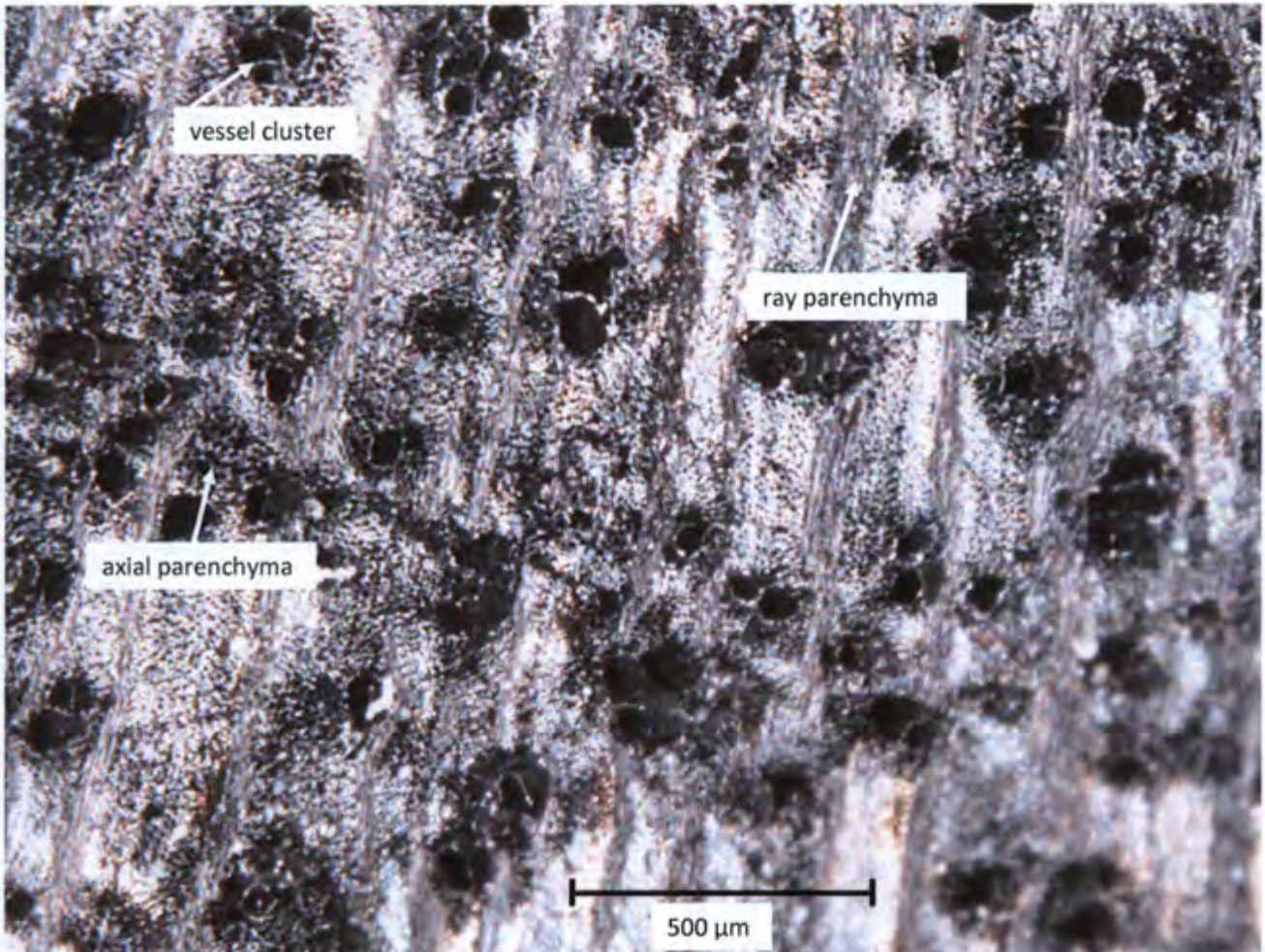


Figure 5: Each genus from the modern wood collection was defined by unique/diagnostic arrangement and combinations of the cells which make up the wood anatomy system. This photograph is an example of three of these features on *Acacia karroo*.

Fossil Charcoal Sampling

The first two contexts below the ground surface were sampled for this project, in other words contexts 1 and 2. The 'context' was therefore taken to be the most meaningful sub-sample division. Fossil charcoal from these two contexts was sampled from the combined three square meters excavated (G3, F3, F4) and all 'spits' were ignored as this division is too fine to represent any meaningful changes in the environment. We aimed to sub-sample 100 fragments of charcoal from context 1 and 2 respectively. 100 fragments were randomly sub-sampled from context 1, ensuring that fragments of all sizes were sampled. However, only 34 fragments were obtained from context 2 as it did not contain a substantial amount of fossil charcoal fragments – every fragment was sampled.

A number of techniques have been used to examine fossil charcoal. Some of these techniques involve the embedding of charcoal, for example in wax or resins, which can then be polished or a thin section taken by microtome (Leney 1975; Tusenius 1986). These embedding processes are however very time-consuming. Manual fracturing is a far more efficient method that produces similar results to the embedding method, so a larger sample of fossil charcoal can be examined in a shorter time. Therefore, transverse sections of the fossil charcoal were prepared using the manual fracture method previously mentioned. In some cases, odd-shaped fragments were cut longitudinally to create a suitable shape for transverse breaking. The sections of fossil charcoal were mounted in 'Prestik' on glass slides and were examined using the dissecting and dark field microscopes. The fossil charcoal sections were identified to genus level through comparison to the reference collection.

Results

The abundance ranking of the species currently found at Spitzkloof Rockshelter was given relative to *Zygophyllum* sp., as it was the most abundant species at the site and was ranked 10 (Figure 6). Besides the *Zygophyllum* species, fourteen other woody species were collected from the site, but some species had more substantial wood than others. For example: *Acacia karroo*, *Boscia albitrunca*, *Euclea pseudabenus*, *Lycium oxycarpum* and *Ozoroa dispar* were large shrubs; while *Dyerophytum africanum*, *Haembstadia glauca* and the *Portulacaria* sp. were small shrubs with insubstantial woody material. In the case of *Solanum* sp. and *Rhus* cf. *erosa*, only one individual was seen in the area. It was also noted that a couple of species, *Acacia karroo* and *Solanum* sp., were thorny.

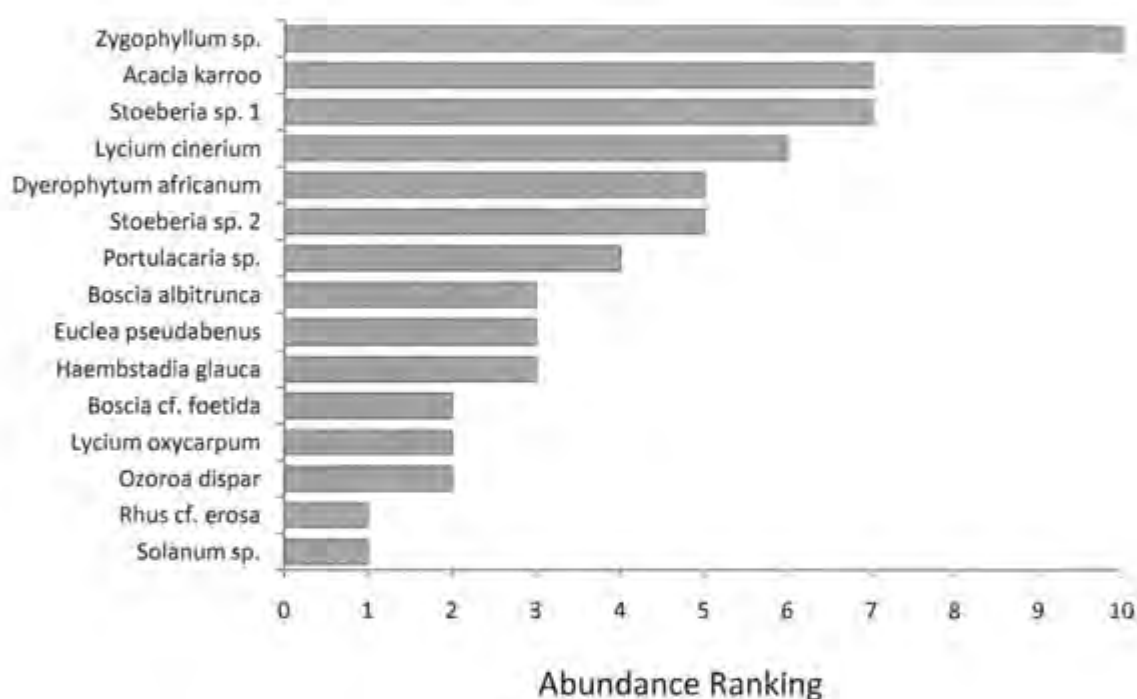


Figure 6: **Modern** woody species found at Spitzkloof Rockshelter, Richtersveld - South Africa, and their abundances at the site relative to the most abundant *Zygophyllum* sp.

Context 1 from the archaeological excavation of Spitzkloof Rockshelter contained 21 packets of fossil charcoal, which were sub-sampled to obtain 100 fragments. Therefore, the number of fragments per species identified within this sub-sample represented a 'percentage' of the total context. The context contained five species that were present at Spitzkloof currently (*Zygophyllum*, *Stoeberia*, *Euclea*, *Acacia* and *Solanum*) (Figure 7). The context also contained six charcoal types that did not match any of the modern reference charcoal. *Zygophyllum* was the most abundant species, comprising 26% of context 1. 'Zygophyllum-type' and *Stoeberia* were also abundant in context 1. *Euclea* was interestingly the fourth most abundant species in the context (14%), compared to the modern vegetation where it was given a ranking of 3, therefore not particularly abundant in the landscape today.

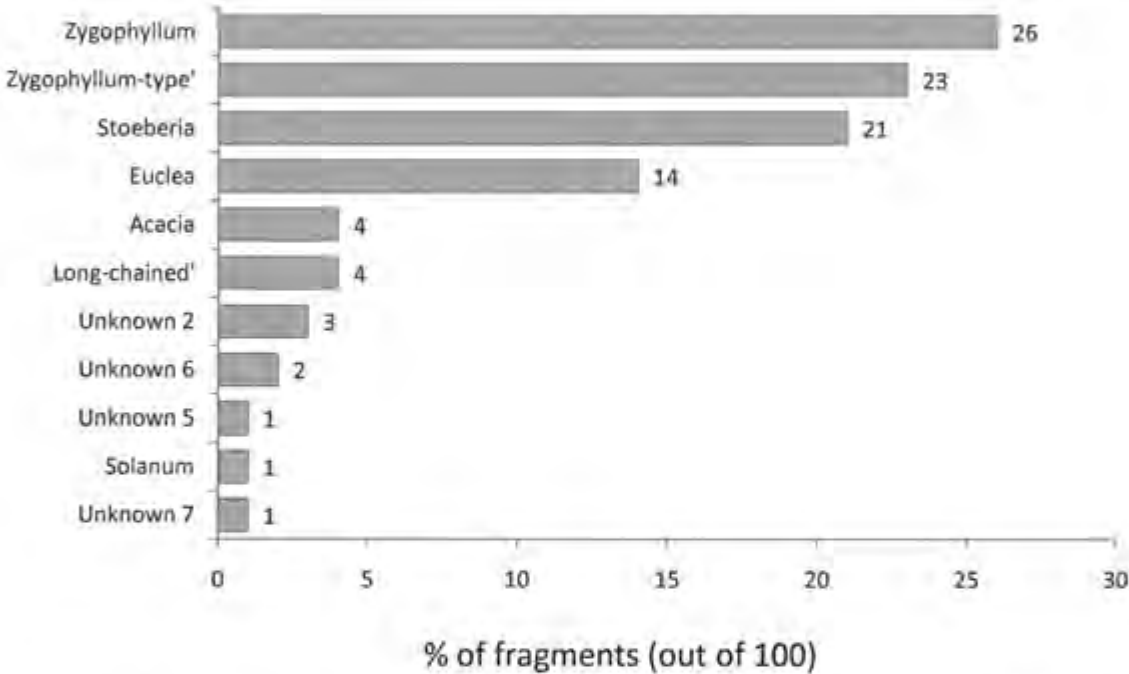


Figure 7: Species found in **context 1** of the archaeological excavation at Spitzkloof Rockshelter, Richtersveld - South Africa. Numbers next to the bars show species presence within the context, as a percentage.

Context 2 from the archaeological excavation of Spitzkloof Rockshelter contained only 7 packets of fossil charcoal to be sampled. Only 34 fossil charcoal fragments were obtained from this context, so the total percentage was calculated as the number of fragments per species identified out of 34. The context contained five species that were present at Spitzkloof currently (*Zygophyllum*, *Stoeberia*, *Euclea*, *Acacia* and *Lycium*) (Figure 8). The context also contained five charcoal types that did not match any of the modern reference charcoal, they will be described later. Interestingly, *Stoeberia* was the most abundant species, comprising 47% of context 2. *Acacia* (12%) was slightly more abundant than context 1, while contrastingly, *Zygophyllum* (9%) was considerably less abundant than context 1.

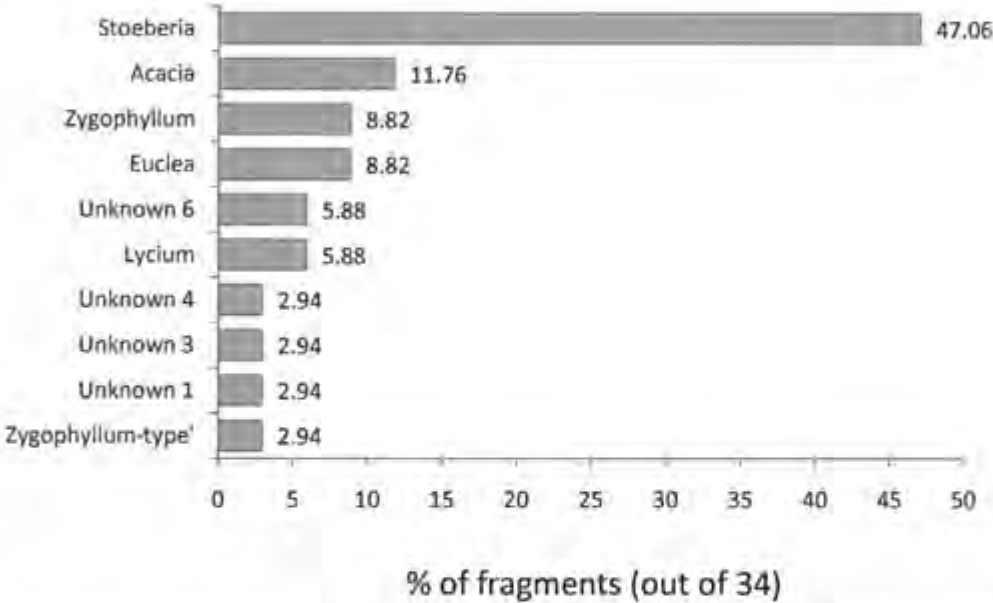


Figure 8: Species found in **context 2** of the archaeological excavation at Spitzkloof Rockshelter, Richtersveld - South Africa. Numbers next to the bars show species presence within the context, as a percentage.

Photographs of the modern charred wood reference collection as well as descriptions of the charcoal fragments which did not match any of the modern species collected can be found in the appendix.

Discussion

This aim of this investigation was to determine what the main genera found in the excavated charcoal were and crucially, if the charcoal deposits relate to modern species composition in areas surrounding Spitzkloof Rockshelter. Current species collected from the Spitzkloof site were able to be identified in context 1 and 2 of the charcoal deposits. Further examination of the deeper contexts to determine past species compositions is, therefore, feasible. Further investigation should aim to confer the preliminary results from the archaeological side of the investigation. The results, from the deepest two layers, reflect an arid to semi-arid environment (Dewar and Stewart 2011). Macrofaunal remains indicate a similar composition of dry-adapted species to that found today in the landscape. The decrease in gypsum crystals in these layers, and the discovery of a couple of land snail (*Trigonephrus* sp.) shells suggests the environment may have been slightly more humid than present.

It is difficult to interpret the results from context 1 and 2 in terms of past species composition and how it relates to the 'past environment' mainly due to the fact that material from the excavation at Spitzkloof has not been accurately dated yet. In other words, context 1 and 2 may only be a couple of hundred years old and if this is the case, one would not expect the species composition to have changed considerably since then. If, however, context 1 and 2 are say a couple of thousand years old and the species composition of these layers is similar to the current species composition of the area, this would be a significant result. Dating of the excavation contexts is vital to be able to 'place' the evidence from these contexts in palaeoenvironmental history (specific events such as the LGM or Holocene Altithermal). Two bone samples from the archaeological excavations were sent for radiocarbon dating, but the collagen component of the bone was too degraded to give accurate dates (Dewar and Stewart 2011). Collagen may be degraded by leaching or burning, but these specific bone samples did not show signs of this. Rather, Dewar and Stewart (2011) interpret this protein degradation as a sign that the bone samples are older than 20kya. Dewar and Stewart (2011) plan to collect sediment samples for OSL (Optically Stimulated Luminescence) dating and various teeth and ostrich eggshell fragments for thorough AMS (radiocarbon) dating. These dates will definitely aid further investigations of the charcoal deposits.

Charcoal fragments from context 1 and 2 could only be identified to genus level because species from the same genera in the modern reference collection displayed extremely similar wood anatomical patterns (see Appendix photographs, specifically *Stoeberia*, *Lycium* and *Boscia*). It must be noted that from the two contexts sampled, roughly 80 fragments of charcoal were 'discarded' and could not be identified (out of 134 fragments). Many of the fragments were not 'clean' breaks so certain anatomical features were not displayed (when fractured), or fragments were inundated with dust and consolidated sand that clogged vessels making them indistinguishable. Many of the charcoal fragments from context 1 were so brittle/rotten that they just crumbled when fracturing. As the fossil charcoal was formed in an open fire, not anoxic conditions, some of the fragments displayed splitting similar to Figure 4. It is

possible that many of the 'unknown' charcoal types were in fact one of the modern reference collection species, because many of the 'unknown' types displayed similar anatomical patterns to a specific reference species, but that they were not identified as such because of preservation complications. If this is the case, it might be expected that the species composition of either context is inaccurate (problematic for interpretations of past environments). The large sample size of context 1 should correct this inaccuracy; however, the sample size of context 2 was small. Context 2 was seemingly different to context 1 in terms of species composition. If context 1 was deposited a short time after context 2, a similar species composition would be expected (again, accurate dating of the contexts would solve this matter). Consequently, the difference between context 1 and 2 may be due to either a long period between depositions, allowing for environmental change to affect the vegetation, or may be the signature of a 'hearth' feature (fire pit/fireplace). Tusenius (1986) and Allott (2006) indicate that hearth features need to be sampled separately, as there may be substantial inter-hearth variability even within the same stratigraphic unit. Therefore, in this investigation, context 2 may be a deviation from the actual vegetation surrounding the rockshelter at that time, if a fire was made in a confined area using specifically *Stoeberia* wood, and the excavation happened to remove this 'hearth'.

Three suggestions for future investigation into the Spitzkloof Rockshelter charcoal deposits, regarding the modern reference collection, can be made. Firstly, branch thickness was not taken into account when collecting the woody species. Tusenius (1986) states that she collected a variety of branch sizes for the modern reference collection, in other words from twigs to thicker branches. This would allow for the evaluation of the variability of the wood anatomical structure of a specific species. For example, 'Zygophyllum-type' resembled the reference *Zygophyllum* in every aspect except vessel size – vessels were much larger. The collection of a variety of branch sizes would enable the identification of 'Zygophyllum-type' as either a different species or as *Zygophyllum*. Secondly, modern wood should be collected from a number of individuals per species, again to evaluate variability, and from the same species growing in different areas, to assess anatomical variation due to somewhat different environmental conditions (Tusenius 1986). Thirdly, the actual describing of the modern species wood anatomical features should be more rigorous/stringent, taking into account more features and actually measuring some of the features. In addition, the current species composition of the area needs to be surveyed with a method that would give data on actual abundances (counts or percentages), rather than just a ranking, so that the modern vegetation can be statistically compared to the excavation contexts.

In order to begin making inferences about past environments from the charcoal deposits, the ecological requirements of the current woody species at Spitzkloof needs to be explored. It would be very useful if taxa that are habitat or niche-specific can be identified, as this would allow for fairly detailed descriptions of past environments. For example, the Atlas Cedar (*Cedrus atlantica*) of north Africa grows under a well-defined climate envelope, such that temperatures and precipitation of past environments can be determined according to the fluctuation of cedar pollen within lake cores (Cheddadi *et al.* 2009). A long-term decline in pollen from the Clanwilliam Cedar (*Widdringtonia cederbergensis*), a habitat-

specific species found in the Cederberg (Western Cape), within a Driehoek Vlei core is interpreted as a transition from a cooler, wetter glacial period into a warmer, drier Holocene (Chase and Meadows 2007). Distributions of the Spitzkloof woody species could possibly be determined from herbarium records, and coupled with climate data from the area to make inferences about ecological requirements. Parkington *et al.* (2000) make use of vegetation categories/assemblages to display trends through the charcoal record at Eland's Bay Cave. For example they identified an 'afromontane assemblage' occurring before 20kya, which consisted of species that are intolerant of prolonged summer drought, suggesting an extended winter rainfall period over the area – an environment extremely different to the current landscape. Many of these afromontane species are only found today in forests along the south coast of South Africa. If certain groupings of species can be made at Spitzkloof, especially if deeper contexts contain unique species not found in today's landscape, overall trends in palaeoenvironments may become clearer. Another potential area of investigation is how the percentage of *Acacia karroo* changes throughout the excavation, as it has been noted that there has been a significant increase in riparian vegetation cover over the last 100 years across the WRZ, the most important species being *Acacia karroo* (Hoffmann and Rohde 2011).

Possible human-derived biases in the charcoal deposit may be understood through the questioning of what today's local people consider good fuel woods (Allott 2006). During this investigation, when burning the modern wood over an open fire, it was noted that certain species burn far more readily than other species. For example it was noted that the *Zygophyllum* sp. burned extremely well – catching alight instantaneously and burning for a substantial period. As *Zygophyllum* was common in context 1, it would be important to determine if this is a signal of selection or actual species composition in the landscape.

In conclusion, this preliminary study of the charcoal deposits of Spitzkloof Rockshelter indicates that there is the potential to gather important information about palaeoenvironments in this region of the Richtersveld, through detailed charcoal analysis.

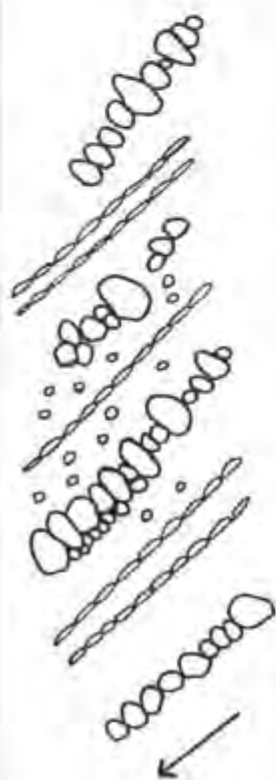
References

- Allott, L.F. 2006. Archaeological charcoal as a window on palaeovegetation and wood-use during the Middle Stone Age at Sibudu Cave, *South African Humanities* **18**(1): 173 – 201.
- Chase, B.M. and Meadows, M.E. 2007. Late quaternary dynamics of southern Africa's winter rainfall zone. *Earth-Science Reviews* **84**: 103 – 138.
- Cheddadi, R., Fady, B., Francoic, L., Hajar, L., Suc, J.P., Huang, K., Demarteau, M., Vendramin, G., G., and Ortu, E. 2009. Putative glacial refugia of *Cedrus atlantica* deduced from Quaternary pollen records and modern genetic diversity. *Journal of Biogeography* **36**(7): 1361 – 1371.
- Cowling, R. M., Cartwright, C.R. Parkington, J.E. and Allsopp, J.C. 1999. Fossil wood charcoal assemblages from Elands Bay Cave, South Africa: implications for Late Quaternary vegetation and climates in the winter-rainfall fynbos biome. *Journal of Biogeography* **26**: 367-378.
- Dewar, G. and Stewart, B.A. 2011. Preliminary results of excavations at Spitzkloof Rockshelter, Richtersveld, South Africa. *Quaternary International* (in press): 1 – 10.
- Hoffmann, M.T. and Rohde, R.F. 2011. Rivers through time: Historical changes in the riparian vegetation of the semi-arid, winter rainfall region of South Africa in response to climate and land use. **44**: 59 – 80.
- Klein, R.G., Cruz-Urbe, K., Halkett, D., Hart, T., Parkington, J.E. 1999. Paleoenviromental and human behavioral implications of the Boegoeberg 1 Late Pleistocene hyena den, Northern Cape Province, South Africa. *Quaternary Research* **52** (3): 393 – 403.
- Leney, L. 1975. Simplified procedure for examining charcoal specimens for identification. *Journal of Archaeological Science* **2**: 153 – 159.
- Meadows, M.E. and Sugden, J.M. 1991. A vegetation history of the last 14,000 years on the Cederberg, southwestern Cape Province. *South African Journal of Science* **87** (1-2): 34–43.
- Mucina, L. and Rutherford, M. 2006. *The vegetation of South Africa, Lesotho and Swaziland*. South African National Biodiversity Institute: Pretoria. pg 238.
- Parkington, J., Cartwright, C., Cowling, R.M., Baxter, A., Meadows, M. 2000. Palaeovegetation at the Last Glacial Maximum in the Western Cape, South Africa: wood charcoal and pollen evidence from Elands Bay Cave. *South African Journal of Science* **96** (11- 12): 543 – 546.
- Quick, L.J., Chase, B.M., Meadows, M.E., Scott, L., Reimer, P.J. 2011. A 19.5 kyr vegetation history from the central Cederberg Mountains, South Africa: Palynological evidence from rock hyrax middens. *Palaeogeography, Palaeoclimatology, Palaeoecology* **309**: 253 – 270.
- Scott, L. and Woodborne, S. 2007a. Pollen analysis and dating of Late Quaternary faecal deposits (hyraceum) in the Cederberg, Western Cape, South Africa. *Review of Palaeobotany and Palynology* **144**: 123 – 134.
- Scott, L. and Woodborne, S. 2007b. Vegetation history inferred from pollen in Late Quaternary faecal deposits (hyraceum) in the Cape winter-rain region and its bearing on past climates in South Africa. *Quaternary Science Reviews* **26**: 941 – 953.
- Thackeray, J.F. 1979. An analysis of faunal remains from archaeological sites in southern Southwest Africa (Namibia). *South African Archaeological Bulletin* **34**: 18 – 33.
- Tusenius, M.L. 1986. The study of charcoal from some southern African archaeological contexts. South Africa: University of Stellenbosch (MA Thesis).

Acknowledgements

Firstly, I would like to thank Timm Hoffmann for giving me this project, and for collecting the current woody species from Spitzkloof. I thank Ed February for his help in guiding the technical aspects of the project. Big thanks to Tony Verboom and Jeremy Midgley for giving me an extension to be able to finish this project. I would also like to thank the NRF for funding support.

Appendix

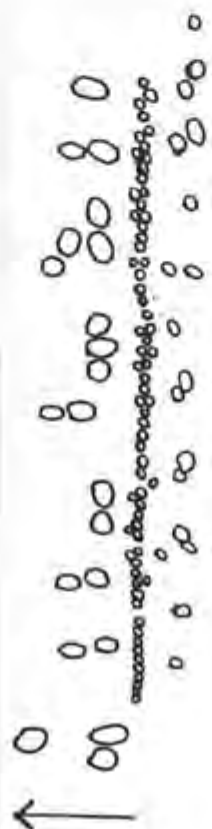
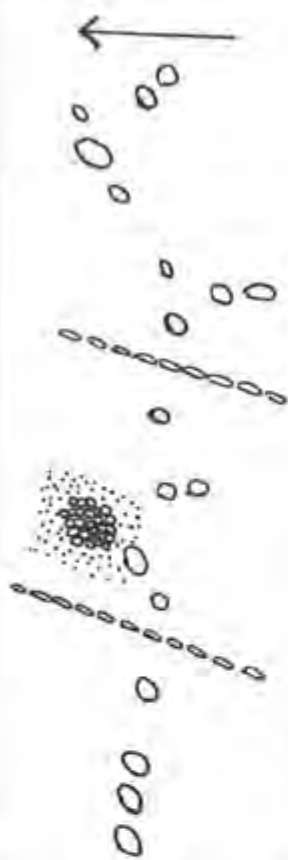


Long Chained:

Many rays, 1 cell thick
Scattered axial parenchyma
> 6 vessels mostly forming long chains, few vessels single or double (as opposed to *Euclea*)

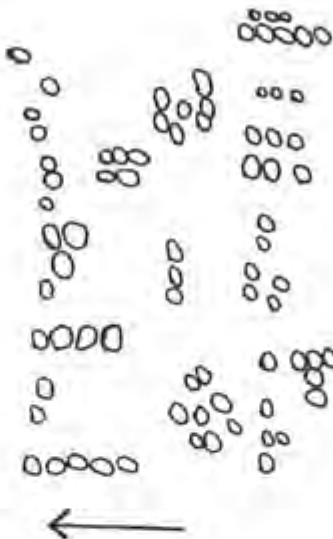
Unknown 1:

Vessels single (as opposed to *Solanum* which tends to have groups of vessels)
Vessels show no clear evidence of forming rings (as in *Zygophyllum*)
Axial fibres/parenchyma are more evident than the reference *Zygophyllum*



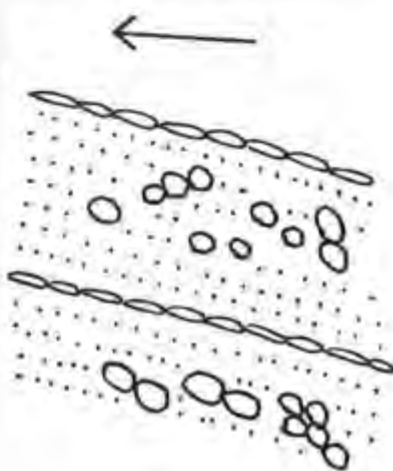
Unknown 2:

Vessels do not form such a clear ring pattern as in *Zygophyllum*
Axial parenchyma (not evident in reference *Zygophyllum*) form rings



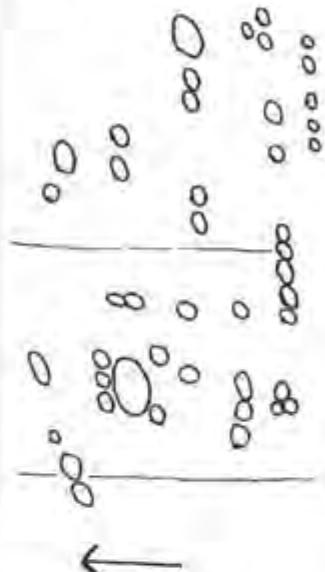
Unknown 3:

Unlike any reference species collected
Vessels are arranged in a diffuse manner
Vessels either chained (4-8) or clustered (2-3)
Rays are 1 cell width



Unknown 4:

Could possibly be 'young' *Lycium*
Vessels form small clusters, but do not quite form the waves seen in reference *Lycium*
Rays are very structured, one cell width
Axial parenchyma between the vessels are arranged in straight lines

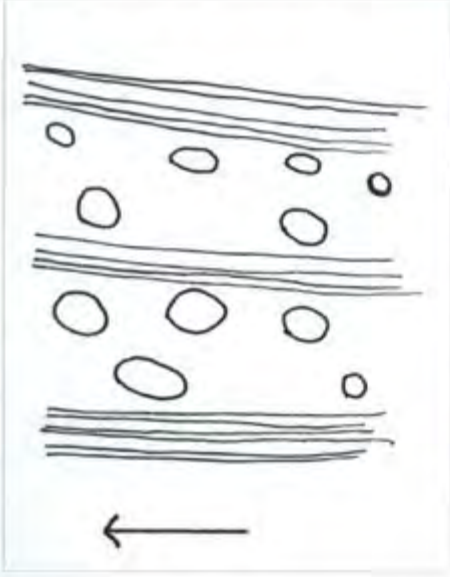


Unknown 5:

Indistinct rays
Vessels are semi-diffuse, 1 ring was visible while other vessels, were single, double or formed diffuse clusters.

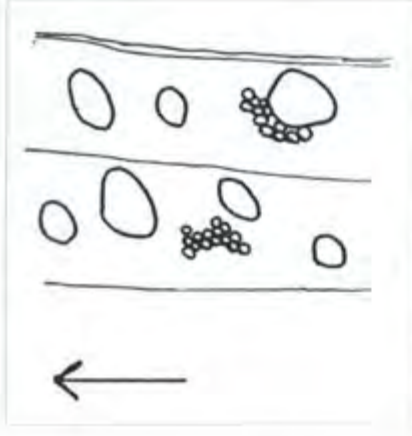
Unknown 6:

Large, single vessels (as opposed to *Ozoroa* which has more vessel clusters)
No evidence of axial parenchyma (as opposed to *Acacia*)
Rays are multiple, small cells (as opposed to *Ozoroa* where rays are 1 cell width)



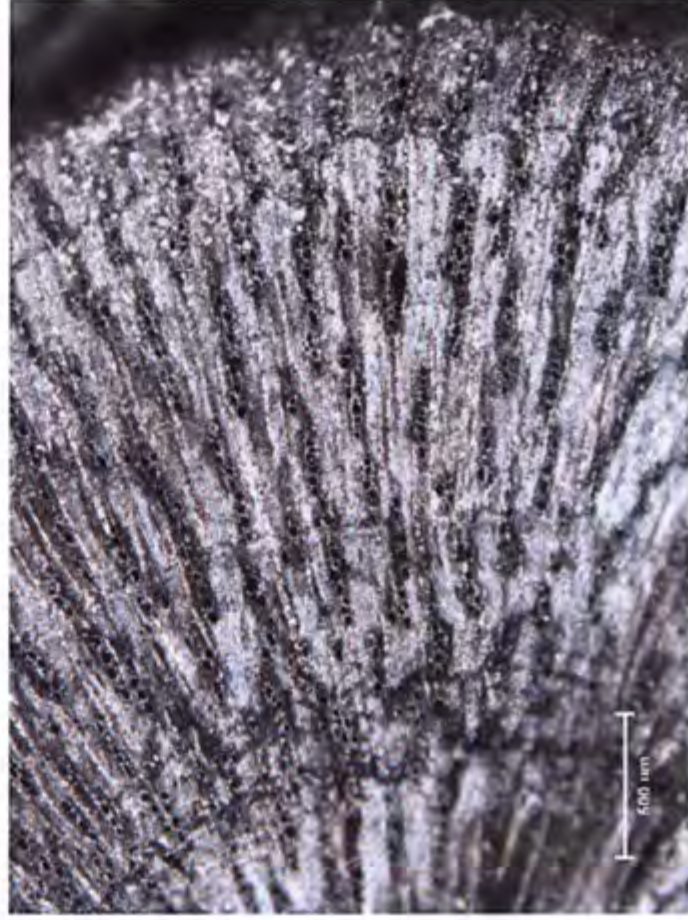
Unknown 7:

Similar to Unknown 6, but rays are unclear, most likely 1 cell width and certainly not multiple celled



Acacia karroo:

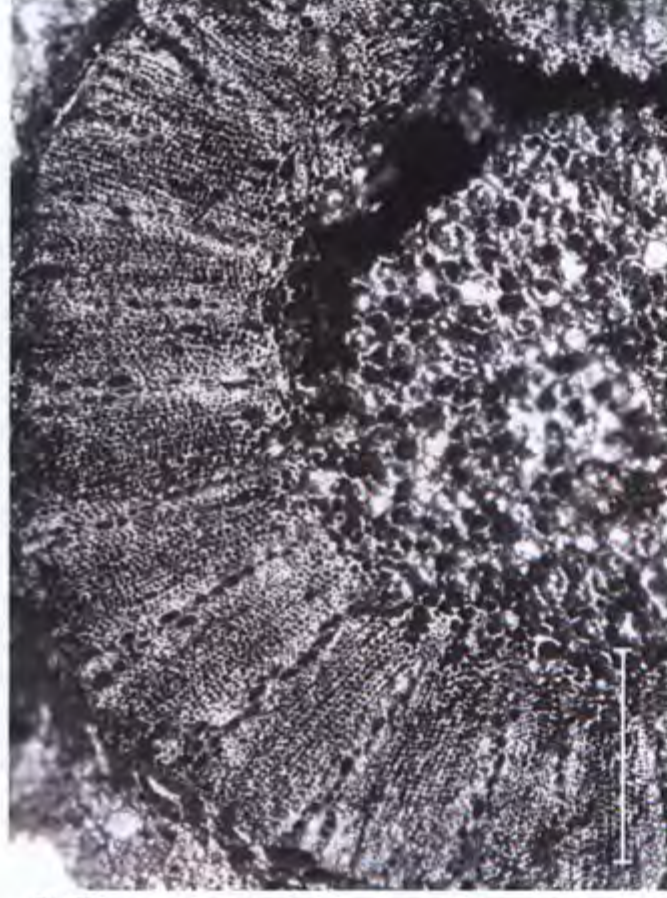
Vessel individual or in clusters of 2, semi-diffuse
Rays quite wide > 4 cells
Axial parenchyma tissue around vessels



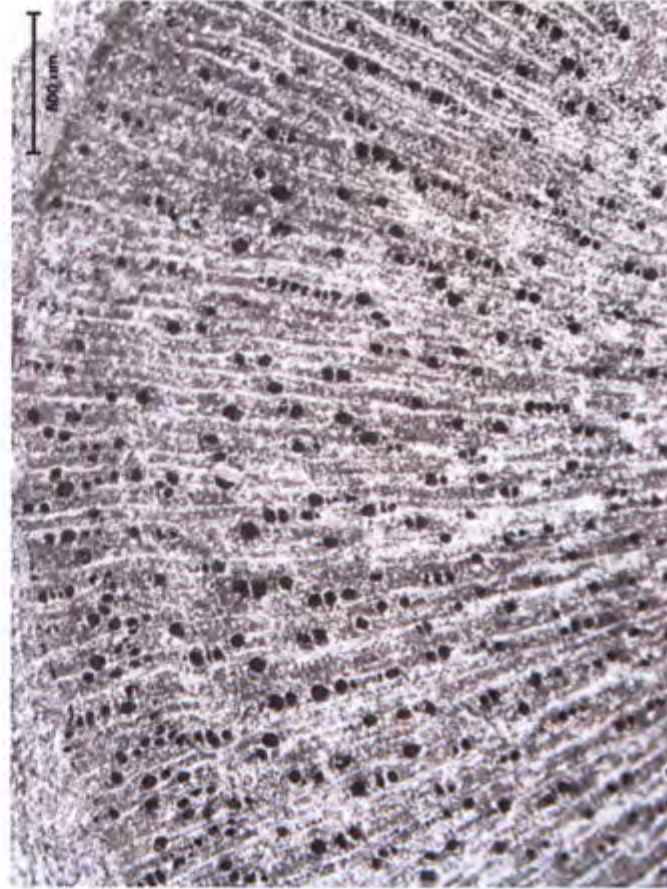
Boscia albitrunca



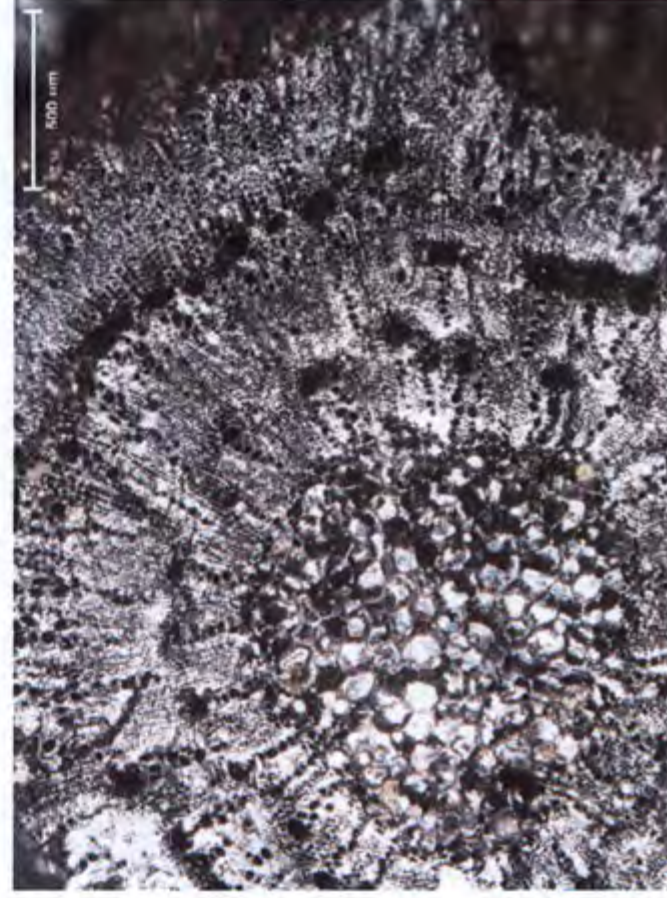
Boscia cf.
foetida



Dyerophytum
africanum



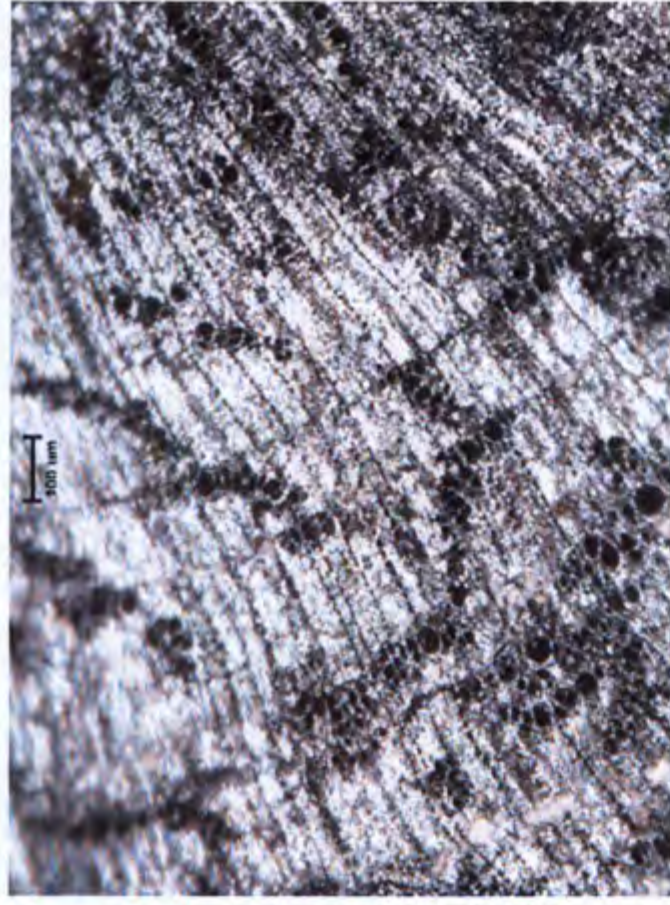
Euclea
pseudobambus:
Rays 1 cell width
Vessels mostly
single or double,
some form chains
Axial parenchyma
scattered



Haembstadia
glauca

Lycium cinereum:
Cluster of vessels
forming distinct
waves
Axial parenchyma
form straight lines

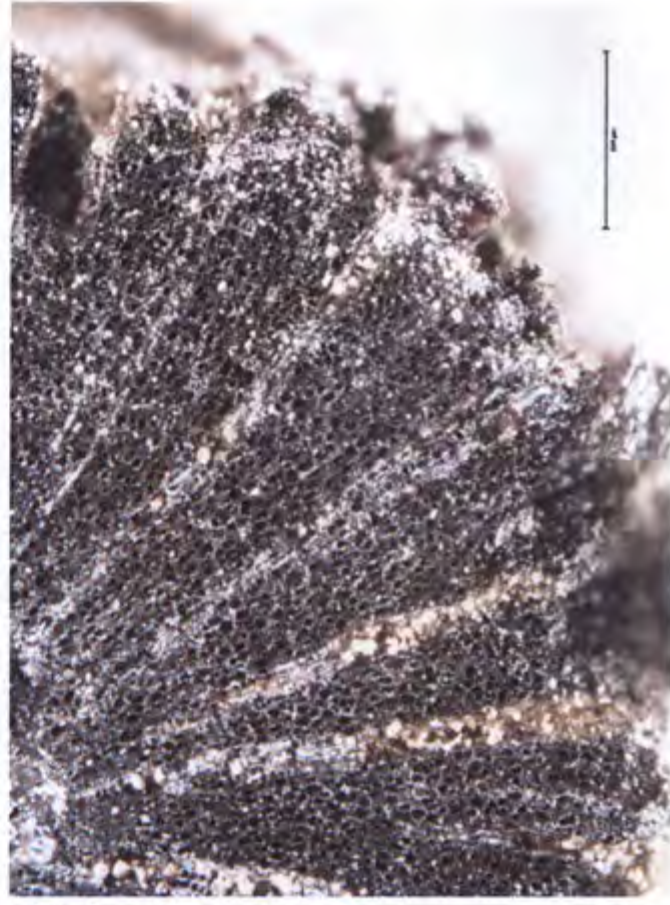
Lycium
oxycarpum



Ozoroa
dispar



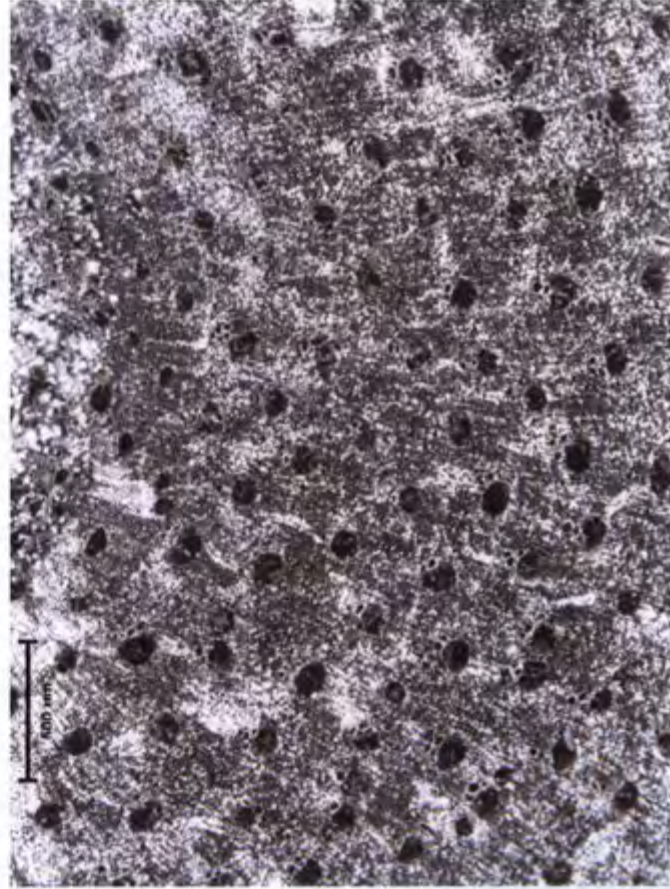
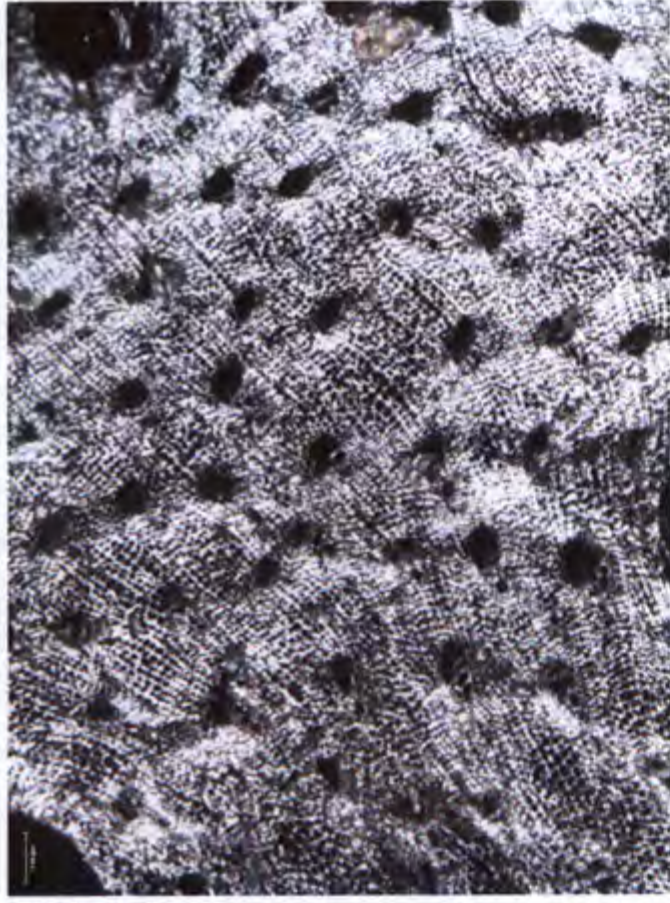
Portulacaria
sp.





Solanum
sp.

Stoeberia sp. 1:
Very large, single
vessels surrounded by
unique parenchyma
patterning



Stoeberia
sp. 2.

Zygophyllum
leptopetalum:
Vessels arranged in rings
Very fine fibres

