ANALYSIS AND INTERPRETATION OF BOTANICAL REMAINS FROM SIBUDU CAVE, KWAZULU–NATAL

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A dissertation submitted to the Faculty of Science, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the Degree of Master of Science

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DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

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Signature of candidate

…….. day of …..…………… 2005

ABSTRACT

The identification and analysis of seeds (including fruits and nuts) from second millennium AD deposits at Sibudu Cave, KwaZulu-Natal, constitute the first in-depth archaeobotanical study of seeds in South Africa. The study highlights problems in the reconstruction of past vegetation and climatic variables from seed data. The Sibudu seed assemblage produced no evidence to suggest vegetation change in the Sibudu area during the last 1000 years. Either it is not possible to identify short-term fluctuations in indigenous vegetation from seed data, or the evidence of vegetation change has been masked by the influence of the perennial Tongati River, depositional history, differential preservation and recovery, and identification difficulties. Actualistic studies of seeds on the cave floor, the first of such studies in South Africa, indicated a range of non-human agents of seed accumulation and post-depositional redistribution. Definitive statements about people/plant relationships are problematic because of the number of agents of seed accumulation.

This dissertation is dedicated to all undaunted researchers who pursue and enjoy archaeobotanical studies.

‘*It is by studying little things that we attain*
the great art of having as little misery and
as much happiness as possible’

Samuel Johnson

ACKNOWLEDGEMENTS

Without the support, encouragement and time given patiently and generously by my supervisor, Prof. Lyn Wadley, this study would not have been initiated or completed. I give her my sincere and grateful thanks. I gratefully acknowledge financial aid from the University of the Witwatersrand Bursary Fund and the National Research Foundation.

The research and completion of this dissertation has been a thoroughly enjoyable experience, in large measure because of the liberal assistance from numerous people. Thanks to the many 'tree' friends who helped with identification and taught me so much, especially Geoff Nichols. Discussions, academic and less academic, with Lucy Allott, Dr Chet Cain and Gavin Whitelaw were invaluable. My grateful thanks also go to experts in their various fields; Tony Abbott (plant identifications), David Allen (bird feeding habits), Dr Tony Cunningham (ethnographic uses of plants), Frank Jolles (cucurbits), Prof Tom Huffman (Iron Age), Dr David Johnson (bird feeding habits), Don McCulloch (rainfall records), Jim Feeley, Thembi Msomi (ethnographic uses of plants), Dr Henry Moolman (statistics), Dr Ashley Nicholas (seed definitions), Mkhipheni Ngwenya (preparation of herbarium specimens), Bruce Page (ecology), Robyn Pickering (sedimentology), Dr Ina Plug (fauna), David Styles (plant distributions), Dr Peter Taylor (small mammals), Prof. Peter Tyson (climate), Dr Lia Wissing (editing) and Marilee Wood (beads). Thank you too to the South African National Biodiversity Institute (previously the NBI) in Pretoria for allowing me to re-arrange their basement to gain access to parts of the valuable 'du Plessis' seed collection. The SANBI is also thanked for the use of plant distribution data from the National Herbarium, Pretoria (PRE) Computerized Information System (PRECIS). I thank Wendy Voorvelt for the section drawings, Brennan Walsh for the maps and the technicians at the Seed Room at Kirstenbosch who shared their expertise.

Thank you to my sons Dan and Will for their help and tolerance concerning my computer skills and their patience while I 'quickly' collected fruits and vouchers on holiday trips. I thank my mother for her support and my brother J. for the time and dedication spent in the compilation of bird feeding records (Appendix C). Thank you to my brother Peter and husband Jonathan for construction of the grid squares and to the Keith Scotts for the invaluable microscope. Jack and Ms.T., the faithful canines on many collecting and recording trips, were enthusiastic and reassuring companions. Finally, a very special thanks goes to Jonathan for his moral and financial support of my endeavours and his interest in my work. He had many useful ideas (e.g. about flotation apparatus), made equipment (e.g. a light table) and searched for and purchased numerous essential items (e.g. the flower press and many invaluable books).

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PREFACE

I have used modern orthography for isiZulu names e.g. Tongati rather than Tongaat. I have followed the taxonomic classification and nomenclature used in the third edition of Keith Coates-Palgrave Trees of Southern Africa (Coates Palgrave 2002) and the seventh edition of Roberts Birds of Southern Africa (Hockey *et al.* in press). For the sake of clarity I will define and elaborate on some terms that I have used:

Agriculturist* vs. *Iron Age

Although the term Iron Age is considered inappropriate by some (Maggs 1992; Steele 2001), its use continues (Wadley and Jacobs 2004) because the term is convenient shorthand widely understood to encompass a particular set of economic, social and technological practices. Some specialists prefer the term 'mixed farmers' to refer to the people involved in these practices and use the term 'Iron Age' for reference to the particular period of these practices (T. Huffman pers. comm.). In East Africa the term 'early farmers' is used (C. Cain pers. comm.) and in KwaZulu-Natal (KZN) the trend is to use the term 'agriculturists'. Agriculture refers to animal husbandry and planting of crops (Concise Oxford Dictionary 9th Edition 1995) so the term is appropriate. I prefer the term mixed farmers because it sounds less unwieldy but I use the term agriculturists because it is the accepted practice in KZN and Sibudu Cave is in KZN. Rather than use the term Iron Age, I again follow the trend in KZN and refer to the particular period under discussion e.g. second millennium AD.

Archaeobotany* and *Palaeoethnobotany

The terms archaeobotany and palaeoethnobotany are sometimes used synonymously. However, archaeobotany is the art and science of recovering, identifying and interpreting plant remains from archaeological sites (Miksicek 1987) whereas palaeoethnobotany stresses the relationships between people and plants. Palaeoethnobotany is the study of the interrelationships between human populations and the plant world through the archaeological record (Pearsall 2000:xix) and palaeoethnobotanical work involves anthropology and botany. This study is primarily archaeobotanical in that it aims to elucidate past vegetation. However, people are part of the ecosystem and there are some elements of palaeoethnobotany in the study too.

Seeds

I use the term 'seeds' for convenience to encompass a number of different plant reproductive structures such as the seed itself, the seed coat, hardened stony endocarps, capsules and pods. These structures are represented in the following various types of fruit:

Berries A berry is a fleshy, pulpy, indehiscent fruit with one or more seeds and no true stone, such as *Asparagus, Capparis, Carissa, Chrysophyllum, Diospyros, Rhoicissus, Sideroxylon* and *Strychnos* (the rind is leathery or thick and woody).

Capsules A capsule is a dry fruit that opens on maturity along one or more lines of dehiscence to release seeds e.g. *Acacia, Justicia, Strelizia* and *Trichilia*.

Drupes A drupe consists of an exterior or pericarp of fleshy tissue, beneath which is a hard stony layer or endocarp with the seed proper inside e.g. *Celtis, Commiphora, Ekebergia, Grewia, Harpephyllum, Rhus, Sclerocarya,* Vanguerieae and *Ziziphus.*

Receptacles A receptacle is a hollow sphere inside which the flowers and fruits are produced. It has a small opening at the apex e.g. *Ficus*.

Fruits are the transformed and ripened ovaries of flowers and contain seeds. The distinction between fruits and vegetables used in commerce is sometimes botanically incorrect e.g. tomatoes, cucumbers and eggplant are technically fruits but are classified as vegetables in grocery stores because they are not sweet (Kaufman 1989:653). Similarly the use of the term nut is sometimes incorrect; the fruit of the peanut or groundnut is technically a legume and the seeds we eat are commercially referred to as nuts. Brazil nuts too are seeds. The common definition of a nut is a fruit consisting of a hard or tough shell around an edible kernel (Concise Oxford English Dictionary 9th

Edition 1995) but the terms nuts and kernels are variously used. In Coates Palgrave (2002:540) marula is described as a drupe with a single stone containing two or three seeds, ‘nuts’ that may be eaten raw or used for various purposes. Quin (1959:89) uses the term kernel to refer to a hard stony endocarp and states that the marula kernel approximates in both size and shape a small walnut; that it is polyembryonic with the embryos encased in a very hard and tough woody endocarp; and that in a sample of 50 kernels 31 had two embryos and 19 had three embryos. Fox and Norwood Young (1982) also do not refer to kernel as soft edible tissue and write that the *Harpephyllum caffrum* fruit is an obovate red drupe, smooth and fleshy with a woody fibrous kernel. The use of the term kernel for soft edible tissue is, however, widespread. A caryopsis of *Zea mays* is generally referred to as a maize kernel in botanical and archaeobotanical literature (e.g. Kaufman 1989; Pearsall 2000; Popper and Hastorf 1988). The maize/mealie caryposis is a fairly complex structure that results from the fusion of the fruit with the seed (the fruits are one-seeded and indehiscent) (A. Nicholas pers. comm.). It is also referred to as a grain (Smith 1960; Van Wyk and Gericke 2000). The Latin word for grain is the source of the term ‘mielie’ (Smith 1960:337):

> ‘The Afrikaans word “mielie” is derived from the Portuguese “Milho” (itself a descendent of the Latin “milium”, meaning any kind of grain, but more specifically millet). Jan van Riebeeck was probably the first South African to write the word and in his “journal” he spells it “mily”.’

Symbols

The symbols are explained in association with the tables in which they are used. An exotic plant is indicated by ’~’. The abbreviation ‘cf.’ means ‘looks like’. Alternatively, archaeobotanists give identifications a ‘confidence rating’: * for very secure, ** for secure and *** for somewhat insecure (Pearsall 2000: 138). This system is useful for individual seeds whose presence may have important implications. Degrees of confidence are also used in geology where an ore reserve may be categorized as ‘proven’, ‘probable’ or ‘possible’ (J. Scott pers. comm.). ‘Probable’ and ‘possible’ could provide informative detail in the archaeobotanical category ‘*** somewhat insecure’.

CHAPTER 1

INTRODUCTION AND AIMS

The need to understand and predict climatic change and variability has been given high priority internationally. Increasing pressure is being placed upon natural resources such as food, water and energy and small changes in climate may seriously affect the balance between the supply and demand of these basic commodities (Tyson and Partridge 2000). A key issue in archaeological research is the need to establish more detailed past climatic and ecological parameters to assist with modelling the effects of global climatic change on southern African biomes (Mitchell 2002:427). Pronounced climatic oscillation can occur frequently and rapidly and better definition and recognition of these events is essential to provide more accurate data for predictive modelling and long-term forecasts (Hassan 1997).

Climate, interacting with relief, is the primary determinant of vegetation and thus the identification of past vegetation is an important goal in climatic reconstruction. Archaeobotany contributes to the identification of past vegetation and studies of seeds are particularly useful because in many cases they can be identified to species level, whereas wood, many herbs and grasses, and pollen can rarely be taken beyond genus level (Dimbleby 1977:20; Roberts 1989:24).

1.1 Aims

The aims of this study are to reconstruct the vegetation in the Sibudu area during the last millennium and to investigate whether changes in vegetation can be identified from seeds recovered from the second millennium AD archaeological deposits at Sibudu Cave, KwaZulu-Natal. This involves the identification of archaeologically recovered seeds, and the analysis of species composition and the abundance of particular species, through time. Observed trends will be evaluated with regard to factors influencing the accumulation, preservation, recovery, identification and interpretation of the seed data. According to the process of palaeoclimatic reconstruction (Butzer 1984) the primary work will be inductive at the level of data gathering and analysis and the deductive phases will follow with synthesis and interpretation of the results.

1.2 Description of Cave and Present Environmental Conditions

The geographical and environmental situation of Sibudu Cave has been described in detail (Wadley and Jacobs 2004). The cave is approximately 12 km from the Indian Ocean and 45 km north of Durban in KwaZulu-Natal, South Africa (Figure 1.1). It is situated at approximately 100 m above mean sea level in a west-south-west-facing sandstone and shale cliff on the Tongati River. It has a floor about 55m in length and 18m in width that slopes towards the south. The steeply sloping ceiling allows for standing throughout the cave. The ceiling and fringing vegetation, especially an enormous *Celtis mildbraedii*, provide shelter from rain but not wind. The wind brings in leaf litter that is caught up in rock fall especially at the northern end of the cave. Access to the cave is from the southern end. Most people and agile animal species can negotiate access via the rock face that descends to the river. Goats can scramble into the cave but it is unlikely that ungulates such as modern domestic sheep or cattle could manage to do so.

The remnant forest that survives along the Tongati River and in the kloofs and cliffs around the cave supports a wide variety of birds. Swifts, red-winged starlings, lanner falcons, white-necked ravens and Egyptian geese nest in the cliff face. Rock hyraxes (dassies) are also resident and vervet monkeys visit the cave. Although a wide range of indigenous plant species survive in the area (G. Nichols pers. comm.; D. Styles pers. comm.; Wadley 2001a) there are many exotic plants and vigorous invader species that are encroaching on the natural vegetation and growing on the surrounding land that has been cleared for sugarcane and small-scale subsistence farming.

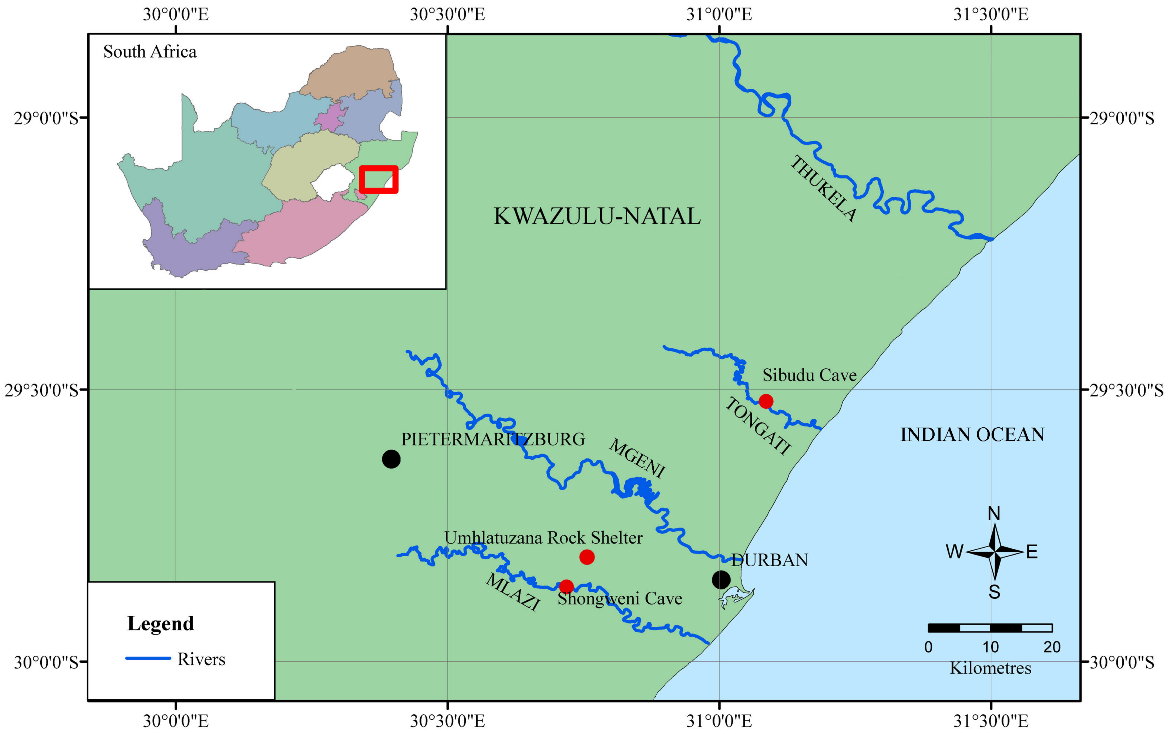

Figure 1.1: Location of Sibudu Cave

Average present-day temperatures for January are 22-25°C and for July are 17-20°C (Grant and Thomas 1998:9). There is high humidity throughout the year, especially in January and February. Average rainfall is 501-750 mm for summer and 251-379 mm for winter (Grant and Thomas 1998:9). Rainfall records are available from Sukamani about 350m from Sibudu Cave. The annual average for the 15 years from 1988 to 2002 was 975 mm (D. McCulloch pers. comm.). The driest month on average was June followed by May and August. It usually rained every month and only once did no rain fall in May, June and August. No rainfall was recorded in July three times during the 15-year period. On average however, July received twice as much rain as June. December, November and February were the wettest months.

Various epithets have been assigned to the vegetation surrounding Sibudu Cave and these will be discussed in detail in Chapter 6. According to the vegetation map by Low and Rebelo (Low & Rebelo 1996) Sibudu is situated approximately on the ecotone of Thicket and Savanna biomes (Figure 1.2), specifically Valley Thicket (Vegetation Type 5) and Coastal Bushveld/Grassland (Vegetation Type 23). Savannas are also known as bushveld and consist of a discontinuous canopy of tree and shrub cover interspersed by grasses. A broad-leaved savanna (savanna in a nutrient-poor, moist environment) occurs along the eastern littoral of South Africa (Cowling *et al*. 1997:260). Although ‘there is no formal “Thicket Biome” recognised in the scientific literature’ (Lubke 1996:14), the term thicket is used to describe closed shrubland to low forest that is ‘often almost impenetrable, is generally not divided into strata, and has little herbaceous cover’ (*ibid*).

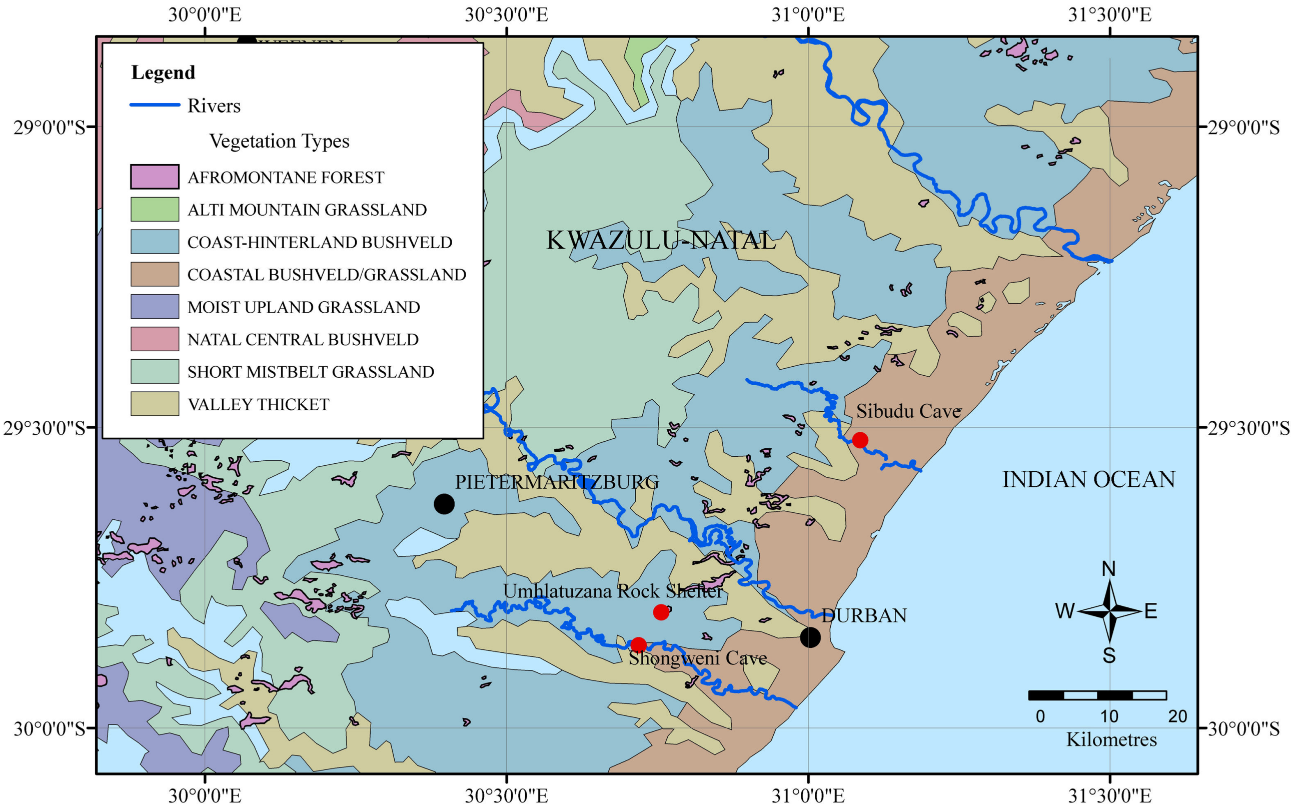

Figure 1.2: Vegetation map adapted from Low and Rebelo (1996)

1.3 Excavation of Sibudu Cave

Aron Mazel of the Natal Museum in Pietermaritzburg first undertook test excavations at Sibudu Cave in 1983. Large-scale excavations began in 1998 under Professor Wadley and her ACACIA Project of the Archaeology Department, School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand. Excavations are ongoing.

The deposits at Sibudu are unusual in that they represent a long, well-dated and culturally rich Middle Stone Age (MSA) sequence with good preservation of organic remains. There is no Later Stone Age (LSA) evidence in the cave and agriculturist material lies directly on MSA deposit.

1.4 Stratigraphy and Dating of the Second Millennium AD Deposits

The stratigraphy of the second millennium AD deposits (Figures 1.3; 1.4 and 1.5) consists of a shallow surface layer (Surface) that overlies compacted dung (Dung), which lies on brown soil/silt with vegetal material (BSV, BSV1, BSV2). The Dung layer is discontinuous across the site. BSV lies upon brown sand with stones (BSS). As previously stated, there is no Later Stone Age material in the cave and BSS lies directly on Middle Stone Age (MSA) material. There is mixing of material because pits were dug from the upper layers into the MSA deposits.

Surface, Dung, BSV and BSS contain identifiable botanical remains, upper and lower grindstones, remains of domesticated animals and other fauna, marine shells, potsherds, gourds, flaked stone, many glass beads, rare pieces of metal, worked wood and basketry. Daga hut floors, wooden stakes, posts and post-holes occur in BSV and BSS. Small patches of dung occur in BSV. A small pit in BSS contained a cache of coiled bead necklaces made from thousands of Indian red beads interspersed with turquoise glass beads, ostrich eggshell beads and a few copper beads

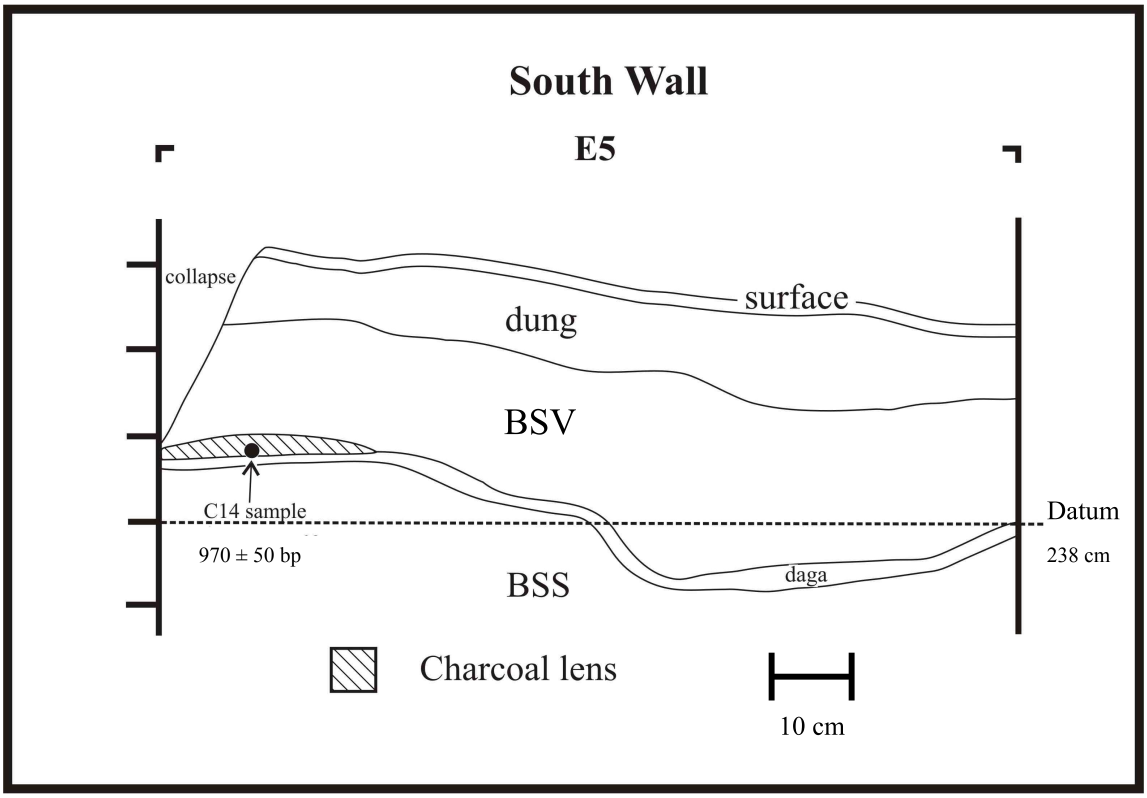

Figure 1.3: South section of the second millennium AD layers at Sibudu Cave, 2003

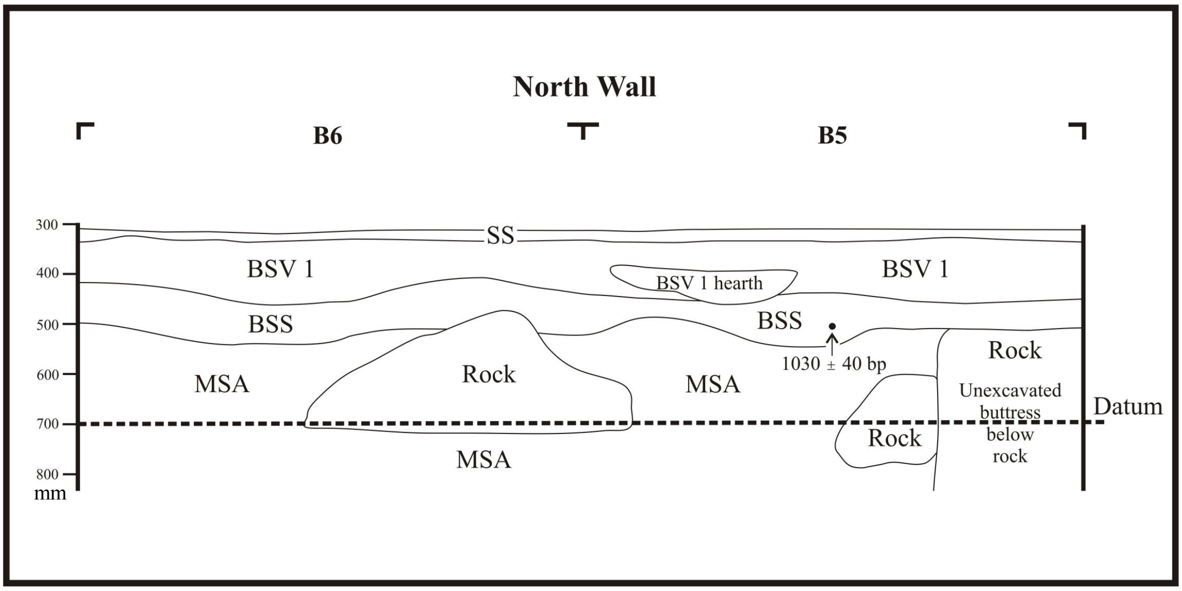

Figure 1.4: North section of second millennium AD layers at Sibudu Cave, 1999. Note that Dung layer is not continuous across the site

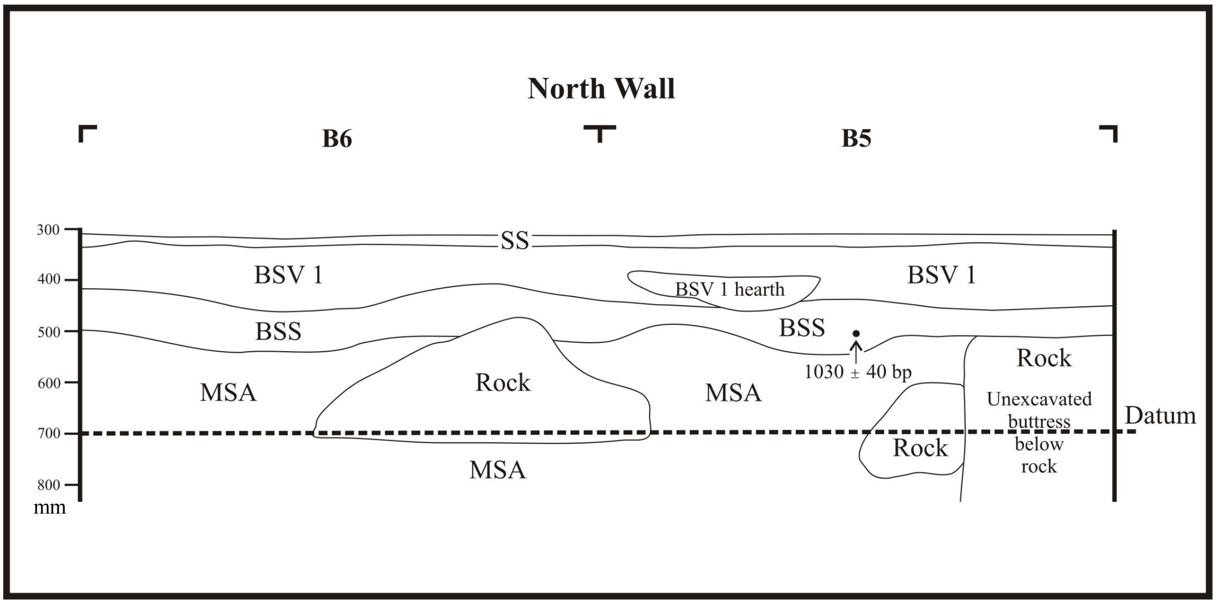

Figure 1.5: North section of second millennium AD layers at Sibudu Cave, 1999

Three radiocarbon dates (Table 1) indicate that BSV and BSS, although stratigraphically distinct, probably represent a continuous period of intensive occupation of the cave from about AD 1000 to about AD 1180.

Table 1: Radiocarbon dates from the upper layers at Sibudu Cave

Analysis number Pta-	Sample designation	Radiocarbon age yrs BP	Calibrated Date
0815	Sibudu Sq E, Pit	960 ± 25	AD 1044(1069,1157)1171
9202	Sibudu Sq F5a, Hut floor	970 ± 50	AD 1026(1097,1136)1175
9196	Sibudu Sq B5c, BSS2	1030 ± 40	AD 1007(1023)1037

Dates are reported in conventional radiocarbon years Before Present (BP), i.e. before AD 1950, using a half-life of 5568 years for C-14. Ages are corrected for variations in isotope fractionation and are calibrated for southern hemisphere with the Pretoria programme (Talma & Vogel 1993) updated 2000. The 1-sigma range is given, with the most probable date between brackets.

Apart from the radiocarbon dates, pottery, beads and the hut floors also give indications of the occupation dates. Pottery is abundant at the site but there are surprisingly few decorated pieces. The four decorated pieces that were found are probably Blackburn phase (T. Huffman, G. Whitelaw pers. comm.). Dates from the Blackburn type-site, about 30 km from Sibudu and dates from Mpanbanyoni further south, correspond with the Sibudu dates (G. Whitelaw pers. comm.). Glass beads similar to the red Indian beads from the pit in BSS first appeared in southern Africa in the 10th and 11th centuries. Their manufacture ceased in the 16th century (M. Wood). Hut floors are not common in caves and their presence at Sibudu suggests a possible refuge situation (Wadley 2001b). The date Pta-9202, 970 ± 50 BP was from a discrete patch of charcoal directly on the hut floor. This indicates that the hut floors were not associated with the *Mfecane*, a period of great unrest and social upheaval during the early 19th century (Edgecombe 1992).

1.5 Theoretical Background to Vegetation Change

1.5.1 Factors that Influence Vegetation

The primary determinants of vegetation growth and structure are climate, altitude and proximity to the sea or other water (Grant and Thomas 1998). Coastal winds, salt spray, proximity to rivers, underground water levels, rainfall, absolute maximum and minimum temperatures, aspect and soil type all contribute to the determination of habitats and the vegetation that occurs in them. With respect to Sibudu over the last 1000 years, climatic variation and human interference are allogenic factors that could have brought about changes in the vegetation. External influences are termed allogenic. Autogenic factors are intrinsic to plants themselves and autogenic change occurs when plants themselves alter prevailing conditions and encourage the growth of alternative plants (Burrows 1990:20).

Rainfall seasonality, summer aridity and minimum winter temperatures are the climatic indices that correlate well with the major biomes, large ecological units covered by broad vegetation types of relatively uniform composition and structure and usually representing major biotic zones (Rutherford and Westfall 1994). However, classification of vegetation is scale-based and biomes are differentiated into smaller more homogenous units (veld types) classified according to floristic composition regardless of the overall distribution ranges of the taxa. Although the overall climatic conditions still play a major role, the smaller units often also reflect the mean annual rainfall and edaphic (soil) factors (Van Wyk and Smith 2001).

Extremes of temperature are more important than mean temperatures, which are greatly affected by extremes. Temperatures, especially minima and particularly in association with moisture availability, are important. Temperatures are influenced locally by surface configuration and in areas of diverse relief katabatic flow and local winds can cause considerable temperature variations over short distances (Tyson 1986:7-8).

Vegetation is variable along rivers (Grant and Thomas 1998) and in valleys. Valleys provide a wide variety of climatic conditions: warm dry northern and western aspects because of greater insolation (direct sunshine), cool damp southern and eastern aspects, and areas sheltered from the severity of winds, fire and grazing animals. Conditions can be so different that, for example, in the Mvoti Valley, forest occurs on the southeast-facing slopes and dry succulent vegetation occurs on the northwest-facing slopes (Moll 1976:20). During climatic fluctuations valleys provide refuge for plants and plants will be able to survive for much longer than in open country (Acocks 1988). Valleys often provide a route for rivers e.g. the Tongati River and the moisture provided by rivers can mimic higher rainfall conditions. It is very difficult to pick up vegetation changes along a river unless the changes in conditions are extreme (Van Wyk 2003).

Year-to-year or longer period environmental variations can cause considerable variations in seed production, and seedling establishment and survival. Fluctuations in seedling survival and adult growth vary from species to species and may not necessarily be reflected in changes in the number of adults. Long-lived adult perennial plants may be able to outlast environmental shifts that severely affect their juveniles or shorter-lived herbaceous plants (Burrows 1990:20). However, the environmental variations may be sufficiently severe over a number of years, to limit or kill mature individuals of some species, thus causing local extinction of adult plants and giving other species an advantage at their expense. In following years the pendulum may swing back in favour of the original species that are able to sprout forth from dormant seed banks. Over long periods (relative to the lifespan of the component species) the species composition of most stands of vegetation probably varies in this way as a result of environmental oscillations (*ibid*).

1.5.2 Determination of the Causative Factors of Specific Vegetation Changes

Although it is possible to list factors that determine different types of vegetation, the identification of the specific causes of particular vegetation changes is not straightforward. It is difficult to distinguish between autogenic factors (intrinsic to the plants themselves) and allogenic factors, which may be the result of a variety of causes such as human interference, fire frequency, introduced diseases or pests and the climatic variations that have been described above. All organisms have ecological minimum and maximum limits, which they can tolerate with respect to essentials such as water, heat, light and various nutrient requirements (Odum 1983). The challenge is to quantify these tolerance limits so that one can suggest possible allogenic effects on the vegetation that might be reflected in the Sibudu record through changes in the species composition over time.

1.5.3 Proxy Climatic Data

The allogenic factors associated with climatic change such as changes in temperature and precipitation have been identified through a great variety of studies summarized by Tyson *et al.* (2001). Two major environmental events have occurred during the last two millennia in southern Africa: a medieval period of warming from AD 900 to AD 1300 and the Little Ice Age of 1300 to 1800 (*ibid*:145). The medieval warming was characterized by highly variable conditions and a climate estimated to have been 3-4°C warmer than present during maximum warming at about AD 1250. In contrast, temperatures were about 1°C cooler than present during the period of the maximum cooling of the Little Ice Age around AD 1700. Another cool spell occurred a century or so earlier. Whereas the period of medieval warming was wet, the Little Ice Age was dry, but punctuated with extended wet periods. Sudden and abrupt changes were a feature of both periods but more marked between 900 and 1300 when oscillations in annual mean daily maximum temperatures of 2-3°C were recorded within a few decades. The Little Ice Age was probably widespread and cool events recorded in tree-ring records for Karkloof (*ibid*) only about 100km from Sibudu, suggest that the conditions of the Little Ice Age are likely to have extended to the Sibudu area.

Tyson (pers. comm.) confirmed that major climatic fluctuations would have extended all the way to the Indian Ocean. Their effect may not have been as marked along the East Coast littoral (Van Wyk 2003) where the ameliorating influence of the Mozambique current would have mitigated against extremes of temperature. It is precisely this warm moist climate that is cited as a reason for high species diversity along the East Coast. Year-long insect activity is possible in the mild climate and enhances the opportunities of pollination of more plant species (Johnson and Johnson 1993).

1.6 Previous Ecological Studies

The relevance of botanical and faunal studies to archaeological research in southern Africa has long been recognised (Goodwin 1953). I will present a summary and discussion of ecological studies relevant to the Sibudu assemblage in Chapter 7. This will include data from a wide range of disciplines. Faunal studies and botanical studies of charcoals and pollens have received much more attention than studies of seed remains and this study aims to present an in-detail approach to seed studies that may be used as a model for future seed research.

CHAPTER 2

METHODS

The methods involve the establishment of a comparative collection of plant reproductive structures such as fruits, nuts and seeds, hereafter referred to as 'seeds' (see Preface), and the recovery, identification and quantification of archaeologically recovered seeds. I shall describe each of these processes in greater detail. Further recommendations on methods are given in Appendix A.

2.1 Establishment of a Modern Comparative Collection

2.1.1 Collection of Seeds and Vouchers

Since late 1999 I have been collecting seeds in the following three types of forest and two types of grassland/ bushveld vegetation (Pooley 1993): Coastal Scarp Forest, namely Oribi Gorge, Palmiet, Krantzkloof and Vernon Crookes Nature Reserves and the forest around Sibudu Cave; Coastal Lowland Forest, namely Pigeon Valley, Hawaan, Burman Bush, Virginia Bush and Danville Nature Reserves all within the eThekwini (Durban) Municipality, Harold Johnson Reserve on the Thukela River and Yengele Forest (Mpenjati) near Port Edward; Dune Forest, namely Umhlanga Nature Reserve and near Zolwane River mouth (Port Edward); Grassland, namely New Germany and Springside Nature Reserves; and Bushveld, namely Shongweni Nature Reserve. On average one or two planned collecting trips are made a week but collection is not confined to these times or to the above areas and fruits are collected whenever and wherever they are found.

Fruits from indigenous and invasive exotic plants are collected from shrubs, trees, creepers, herbaceous perennials and any other fruiting plants. I collect fruits from the same species growing under different conditions of aspect, moisture availability and surrounding vegetation so that the collection represents the natural variation in the population. I collect fresh fruits from the plants and dried and weathered fruits and seeds from the ground. I record the presence of flowers and the approximate quantity of ripe, unripe and dried fruits on the plant and on the ground below and follow the guidelines set out on the standard herbarium forms available from the South African National Biodiversity Institute (SANBI), previously the National Botanical Institute (NBI), in Pretoria. When plants are flowering or when the fruits are still too green for the seeds to be fully formed, I revisit until the fruits are ready to be collected. Repeat visits to a specific plant indicate the length of the fruiting season and annual visits give an indication of the variation in fruiting times. Sometimes fruits take months to ripen and at other times fruits ripen and disappear before I revisit, especially if there are only a few fruits on the plant.

I collect accompanying vouchers for verification of the plant species and follow the guidelines for the collection and preparation of herbarium specimens outlined in Fish (1999) and in Victor *et al.* (2004). The date and locality of collection, the genus and species name and where applicable, the national tree number, are recorded. The vouchers will be stored together with the seed collection in the Archaeology Department, University of the Witwatersrand, Johannesburg.

2.1.2 Preparation and Storage of Seeds

I store dry, weathered fruiting structures and seeds without further preparation. I dry moist fruiting structures and seeds in the sun and remove the seeds from fleshy fruits. In cases where the fruit is edible and tasty the easiest way to clean the seeds is to chew the flesh off them. Otherwise I follow the methods used at the Seed Room at Kirstenbosch and rub or scrub the seeds in a sieve under running water. With some species it is easier to let the flesh dry on the seeds and then peel it off and with other species the rotting flesh is easier to remove than fresh flesh. Another cleaning method is to soak the seeds in an approximately 1:10 solution of household bleach (active ingredient: sodium hypochlorite).

The seeds are mostly dried in the sun. Because this study concerned uncarbonized seeds, seeds were not charred. Pearsall (2000) describes various methods for charring seeds. The easiest way is to use a kiln or muffle furnace. A household oven is quite adequate for small seeds but large seeds produce copious amounts of smoke. A lower temperature and extended charring time prevents excessive distortion of seeds with high moisture content. Charring times vary considerably and because it is very much a matter of trial and error it is essential to collect as many seeds as possible to keep in reserve.

Infestation of the seeds in the field and during drying is a problem that can be overcome by gentle heating of the seeds to kill insects, their eggs or their larvae. I do not recommend the use of a microwave because it is difficult to determine an adequate time to destroy infestation without making the seeds brittle. Naphthalene balls and sealed containers prevent further infestation.

The seeds are stored in glass vials. The scientific name of the plant and the date and provenance of collection is listed on a label that is put into the glass vial with the seeds. The label also bears the national tree number (Coates Palgrave 2002) where appropriate and a generic identification number according to the index used by most herbaria in South Africa (Arnold and De Wet 1993).

2.2 Recovery and Identification of Seeds

All excavated deposits are dry sieved through 2mm and 3mm mesh size sieves and all whole seeds and fragments are collected. The seeds are sealed in polythene packets that are labelled according to excavation date, layer and the 50cm^2 grid squares from which they were excavated. In most cases the positively identified seeds are packaged and labelled separately within these packets.

There are no detailed texts dedicated to southern African seeds and few seeds are illustrated in botanical texts. For this reason and because it is a more reliable method, I identify seeds by comparison with modern samples. Important features in seed identification are 1) size; 2) shape, for example, round, ellipsoid, irregular, ovoid (solid shape of an ovate outline), obovoid (solid shape of an obovate outline), pyriform (pear-shaped), reniform (kidney-shaped) etc.; 3) the seed coat (testa), especially distinctive texture and surface features and sometimes even colour; 4) shape and position of the hilum or point where the seed was attached to the ovary; 5) the number of divisions in a fruit; and 6) any other characteristic features or attachments such as spines, bristles and barbs. I also identify taxa on the basis of the hard stony endocarp in drupes e.g. *Harpephyllum caffrum*, the hard woody shell of some berries e.g. *Strychnos* spp. and the valves of legumes e.g. *Millettia grandis* (see Preface for definition of 'seeds'). Appendix B lists the parts of the fruiting structures that are used to identify the different taxa. Magnification up to 20x is used when details on the seeds are unclear. When I am unable to identify a seed I give it a type number. Practically, unless one has seen a number of seeds from a particular taxon, it is very difficult to recognise the seed or identify it. After working with a certain taxon repeatedly it becomes so familiar that one can recognise it by a fragment.

The frequencies of all seeds, including those unidentified seeds that I categorize by type number, are recorded according to three categories: whole seeds, seed fragments greater than or equal to half a seed and fragments smaller than half a seed. Unless otherwise specified the numbers (frequencies) in the tables refer to the sum of the seeds in the first two categories, i.e. all whole seeds as well as seed fragments that are equal to or larger than half a seed.

2.3 Quantification of Seeds

Seed frequencies are standardized per taxon by volume of deposit and the densities are tabulated per layer. Descriptive statistics and display techniques are used to present certain data.

CHAPTER 3

DISCUSSION OF METHODS

A simplified diagram (Figure 3.1) summarises the main excavation and analytical processes involved in this study and the factors that have bearing on these processes. The three main processes are recovery, identification and interpretation of material and I discuss aspects of each of these.

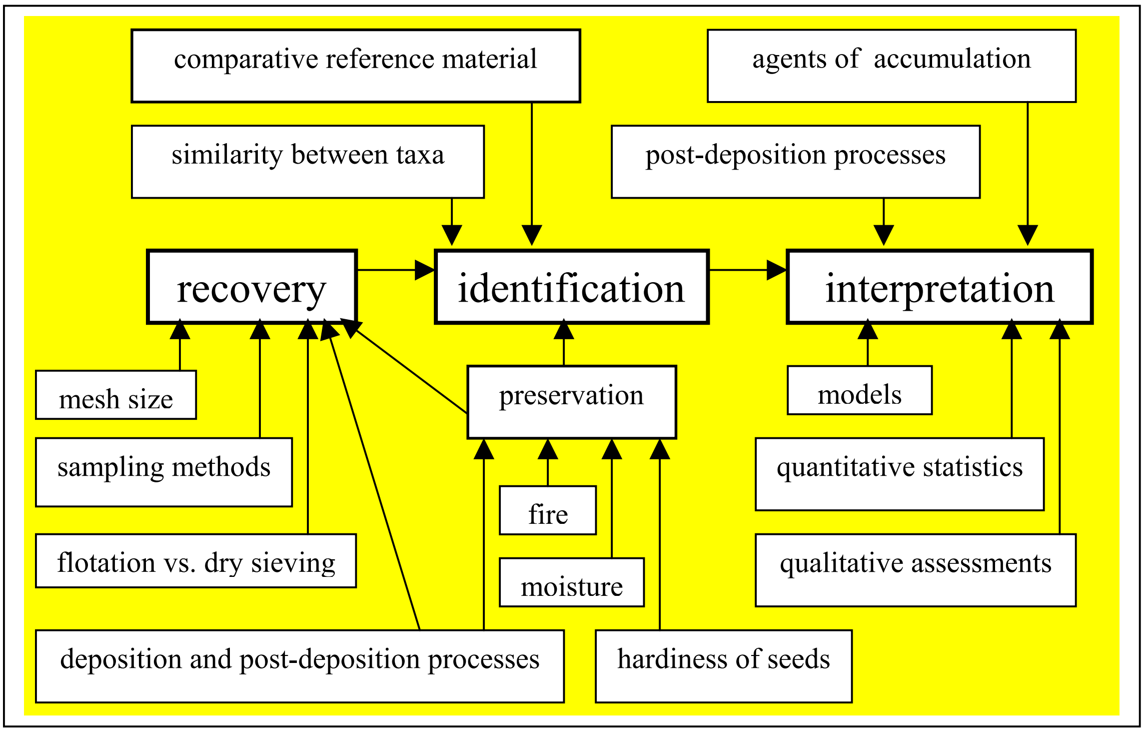

Figure 3.1: Simplified diagram of excavation and analytical processes

3.1 Recovery Methods and the Effects on Assemblage Composition

The factors that influence the recovery of seeds are the state of preservation of the seeds, agents of accumulation and post-deposition processes, the sampling strategy chosen, the methods used to recover the seeds from the excavated deposit, i.e. flotation vs. dry sieving, the mesh size, and occasionally the degree of magnification used for sorting. The seeds are excavated and sorted by a number of people of different abilities and experience, which also influences the recovery of seeds. I will discuss the factors that influence the recovery of seeds in greater detail.

3.1.1 Effect of Sampling on the Recovery of Seeds

Sampling is an inescapable part of archaeological research (Orton 2000) and unless there is limited preservation of material, sampling of botanical remains is essential because of the sheer bulk of remains that are recovered. The analysis of botanical remains is very time-consuming and the expense needs to be justified in terms of the information and interpretive returns gained. Good sampling strategies form the basis of successful archaeobotanical analyses (Pearsall 2000:66) and there has been considerable discussion on appropriate methods in order to ensure accurate interpretations based on the most efficient use of resources (e.g. Keeley 1978; Lennstrom and Hastorf 1992; Van der Veen and Fieller 1982). The objective is to analyse no more material than is necessary to achieve reliable results.

It is crucial to understand what biases have been introduced by the sampling techniques before we may confidently apply analytical and interpretive manipulations to the materials recovered (Wagner 1988:18). Bias due to the intensity of sampling is unavoidable and, because it is impossible to retain, sort, identify and record ‘everything’ from a sampled unit of soil or deposit, it is futile to pursue absolute freedom from bias. Generally the aim is to compare assemblages and it matters not so much that assemblages are biased but that they should have the same bias, and so, can be reasonably compared (Orton 2000:165). Applying standardized sampling techniques is one way of eliminating bias and allowing for inter-assemblage comparisons.

Sampling Strategies and Techniques

Blanket Sampling

Pearsall (2000:66) suggests *blanket sampling* (my italics), whereby soil is collected from all excavation contexts, for practical reasons (taking samples becomes part of the routine) and for the advantages of later analysis. Her reasons for advocating blanket sampling are that 1) routine sampling of all contexts avoids the problem of predicting where remains will occur; 2) it is an easy strategy to carry out in the field; 3) it gives the analyst maximum flexibility for later analysis; and 4) it provides the means of evaluating the contents of different features.

Once the contexts that require sampling have been identified it is necessary to decide on how to collect the samples. There are a number of possible sampling methods that have been variously categorized and labelled, namely grabsampling, column sampling and bulk sampling. I describe these excavation techniques and then describe two methods that are used in the laboratory to subsample the excavated samples, namely, random sampling and cumulative sampling.

Grabsampling

'*Grabsampling*' (Van der Veen and Fieller 1982:288) is also known as '*haphazard selection*' (Redman 1974 in Van der Veen and Fieller 1982:288), '*pinch*' (Popper and Hastorf 1988:6), '*scatter*' (Lennstrom and Hastorf 1992:206) or '*composite*' sampling (Pearsall 2000:69). Small scoops of soil are gathered throughout a given provenience, level, feature or context and are combined in one sample bag. A standard soil volume should be collected wherever possible (Pearsall 2000:69).

Van der Veen and Fieller (1982:288) believe 'grabsampling' is the least satisfactory sampling technique and Pearsall's recommendations (2000:69) that 'soil may be taken toward the bottom of a level, or little by little throughout' confirms their objection that there is no standard way of taking the subsample nor any guide for its size. Van der Veen and Fieller (1982:228) conclude that there is no way of knowing how representative the sample is of the whole. Pearsall (2000:69) nevertheless considers composite sampling appropriate for many sampling situations and stresses that it is important that soil be collected widely over each context so that the sample represents the area as a whole. Lennstrom and Hastorf (1992:207) voice concern, however, that it is often unclear how large an area might be represented accurately by a single scatter sample e.g. should a scatter sample be collected from an area no larger than 1 m^2?

Column Sampling

'*Column*' sampling consists of samples taken in sequence from one area selected at random. More than one balk or sampling column can be left in place until excavation is finished so that each level is visible in profile and precise sampling is possible. The major disadvantage of the method is that column samples represent remains present only in part of the excavation (Pearsall 2000:71). Column samples are often collected at regular intervals e.g. 10cm, to provide a chronological sequence in undifferentiated deposits (Popper and Hastorf 1988:6).

Bulk Sampling

'*Bulk*' sampling (Lennstrom and Hastorf 1992:206), also referred to as '*point*' sampling (Pearsall 2000:96), consists of soil collected from a single location, of contiguous matrix, from a single context and can provide useful information for small, precisely located areas.

Random or Probalistic Sampling

'*Random*' or '*probalistic*' sampling is a way of selecting a sample in such a way as to maximize the chance that it accurately represents the population from which it is selected (Drennan 1996:82). It is designed to avoid any bias introduced by conscious or subconscious human choice. In this section I describe random sampling not as an excavation strategy *per se*, but rather, as a method used to subsample excavated samples, usually in a laboratory. Subsampling is often a viable option to achieve cost-effective but nevertheless valid results. Van der Veen and Fieller (1982), working on laboratory samples of carbonized material, determined that the 'riffle-box' method consistently produced subsamples entirely compatible with the working hypothesis of randomness, that is, showed the most consistently reliable results. A riffle–box consists of two rectangular containers covered by a metal lid with a number of slots leading alternatively to the two containers. The material is poured through the riffle and divided into two portions. One portion is arbitrarily chosen and riffled again until the required sample size is obtained. To determine the appropriate sample size, Van der Veen and Fieller (1982) suggest 'cumulative' sampling.

Cumulative Sampling

‘*Cumulative*’ sampling is used to assess the relationship between the sample size and how representative the sample is. The principle of cumulative sampling has been developed further by the application of bootstrapping techniques (Cochrane 2003:838). I discuss the basic principle of cumulative sampling (Van der Veen and Fieller 1982), which is the division of the excavated material into several subsamples, which are then randomly analysed. The features of interest are plotted on a graph and samples are analysed until the ‘levelling off’ of the graph’s curve indicates that analysis of more samples will hardly alter the projection. This method automatically provides a sample of adequate size to ensure reasonable accuracy of estimation. Unfortunately it is not possible to predetermine whether the sample will be unacceptably large and the results will justify the time involved. The method is particularly attractive when the appropriate subsample size is obtained. Subsamples that are too small may bring organizational problems whereas the sorting of subsamples that are too large wastes time establishing confirmation of the stabilization of the graph. Furthermore the subsample size may not always be applicable to other samples.

Van der Veen and Fieller (1982) also state that it is necessary to decide on the margin of error or the degree of accuracy that is desired and the probability that that degree of accuracy will be obtained for a particular sample. Their work refers specifically to carbonized seeds in the laboratory stage of analysis but they state that the statistical theory and numerical results apply to any sampling problem (Van der Veen and Fieller 1982:297).

Although cumulative sampling can be used in the field to adjust the size of the samples being excavated, both the random and cumulative sampling methods I have described are concerned more commonly with the size of subsamples of already excavated samples. I will now discuss the sample size, or volume of deposit, that is appropriate during excavation.

Sample Size

Popper and Hastorf (1988:7) state that

> ‘The adequate soil volume for a sample is specific to the information sought from a deposit and its density of remains. For example, one needs more maize remains to analyse maize varieties than to document maize cultivation … In general, the better the organic preservation, the smaller the sample need be. A larger volume of soil per sample increases the number of remains per sample and the range of taxa.’

The density of remains in the deposits is generally unknown before excavation, so the excavator may have to process a variety of deposits in different quantities before deciding on appropriate soil sample size. It is necessary to have an adequate number of seeds for statistical analysis. The sample size may therefore have to be adjusted accordingly after tests in the field. Sample sizes chosen at the start of a season may not be appropriate for contexts encountered later in the season.

‘The only way to choose an appropriate sample size is by experimentation and prior experience’ (Pearsall 2000:75). Pearsall suggests taking 10-litre samples from different contexts and evaluating the quantity of material recovered. It is best to take standard size samples from all contexts because samples with exceptional preservation can always be subsampled in the laboratory. It is important that sample sizes do not fluctuate dramatically among contexts because sample size fluctuations affect the comparability of rare remains. In some contexts it may not be possible to take a standard size sample. In such a case the analyst can adjust the degree of accuracy chosen or combine individual samples. Combining of samples is not ideal or recommended unless absolutely necessary because it is statistically stronger to use a number of individual samples to characterize a locus than a single large sample (Pearsall 2000:116).

3.1.2 Suitability of Flotation vs. Dry Sieving for Recovery of Seeds

The retrieval of vegetation from sediments has been made simpler by the development of flotation techniques able to separate mineral grains from organic materials because of their different densities (Renfrew and Bahn 1996:229). Flotation involves the immersion and agitation of soil in water so that light material floats on the surface and can be skimmed off. It is distinct from water screening where soil is placed on a screen and washed with a water jet so that all material smaller than the screen mesh is washed through the mesh. A ‘water sieve’, or Ankara machine, uses continual water flow from beneath to separate out botanical material and wash heavier artefacts and so it serves as both a flotation device and a water screen. It was devised to secure unbiased samples of all sizes of all artefacts, not just botanical remains (Pearsall 2000:18).

Pearsall (2000) has summarised the various methods of flotation and various archaeobotanists e.g. Wagner (1988), have tested the efficacy of different flotation methods.

Flotation is well suited for sandy sediments with light carbonized macroremains, but less suited for claylike samples of mineral soil, and waterlogged material (Hosch and Zibulski 2003). Pearsall (2000) states two conditions that render flotation an unsuitable method: waterlogged and extremely dry conditions. Moreover, it is important to bear in mind that ‘flotation is a technique for the recovery of carbonized woody tissues rather than humified leafy remains’ (Deacon 1979:247). ‘Humified’ and ‘leafy’ are apt descriptions for the second millennium AD material from Sibudu and the desiccation and predominantly uncarbonized nature of the remains make them unsuitable for flotation. Uncharred material can become waterlogged during flotation so that it sinks. Furthermore, wetting and drying has a detrimental effect on fragile material. Wet material is more vulnerable to damage during handling and unless material is dried slowly it can became brittle and crack (Pearsall 2000).

In most archaeobotanical studies, only charred remains are noted and uncharred remains are dismissed as modern contaminants. In many cases and especially in open-air sites in mesic environments this is the correct assessment (Lopinot and Brussell 1982). In cases where mineralization has occurred it is not appropriate because seeds preserved by mineralization often exhibit a fresh, even modern appearance (Green 1979:279), which in the past may have led to their exclusion from botanical assessments. Moreover, flotation, the method used to recover the carbonized seeds, acts against mineralized seeds because they do not float.

As mentioned earlier, the bulk of the botanical material from the second millennium AD layers at Sibudu is uncharred. The abundance of uncharred botanical material of anthropogenic origin, such as wood shavings, indicates that uncharred seeds could have the same source. In a curious twist of the norm it is possible that at Sibudu charred seeds indicate contamination and that the charred seeds in the upper layers are from the MSA, because of the mixing of deposits caused by the pits that were dug into the MSA layers. Because very few charred seeds were found in the upper layers and because of the possibility of an MSA origin, charred seeds were not included in this analysis.

3.1.3 Effect of Sieve Mesh Size on Recovery of Seeds

The mesh size of sieves places a bias on the seeds that are recovered. The mesh size is relevant to both dry sieving and flotation systems where the recovery of the remains depends on the screen mesh size of the flotation bucket and the mesh size of the hand or catch sieve used to capture the flot (floating materials). Pearsall states that a mesh size appropriate to the nature of the soil matrix should be chosen. Fine, silty or clayey soils allow use of finer mesh (0.42mm), sandy soils limit the mesh to 0.59 mm. Pearsall uses a 0.25mm mesh in flotation scoop sieves and also mentions a quick short-term solution involving a nylon stocking over a tea strainer (Pearsall 2000:33). It took me 30 minutes to sort, under 20x magnification, a tablespoonful of material (12mm) that had been recovered from dry sieving through a 0.425mm sieve. Although this figure would presumably improve when I become more experienced, the effort is not justified because there is no southern African comparative material for identification of seeds in this size range. The material that was analysed in this study is biased in favour of seeds that do not pass through 2mm and 3mm mesh size sieves.

3.1.4 Effect of Preservation on Recovery of Seeds

Differential preservation of plant remains presents a great challenge to archaeobotanical analyses. Preservation is a vital aspect in the recovery of seeds. Preservation factors also have a major influence on the identification of seeds and whether or not diagnostic features remain on the seeds.

Whether a plant or part of a plant is preserved depends only partially on the physical properties such as density, surface characteristics, or size. Fleshy fruits with less-resistant sugars and starches preserve less well than seeds with more-resistant cellulose (Popper 1988:56). Plant preservation is also affected by whether the plant is charred, the frequency and method of use and disposal by the site inhabitants, and the site-formation process (soil-type, depth of deposit, moisture regime) (Popper and Hastorf 1988:5). The survival of uncarbonized seeds can be achieved by waterlogging, freezing, acidity and importantly in the Sibudu context, aridity. Uncharred remains may also persist due to microscale chemical effects from adjacent metals such as copper or iron. Phosphatic mineralization may occur in coprolites or in latrines and fossilization by casting or mineral replacement may involve silicates, carbonates, gypsum or calcite. Seeds with naturally high concentrations of calcium carbonate in their seed coats, such as *Celtis* spp. or some sedges will survive for millennia without carbonization (Miksicek 1987:218).

Complete carbonization occurs when plant materials are subjected to temperatures between 250 and 500°C under low oxygen conditions (Miksicek 1987:219). Rapid burning at high temperatures with abundant oxygen reduces seeds to mineral ash but seeds that are carbonized largely maintain their characteristic shape. Some seeds are distorted by heat and ‘puffing and shrinkage’ (Willcox 2004:148) may occur resulting in a change in shape, size or proportions. Renfrew’s experiments on domesticated grains showed that charring decreased the length of the grains, increased the breadth of grains and had a variable effect on the thickness of the grains (Renfrew 1973:11-12). Carbonization reduces seeds to elemental carbon that is resistant to organic decay and mechanical damage is the only likely process that will destroy a completely charred seed (Miksicek 1987:219).

3.1.5 Effect of Agents of Deposition and Post-Deposition

The agents of accumulation and post-deposition determine what comes into the cave, how well the material will be preserved and whether it is still in its original context when it is recovered. The agents of accumulation and post-deposition are important at each level of archaeological investigation and I discuss them in detail (Chapter 5). They determine what is initially deposited; they affect the preservation of this material e.g. whether it is burnt or modified in any way at deposition or subsequently; they affect subsequent chances of recovery and identification because they affect preservation; and they are integral to valid interpretations of the results.

3.2 Identification of Seeds

The identification of the seeds relies chiefly on how well features of the external morphology are preserved. A comprehensive comparative collection is essential for the identification of the seeds. I discuss comparative collections needed for identification, difficulties in identification because of similarity between taxa, and then I outline the effect of preservation on the identification of seeds.

3.2.1 Establishment of a Comparative Seed Collection

A comparative sample of a limited range of species exists in the seeds from Umhlatuzana Rock Shelter excavated by Kaplan (1990), identified by Dr E. du Plessis and presently stored at the Natal Museum in Pietermaritzburg. Dr Oliver Davies compiled a small collection of modern seeds that is also housed at the Natal Museum. The late Dr du Plessis made an extensive collection of indigenous seeds that is presently housed in the basement of the SANBI in Pretoria. Lack of space means that this valuable reference collection is not easily accessible to researchers. I was unable to find any other comprehensive reference collections in South Africa. Dried fruits are present on many specimens in herbaria, but the dried flesh obscures details of the structures within. Furthermore, because many archaeological seeds are fragmented and/or charred, modern comparative specimens often need to be reduced to a similar state to be of use for identification. This precludes the use of material presently housed in herbaria and stresses the need for the establishment of a collection devoted specifically to archaeobotanical purposes.

The establishment of a comparative reference collection of fruiting structures and seeds is a time-consuming task. Abundances of fruit may vary from year to year and some years certain species may not bear fruit at all. Often it is difficult to find enough seeds for a sample representative of the range of variation within the species. Furthermore, in view of the variability of the seeds from different specimens of the same species, it is advisable to make collections from as many individuals in as many different situations as possible.

It is important to collect all parts of the fruits. In many cases the archaeological seed is not preserved and identification is of other parts of the fruit such as the hard stony endocarp that surrounds the seed/s in drupes such as *Grewia* spp., *Harpephyllum caffrum* and *Sclerocarya birrea*; the hard woody shell that encloses the flesh pulp and seeds of some *Strychnos* spp.; and the valves that protect the seeds of leguminous plants e.g. *Millettia grandis* and *Acacia* spp.

The degree of preservation of the modern sample can sometimes affect identification. Often the similarity between the archaeological seeds and modern seeds is only recognisable once the modern seeds have been subjected to a certain amount of weathering. This is the case with *Harpephyllum caffrum* endocarps and with *Xylotheca kraussiana* seeds where the distinctive features are only evident once the modern seed has been damaged in the hilum area.

3.2.2 Difficulties caused by Similarity between Taxa

Although most species have distinctive seeds, some taxa that are distinguished on the basis of flower characteristics may produce similar seeds. This is the case particularly with Rubiaceae. Some *Lagynias lasiantha* seeds may be distinctive to the species but the variation of shape and size of seeds within the species may be such that some *L. lasiantha* seeds are indistinguishable from *Vangueria infausta* seeds.

V. infausta seeds are often indistinguishable from *Pachystigma macrocalyx* seeds. Similarly, seeds from different species in the *Canthium* genus may be difficult to tell apart. For this reason some taxa have been identified only to genus or tribe level.

3.2.3 Effect of Preservation on Identification of Seeds

The identification of seeds is often adversely affected by poor preservation. Definitive features such as surface details on testa are often fragile and the first to decay. Results are compromised accordingly.

3.3 Interpretation of Results

The interpretation of results follows recovery and identification of the seeds and is influenced by the many biases in these procedures. The agents of deposition (accumulation and redistribution) and the analytical methods employed with respect to quantification also have bearing on the results and their interpretation. As I stated earlier, I dedicate a separate chapter to agents of accumulation and post-deposition (Chapter 5). In the remainder of this chapter I discuss approaches to quantification.

3.3.1 Determination of Absolute Counts

Seed analyses are usually based on the frequency of charred whole seeds and the determination of absolute counts is the first step in quantification. I have discussed why uncharred seeds are used in this study (Chapter 3.1.2) and will now discuss why and how I have quantified seeds that are not whole. Practically, unless one has seen a number of seeds from a particular taxon, it is very difficult to recognise the seed or identify it. After working with a certain taxon repeatedly it becomes so familiar that one can sometimes recognise the species by a fragment of a seed. In some instances only fragments of seeds rather than whole seeds remain and the system I use incorporates these fragments.

Some researchers make up ‘whole’ seeds by combining fragments of seeds (Wintjes 2003) but I find this method tends to be subjective. A more accurate method is to separate the seeds into three categories: whole seeds, broken seeds that are larger than half a seed and broken seeds that are smaller than half a seed. Seeds sometimes break exactly in half, e.g. occasionally *Apodytes dimidiata* breaks exactly in half, and in such cases the seeds are included in the greater than half a seed category. This might inflate the frequency but the inflation will be consistent for the species.

For certain species the three-tier frequency grouping, or fragmentation index, is not the best method of quantification. Calculation of mass or volume is an alternative but often the frequency of a species is so low that mass measurements need sophisticated and expensive machinery. I did not calculate masses because the apparatus is currently unavailable to me. An inherent problem with mass measurements is that mass can be affected by charring; charred seeds have a lower density and thus lower mass than uncharred seeds. Rather than use mass measurements, methods of counting appropriate to the specific species are preferable and rather than using a fragmentation index, a distinctive feature can be selected on which to base a single count. Each seed has one hilum, which is the scar where the seed was attached to the ovary and so counting of the hilums is a good approach. In this study the most common species are identified by their stones rather than their seeds, e.g. *Harpephyllum caffrum*, *Canthium* spp., *Commiphora* spp. and Vanguerieae. The point of attachment of the seed is frequently absent, especially with the Rubiaceae (*Canthium*, other Vanguerieae) where the stone (pyrene) invariably splits or breaks in this area. *Cryptocarya latifolia* has a single ovule in an ovary enclosed by a receptacle (Ross 1972:171) that becomes hard (Coates Palgrave 2002:215). These are the little ‘wooden balls’ also called ‘crustaceous shells’ that are frequently washed up on beaches along the East Coast (Muir 1937:40). The scars and thickening caused at the points of the persistent calyx and the attachment to the stalk at opposite ends of *Cryptocarya*’s receptacle are distinct and in this study would have served better as frequency markers than a measure of fragmentation of the receptacle.

It is not important that the frequency calculation methods are the same for different species, only that they are constant within a species and that they are clearly recorded for each species. In this way valid intra-site and inter-site comparisons of specific species are applicable. I describe the fruiting structures used to define seed counts of the different taxa in this study in Appendix B.

A whole seed is not essential when one is considering absence/presence of taxa, although the chance of mis-identification is greater with a single fragment. If a single seed (or fragment) of a taxon is found in a layer above or below another layer in which the taxon is very abundant one might consider the single representative to be out of context. On the other hand, if only one seed of a particular taxon is found in a number of layers the single seeds assume greater importance, although the interpretation is not straight-forward: rare seeds in the deposit may not necessarily be a reflection of the abundance of the species in the surrounding vegetation. The presence of a rare seed is important in vegetation studies although Shackelton and Prins (1992:631) believe that trends of increasing or decreasing abundance of chosen indicator species should be accorded greater emphasis than erratic changes in the abundance of rare species. Their work concerns the effect of firewood collection strategies on the vegetation and suggests that changes in abundance may be the result of collection strategies rather than climatic change. I discuss changes in the abundances of seeds of indicator species (Chapter 6 Discussion of Results).

Some species can appear rare depending on what criteria are used to record their presence. For example, *Canthium* spp. seeds are seldom found whole but *Canthium* spp. seeds are nevertheless very common. If only whole *Canthium* seeds were recorded the total for the assemblage would be 21. But using the method of recording fragments larger than or equal to half as a single count, the total is 1212 seeds for the assemblage. Quantifying seeds according to degrees of fragmentation (or completeness) can be informative in other ways too. For example, I identified 7 whole seeds, 38 fragments that are more than half a seed and 704 fragments smaller than half a seed of *Calodendrum capense* (the Cape chestnut). The Cape parrot cracks open *C. capense* to get at the nut inside (Fry *et al.* 1988) so the high degree of fragmentation could be an indication that the Cape parrot is the agent of accumulation. Presumably the *C. capense* tree would need to be quite nearby, perhaps on the cliff above, because the parrot would probably sit and feed in the tree. African Olive-Pigeons (previously Rameron pigeons) and Samango monkeys also eat *C. capense*, amaXhosa hunters use the plant for good luck, the plant is widely used for various medicinal purposes (parts of the plant used are not specified) and the leaves are used for toothache (Pooley 1993; Van Wyk and Gericke 2000). It is difficult to estimate the effects of these agents on the hardy seed coats. The high frequencies of *C. capense* fragments are from the same squares as the whole seeds, which suggest that preservation differences are probably not a factor causing increased fragmentation.

3.3.2 Frequency Measurements and Statistics

‘Because archaeobotanical data have certain limitations and biases, raw counts and weights of botanical material are usually transformed in ways that make the material more easy to compare and interpret’ (Lennstrom and Hastorf 1992:220). ‘We use quantitative measurements to describe the patterning found in data and to distinguish the patterning defined by our research questions from other sources of patterning’ (Popper 1988:53). Quantitative evidence is needed for economic interpretations (Van der Veen and Fieller 1982:287) and environmental data must always be quantified to answer questions on the domestication of species and what proportions were collected (Watson *et al.* 1984:142). The choice of the method used depends on the research questions as well as practical considerations such as the time and difficulty involved in each method (Orton 2000:163). No single quantitative method is suitable for every research question or every analysis (Kintigh 1987:130; Popper 1988:60). The methods used to quantify data are absolute counts, ubiquity, ranking, diversity and ratios. I discuss the various methods.

Absolute Counts

Absolute counts or *richness* refers to the raw number of each taxon in a sample. The sample size often has a crucial bearing on the richness value that tends to get larger as the size of the population increases (Cochrane 2003). Absolute frequencies may reflect accumulation, preservation, sampling and various other factors and cannot be assumed to accurately reflect past human-plant interaction. At least, absolute counts need to be standardized or converted into ratios to account for differences in sample size or sample abundance (Popper 1988: 60). In this study I convert the absolute counts into a density ratio.

The density ratio is only relevant for intra-species comparison because of differential seed production of each species. As described in the discussion on ranking (see below) *Halleria lucida* produces numerous minute seeds whereas *Sclerocarya birrea* produces only two or three much larger ones. Also, it is important to note the criteria selected for determining a single count, namely whether the frequency is based on seeds themselves as would be the case with *H. lucida* or on other parts of the fruiting structure such as the stone that encases the seeds of *S. birrea.*

Ubiquity

Ubiquity, also known as *percentage presence* (Pearsall 2000:194), *presence value* or *frequency* (Miksicek 1988:238), is a statistic that has been borrowed from quantitative ecology and measures how commonly representatives of a taxon occur in independent samples. Ubiquity records only absence or presence of a taxon and disregards the absolute count of a taxon. The frequency score is the number of samples in which the taxon is present, expressed as a percentage of the total number of samples in a group (Popper 1988:60-61). The score of one taxon does not affect the score of another and thus the scores of different taxa can be evaluated independently. Hubbard (in Popper 1988:61) cautions that presence values can be compared within taxa, but probably cannot be used to compare the absolute importance of different taxa directly, e.g. wheat with a 70% presence (P) might be five times more important than hulled barley taxa at 70% P. But Popper (1988:61) states that ubiquity/frequency/ presence scores can provide information on the relative importance of taxa.

The results of ubiquity analysis are highly dependent on the grouping of samples. Incorrect assessments of the homogeneity of deposits or differences in context will skew results. Each taxon in each analytical unit receives equal weight so if one sample is mistakenly split into two analytical units the scores will be artificially inflated. Similar problems arise when independent samples are mistakenly grouped. Mistakes alter the frequency scores less significantly when a group contains many samples (Popper 1988:61). Having few samples more severely skews the frequency scores of rare data, so with few samples rare taxa should be excluded from analyses or interpreted with caution (Popper 1988:63). Too few samples can also inflate frequency scores e. g. in a group of four samples the minimum presence is 25%, in a group of 20 samples the minimum presence is 5% and comparing scores from the two groups can be misleading. Each sample for ubiquity analysis has to be of independent context and neither spatially nor stratigraphically does the Sibudu assemblage provide an adequate number of samples for ubiquity analysis. An adequate sample size is difficult to determine but ‘a taxon whose ‘real’ presence is 10% cannot be properly assessed with less than 10 samples’ (Popper 1988:63). In the second millennium AD deposits at Sibudu there are only four different layers and insufficient discrete activity areas per layer for meaningful ubiquity analyses.

Kadane, a statistician, has illustrated mathematically, via a complicated algebraic calculation that includes various preservation possibilities, that ubiquity, just like counts, does depend on volume and preservation (Kadane 1988). Ubiquity analysis can reduce but does not eliminate the differences in preservation and sampling (Popper 1988:64) and the ubiquity score can reflect the relative presence of the taxa between the layers (Popper 1988). However, it does not necessarily reflect the surrounding vegetation. ‘In interpreting ubiquity scores, it is important to make explicit the relationship between the ubiquity scores and the information we seek’ (Popper 1988:63).

Ranking

Ranking translates the absolute counts of data into an ordinal scale and requires high counts of taxa (Popper 1988:64). It comprises a *relative scale* ranging from trace (E) to abundant (A) or + for fewer than 10 seeds, ++ for tens of seeds, +++ for hundreds of seeds and ++++ for thousands of seeds (Wintjes 2003). Although ranking limits further statistical analysis, it may be the most realistic approach considering the vagaries of differential preservation and recovery (Miksicek 1987:238). These ranking schemes have inherent problems. Although a count of 99, for example, is close to a count of 101, 101 will receive a different rank to 99 and will be accorded the same rank as 999. Furthermore this ranking is based on groupings of absolute counts and so it is not significantly different from absolute counts in terms of interpretation potential. Comparisons of absolute counts of the seeds of different species are meaningless in calculations of the relative importance of the different species in a diet and also in terms of relative abundance of species in the target population, i.e. the vegetation around the cave. The reason for this is differential preservation and that different species have different numbers of seeds and produce different amounts of flesh on fruits that can be of widely differing sizes and nutritional value. For example, the 10mm-diameter berry of *Halleria lucida* (tree-fuschia) has numerous minute seeds whereas the 350mm-diameter drupe of the highly nutritious *Sclerocarya birrea* (marula) has only two to three seeds.

Popper describes a ranking scheme that aims to measure plant frequencies by estimating and adjusting for non-cultural sources of patterning (Popper 1988:64). For each taxon she separately determines a scale of abundance that sets a frequency within each rank. The most important non-cultural sources of patterning in the data, e.g. preservation potential or seed production, are the criteria for determining a scale of abundance for each taxon within each rank. The scale is set to neutralize the biases introduced by the important sources of patterning and is especially useful for interpretations of the relative importance of domesticated species. With domesticated species the agents of accumulation are less ambiguous than with indigenous species where it is impossible to determine the specific agents (see Chapter 5) or to devise a ranking scheme to eliminate the bias they introduce.

The potential of the ranking scheme described by Popper (1988) to compare plant frequencies more accurately may be exceeded by the complications and potential errors in the subjective weighting of taxa frequencies to determine the scales of abundance, or the ranking intervals specific to each taxon.

Ratios

The simplest measure to standardize data is the ratio (Pearsall 2000:196). Standardizing ratios are used to compare samples of unequal size, samples from differing circumstances of deposition or preservation, and quantities of different categories of material that are equivalent in some respect (Miller 1988:72). It is not easy to choose which values to compare, nor to assign a valid meaning to the ratio. Common ratios are density measures, percentages, proportions and comparison ratios. I discuss them briefly.

Typically, the number or weight of an item in a given amount of sediment will give a *density measurement*, or *seed concentration index* (Miksicek 1987) which can be used to test assumptions of uniform deposition, preservation and recovery rates (Miller

1988:73). ‘Density of botanical material is one of the most important and basic measures for interpreting depositional and preservational variability’ (Miller 1988:83). In this study I have calculated the number of seeds per volume (density) to standardize for differing sample sizes. A *percentage* or *relative abundance measure* (Miksicek 1987) is a proportion multiplied by 100 and it standardizes the contents of samples to compare the importance of one taxon relative to other taxa from sample to sample. The numerator and denominator must be expressed in the same unit of measurement, e.g. the proportion of seeds in a particular taxon relative to all the seeds in the sample. Percentage frequency can give an indication of replacement of one category of material by another and can be used to assess the variability of samples due to circumstances of preservation and context (Miller 1988:74). Pearsall (2000:196) cautions that, because percentages are relative rather than absolute measures of abundance, it is impossible to determine with certainty which taxa are actively changing in occurrence and which only appear to be changing because all must sum to 100%. *Comparisons* are ratios that compare relative amounts of two mutually exclusive variables and can be used to assess the effects of different preservation contexts or to identify different use contexts (Miller 1988:75), for example the seed: charcoal. *Averages* are used to simplify data and are best for uniform circumstances of deposition and preservation. However, certain deposits can be weighted to standardize for vagaries in these factors. In summary, ratios allow comparison of samples in spite of inherent variability in accumulation, redistribution, preservation and recovery of remains.

Diversity

Diversity describes the composition of a plant assemblage. Diversity measurements are useful for summarizing groups of data. They do not involve individual taxa, as do ranking and ubiquity (Popper 1988). The Shannon-Weaver information index is an example of a diversity measure and incorporates the total number of taxa in an assemblage and the relative abundance of each taxon. High diversity indicates many taxa evenly distributed and low diversity indicates few and unevenly distributed taxa (Pearsall 2000:130). However, few species of high evenness can give the same index as many species of low evenness (Pielou 1977:292 in Popper 1988:66). Two samples with the same diversity index may contain different taxa. Differences in seed production and preservation are once again factors that cannot be ignored. Nevertheless, Pearsall

(2000:211) states that calculating diversity for a series of phases at a single site, where preservation bias is presumed to be reasonably constant, can give insight into changing patterns of plant exploitation or reveal change in site function.

Summary of Discussion of Quantification Measurements

It is vital to fully understand the interpretive value of the measurement that is used and Pearsall (2000) cautions against using methods that are not fully understood or are too rigorous for the data available. It is not possible to generalize about the suitability of a particular quantitative method. Both the condition of the material and the research question are important in determining the method used (Popper 1988:70).

The information this study seeks is about past vegetation. Changes in vegetation are identified by marker species that are restricted in distribution and by variations in the abundances of the most commonly occurring species. Abundances, or absolute counts of the archaeological seeds of indigenous taxa, are too dependent on too many factors to be of any valid interpretative value. For example, differential preservation, sampling, diverse agents of deposition and various other factors in the recovery and identification of the seeds affect abundances. Many of these biases are unpredictable and abundances cannot be weighted to accommodate these variations. These issues will be discussed again in Chapter 6.

CHAPTER 4

RESULTS

4.1 **Qualitative Results**

4.1.1 Absence/Presence of Taxa

Seventy-three taxa were identified to tribe, genus or species (Table 4.1) Twenty-three more taxa, represented mostly by a single seed, dried fruit or capsule, were distinguished but not identified (Table 4.2). Thirty-one of the identified taxa were found in all layers.

Table 4.1: Identified seed taxa from second millennium AD layers at Sibudu Cave

	Surface	Dung	BSV	BSS
Adenia gummifera			*	*
Allophylus sp.			in pit	
Antidesma venosum	*		*	*
Apodytes dimidiata	*	*	*	*
~Arachis hypogaea			*	
Asparagus sp.			*	*
Bridelia micrantha	*	*	*	*
Calodendrum capense	*	*	*	*
Canthium sp.	*	*	*	*
Capparis tomentosa	*	*	*	*
Carissa bispinosa			*	
Celtis africana	*	*	*	*
Celtis mildbraedii	*	*	*	*
cf. *Chaetachme aristata*			*	
Chrysophyllum viridifolium	*	*	*	*
Commiphora harveyi	*	*	*	*
Commiphora woodii	*	*	*	*
Commiphora sp.	*	*	*	*
Cordia caffra	*	*	*	*
Croton sylvaticus	*	*	*	*
Cryptocarya latifolia	*	*	*	*
Cryptocarya woodii	*	*	*	*
Cryptocarya sp.	*		*	*
Cucurbits Type 1	*	*	*	*

Table 4.1 cont/d: Identified seed taxa from second millennium AD layers at Sibudu Cave

	Surface	Dung	BSV	BSS
Cucurbits Type 2	*	*	*	*
Cucurbits Type 3	*	*	*	*
Curcurbitaceae	*		*	
Cucurbit gourd	*	*	*	*
Cussonia sp.			*	*
Dalechampia capensis	*			
Diospyros sp.	*			cf.*
Drypetes arguta	*	*	*	*
Ekebergia capensis	*		*	
Embelia ruminata	*			
Grewia occidentalis	*	*	*	*
Harpephyllum caffrum	*	*	*	*
Helinus integrifolius	*			
Hippobromus pauciflorus			*	
Justicia campylostemon			*	
cf. *Kraussia floribunda*			*	
Lannea edulis	*	*	*	*
Manilkara discolor	*			
~ Melia azedarach	*	*	*	*
Millettia grandis	*			
cf. *Pavetta* sp.			*	
Poaceae			*	
Protorhus longifolia	*		*	*
~Prunus persica	*			
Psydrax sp.	*		*	
Pupalia lappacea	*		*	*
Pyrenacantha cf. *scandens*			*	
Rauvolfia caffra	*		*	
Rhoicissus digitata	*			
Rhoicissus tomentosa				*
Rhus sp.			*	*
~Ricinus communis var. *minor*	*	*	*	*
~Ricinus communis var. *major*			*	*
Rubiaceae			*	
Sclerocarya birrea	*	*	*	*
Sideroxylon inerme	*	*	*	*
Syzygium cordatum	*			*
Strychnos sp.	*			
Strychnos gourd	*	*	*	*
Trema orientalis			*	
Tribulus sp.		*		
Trichilia sp.			*	
Uvaria caffra	*	*	*	*
Vanguerieae	*	*	*	*
Vepris lanceolata	*		*	*
Vitaceae			*	
~Vitis vinifera	*			
Xylotheca kraussiana	*	*	*	*
Ziziphus mucronata	*	*	*	*
Totals	52	33	59	44

~ = exotic taxa   * = presence

Table 4.2: Unidentified seed taxa from second millennium AD layers at Sibudu Cave

	Surface	Dung	BSV	BSS
Type 1	*		*	*
Type 2			*	*
Type 3	*		*	
Type 4	*			
Type 5	*		*	
Type 6			*	
Type 7	*		*	
Type 8	*		*	
Type 9		*		
Type 10			*	
Type 11			*	
Type 12			*	
Type 13			*	
Type 14			*	
Type 15			*	
Type 16			*	
Type 17	*		*	
Type 18	*		*	*
Type 19			*	
Type 20			*	*
Type 21				*
Type 22				*
Type 23			*	
Totals	0	0	0	0
% Frequency	15	3	32	14
Density	0.02	0.004	0.01	0.003

* = presence

% Frequency = number of unidentified taxa per layer **:** number of identified taxa per layer x 100

Density = number of unidentified taxa per litre of deposit

Table 4.3: Structure (growth forms) of identified taxa from second millennium AD layers at Sibudu Cave

	trees			shrubs	climbers	Other
	large	medium	small			
Adenia gummifera					*	
Allophylus sp.			*	*		
Antidesma venosum			*			
Apodytes dimidiata	*	*	*			
Calodendrum capense	*	*				
Canthium sp.		*	*			
Capparis tomentosa				*	*	
Carissa bispinosa				*		
Celtis africana	*	*	*	*		
Celtis mildbraedii	*					
cf. *Chaetachme aristata*	*	*	*	*		
Chrysophyllum viridifolium	*	*				
Commiphora harveyi		*	*			
Commiphora woodii	*					
Cordia caffra		*	*			
Croton sylvaticus	*	*				
Cryptocarya latifolia	*					
Cryptocarya woodii		*	*			
Cussonia sp.			*			
Dalechampia capensis					twining	perennial herb
Drypetes arguta			*	*		
Ekebergia capensis	*	*				
Embelia ruminata				*	*	
Grewia occidentalis			*	*		
Harpephyllum caffrum	*	*				
Helinus integrifolius					*	
Hippobromus pauciflorus			*	*		
Justicia campylostemon				*		
Kraussia floribunda			*	*		
Lannea edulis						suffrutex
Manilkara discolor	*	*				
Millettia grandis	*	*			*	
Protorhus longifolia	*	*				
Pupalia lappacea				*		
Pyrenacantha cf. *scandens*					*	
Rauvolfia caffra	*					
Rhoicissus digitata				*	*	
Rhoicissus tomentosa				*	*	
Sclerocarya birrea		*				
Sideroxylon inerme		*	*			
Syzygium cordatum		*				
Trema orientalis		*	*	*		
Tribulus sp.						annual herb
Trichilia sp.	*	*				
Uvaria caffra				*	*	

Table 4.3 cont/d: Structure (growth forms) of identified taxa from second millennium AD layers at Sibudu Cave

	trees large	 medium	 small	shrubs	climbers	Other
Vepris lanceolata	*	*	*	*		
Xylotheca kraussiana			*	*		
Ziziphus mucronata		*	*			
Totals	18	23	19	18	12	3

* = Presence

Sources: Coates Palgrave 2002; Moll 1992; Pooley 1993.

Absence/Presence of Indigenous Taxa

Composition (Vegetation Structure) of Identified Indigenous Taxa

The identified indigenous taxa consist predominantly of trees and shrubs and to a lesser extent, climbers (Table 4.3). Grasses, herbs, forest undergrowth species and suffrutices are rare. A suffrutex is a plant with a large underground woody stem that is able to withstand fire and subsequently send up new shoots.

Specific Identifications of Indigenous Taxa

Of the indigenous taxa common to all layers, 24 were identified to species, 2 to genus (*Canthium* spp., *Strychnos* sp.) and 1 to tribe (Vanguerieae). The indigenous taxa are *Apodytes dimidiata* (White-pear), *Bridelia micrantha* (Mitzeerie), *Calodendrum capense* (Cape-chestnut), *Canthium* sp. (Turkey-berry), *Capparis tomentosa* (Woolly Caper-bush), *Celtis africana* (White-stinkwood), *Celtis mildbraedii* (Red-fruit White-stinkwood, previously Natal white stinkwood), *Chrysophyllum viridifolium* (Fluted-milkwood), *Commiphora harveyi* (Copper-bark Corkwood), *Commiphora woodii* (Forest Corkwood), *Cordia caffra* (Septee Tree), *Croton sylvaticus* (Forest Croton), *Cryptocarya latifolia* (Broad-leaved Wild-quince), *Cryptocarya woodii* (River Wild-quince), *Drypetes arguta* (Water Ironplum), *Grewia occidentalis* (Cross-berry), *Harpephyllum caffrum* (Wild-plum), a suffratex *Lannea edulis* (Wild Grape), *Sclerocarya birrea* (Marula), *Sideroxylon inerme* (White Milkwood), *Strychnos* sp. (Monkey-orange), *Uvaria caffra* (Small-fruit Cluster-pear), Vanguerieae (Medlars), *Xylotheca kraussiana* (African Dog-rose) and *Ziziphus mucronata* (Buffalo-thorn).

Antidesma venosum (Tassel-berry), *Protorhus longifolia* (Red-beech) and *Vepris lanceolata* (White-ironwood) were found in all layers except Dung. *Asparagus* sp. and *Cussonia* sp. (Cabbage-tree) were found only in BSV and BSS, *Rauvolfia caffra* (Quinine-tree) and *Ekebergia capensis* (Cape-ash) were found in Surface and BSV. *Pupalia lappacea* (Forest burr) was found in Surface and BSS.

Some seeds were found in one layer only and were represented by low frequencies (Table 4.4). Although many of these seeds were broken they were identifiable to at least genus level. The seeds exclusive to the Surface layer were *Dalechampia capensis* (a perennial herb), *Diospyros* sp. (Star-apple/Jackal-berry), *Embelia ruminata* (East Coast Embelia), *Helinus integrifolius* (Soap Creeper), *Manilkara discolor* (Forest Milkberry), *Millettia grandis* (Umzimbeet), *Rhoicissus digitata* (Baboon Grape), *Strychnos* sp. [only one seed was found although *Strychnos* sp. gourd fragments were found in all layers], and *Syzygium cordatum* (Waterberry/Umdoni). *Tribulus* sp. ('Duwweltjie') an annual herb was found only in Dung. The taxa exclusive to BSV were *Carissa bispinosa* (Common/Forest Num-num), cf. *Chaetachme aristata* (Thorny-elm), *Hippobromus pauciflorus* (False Perdepis), *Justicia campylostemon* (Honey Justicia), cf. *Kraussia floribunda* (Rhino-coffee), cf. *Pavetta* sp. (Bride's-bush), Poaceae (grasses)[the single grain was a modern contaminant], *Pyrenacantha* sp. *scandens* (Blouboktoutjie), *Trichilia* sp. (Mahogany) and *Trema orientalis* (Pigeonwood). A single *Allophylus* sp. (False-currant) was recovered from a pit in BSV. *Rhoicissus tomentosa* (Common Forest Grape) was found only in BSS.

Table 4.4: Frequencies of less common seeds from second millennium AD layers at Sibudu Cave

n < 10	Surface	Dung	BSV	BSS
Adenia gummifera			(1)3	1
Allophylus sp.			1	
Antidesma venosum	1		(3)6	(1)1
~*Arachis hypogaea*			1	
Asparagus sp.			(1)1	(1)1
Carissa bispinosa			(1)1	
cf. *Chaetachme aristata*			(1)1	
Cryptocarya latifolia	1	2	(1)3	(1)3
cf. *Cussonia* sp.			(3)4	1
Dalechampia capensis	1			
Diospyros sp.	3			
Embelia ruminata	1			
Helinus integrifolius	(1)1			
Hippobromus pauciflorus			(3)3	
Justicia campylostemon			1	
cf. *Kraussia floribunda*			(1)1	
Manilkara discolor	1			
Millettia grandis (pod fragment)	1			
cf. *Pavetta* sp.			(1)1	
Poaceae			(1)1	
~*Prunus persica*	1			
Pyrenacantha cf. *scandens*			1	
Rauvolfia caffra	1		(1)5	
Rhoicissus digitata	1			
Rhoicissus tomentosa				(2)2
Rhus sp.			(5)6	(1)1
Rubiaceae			1	
cf. *Syzygium cordatum*	1			
cf. *Strychnos* sp.	1			
Trema orientalis			2	
Tribulus sp.		1		
Trichilia sp.			(1)4	
Vitaceae			1	
~*Vitis vinifera*	(2)2			
10 < n < 50				
Ekebergia capensis	(3)3		(6)11	
Grewia occidentalis	(3)10	3	(3)21	(3)10
Protorhus longifolia	(3)5		(5)17	1
Psydrax sp.	7		(2)20	
Pupalia lappacea	(1)1			(11)11
Uvaria caffra	(3)5	2	(8)9	(6)8
Vepris lanceolata	(1)1		(9)9	(2)2

n = seeds greater than or equal to half a seed and whole seeds

( ) = whole seeds

~ = exotic taxa

Absence/Presence of Exotic Taxa

Melia azedarach (Syringa-berry) and *Ricinus communis* (Castor-oil Bush) were found in all layers. One peach (*Prunus persica*) and two grape (*Vitis vinifera*) pips were found in the Surface layer.

Cultigens

Cucurbits

Type 1 Cucurbits: The Valley Trust's Social Plant Use Project in Botha's Hill, KZN, has a comparative seed collection with a number of cucurbit seeds that are indistinguishable morphologically, but are cultivated for the different types of gourds they produce (*igula lamasi* (isiZulu) - calabash milk vessel, *inkezo enkuluyotshwala* - gourd ladle for beer, *iselwa* - edible calabash). Seeds of this shape and size were all categorized as Cucurbit Type 1 and could possibly include the indigenous *Lagenaria siceraria.*

Type 2 Cucurbits. These seeds could be from a range of edible pumpkins (*ithanga, igalonci, ibhece*) and melons (*ikhabe*), although the external morphologies of all the seeds appear to be the same.

Type 3 Cucurbits. These seeds did not correspond with Type 1 or Type 2 Cucurbit categories either because they were slightly different morphologically or because they lacked distinguishing features because of poor preservation.

Grains and grasses

No evidence of sorghum, millet or maize was found in the analysed squares. However, one possible maize kernel and one sorghum grain have been recovered from subsequent excavations.

Legumes

A fragment of the pod of *Arachis hypogaea* (Ground-nut) was found in BSV.

4.1.2 Seasonality of Species

Fruiting Times of Identified Species

The seasonality pattern is constant throughout the second millennium AD layers (Figures 4.1 to 4.4). Fruiting species that are represented at the site are present throughout the year. Charts for each layer, of the number of identified species that occur in each month, all show a preponderance of fruiting species in the late summer and early autumn months. The lowest numbers of fruiting species occur in winter.

Interpretation of Seasonality Data

The pattern indicated by the presence of identified fruiting species indicates that the cave was occupied, or at least visited, throughout the year. The preponderance of late summer/early autumn fruits is probably a reflection of the fruiting times of species rather than an indication of the habits or the frequency of visits by agents of deposition.

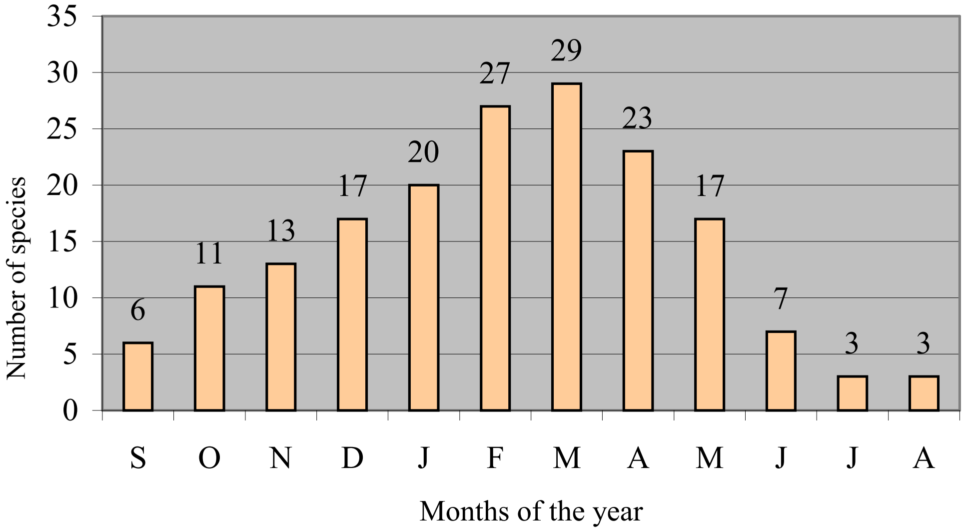

Figure 4.1: Fruiting times of species identified from Surface

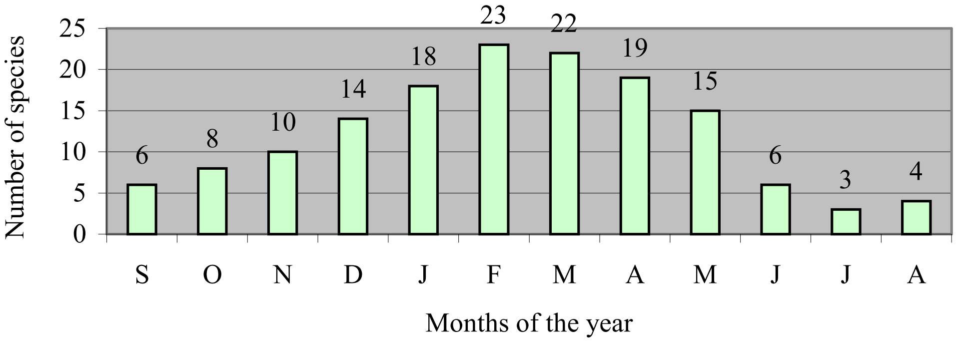

Figure 4.2: Fruiting times of identified species from Dung

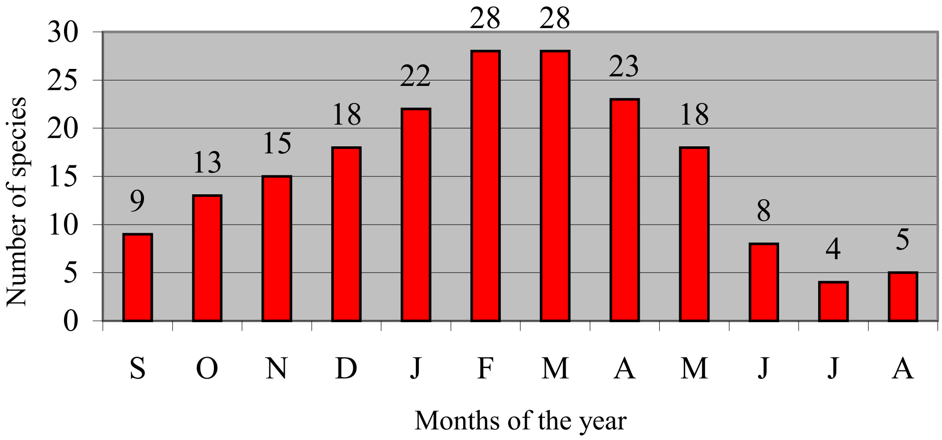

Figure 4.3 Fruiting times of identified species from BSV

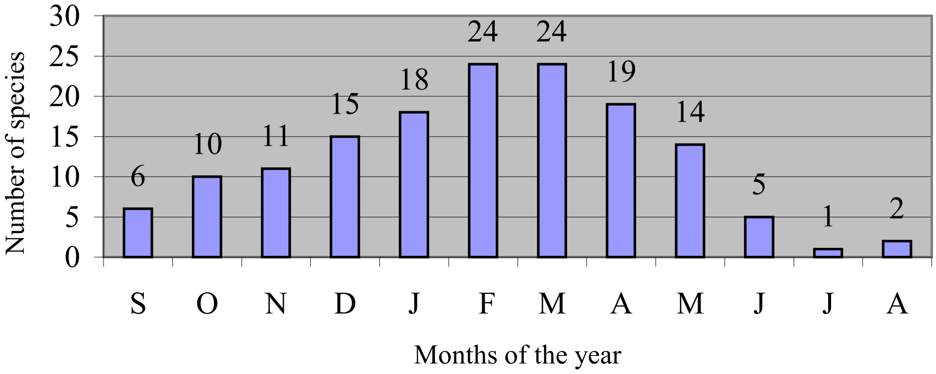

Figure 4.4: Fruiting times of identified species from BSS

4.2 Quantitative Results

4.2.1 Frequencies of Taxa

The seeds with the highest frequencies were invariably found in all layers (Table 4.5). *Cryptocarya latifolia*, *Grewia occidentalis* and *Uvaria caffra* were the only seeds that were recovered from all layers but did not occur in frequencies greater than 50 for the total assemblage (Table 4.4), i.e. all the other seeds that were found in all layers occurred in frequencies greater than 50.

Table 4.5: Frequencies of seeds where total number of seeds per taxon is greater than 50

	1		2		3		4		Total seeds
Apodytes dimidiata	BSV	45	Surface	22	Dung/BSS	1			69
Bridelia micrantha	BSV	75	Surface	14	Dung/BSS	2			95
Calodendrum capense	BSV	41	BSS	6	Surf/Dung	2			51
Canthium sp.	BSV	728	Surface	309	BSS	142	Dung	33	1212
Capparis tomentosa	BSV	31	BSS	29	Surface	6	Dung	0	66
Celtis africana	BSV	50	Surface	27	BSS	23	Dung	1	101
Celtis mildbraedii	BSV	55	Surface	24	Dung	7	BSS	2	88
Chrysophyllum viridifolium	BSS	53	BSV	42	Surf/Dung	1			97
Commiphora harveyii	BSV	217	Surface	129	BSS	24	Dung	4	374
Commiphora sp.	BSV	346	Surface	113	BSS	49	Dung	13	521
Cordia caffra	BSV	30	Surface	19	BSS	8	Dung	4	61
Croton sylvaticus	BSS	107	BSV	102	Surface	9	Dung	5	223
Drypetes arguta	BSV	53	BSS	16	Surface	9	Dung	0	78
Grewia occidentalis	BSV	31	BSS	13	Surface	9	Dung	3	56
Harpephyllum caffrum	BSV	1769	BSS	637	Surface	458	Dung	202	3066
Lannea edulis	BSV	33	Surface	15	BSS	13	Dung	1	62
Melia azedarach	Surface	103	BSV	87	BSS	11	Dung	1	202
Ricinus communis	BSS	400	BSV	167	Surface	16	Dung	13	596
Sclerocarya birrea	BSV	89	Surface	39	BSS	35	Dung	3	166
Sideroxylon inerme	Surface	53	BSV	50	BSS	4	Dung	1	108
Vanguerieae	BSV	255	Surface	85	BSS	45	Dung	6	391
Xylotheca kraussiana	BSV	32	BSS	21	Surface	6	Dung	3	62
Ziziphus mucronata	BSV	99	Surface	52	BSS	38	Dung	7	196

Frequency = number of seeds

Ranking: 1 = highest frequency, 4 = lowest frequency

Harpephyllum caffrum was by far the most common seed (3066) identified in every layer, followed by *Canthium* sp. (1212), *Ricinus communis* (596), *Commiphora* sp. (521), Vanguerieae (391), *Commiphora harveyii* (374), *Croton sylvaticus* (223) and *Melia azedarach* (202) (Table 4.5). The general trend was that the greatest frequencies of seeds from each species were recovered from the layer that produced the largest volume of deposit (Table 4.6), i.e. for 75% of the species which occurred in frequencies greater than 50, the highest number of seeds were recovered from BSV which produced 50% of the total deposit removed. In cases where the highest frequency was not from BSV, BSS, which yielded the second largest amount of deposit, had the highest frequency. The two exceptions to this pattern were the exotic syringa-berry, *Melia azedarach* and White milkwood, *Sideroxylon inerme,* which were more common in Surface than in BSV and BSS.

Table 4.6: Volumes of excavated deposit from second millennium AD layers at Sibudu Cave

	B5	B6	C2	C4	C5	C6	D2	D4	D5	D6	E2	E3	E4	E5	E6	Totals	% of total
Surface	35	40	20	20	30	40	20	80	20	20	25	10	30	15	45	450	10
Dung								55					67	103		225	5
BSV	90	180	80	70	290	240	115	10	250	390	98	58	30	55	245	2201	50
BSS	180	105	180	55	85	90	160	55	50	60	160	80	100	113	70	1543	35
Totals	305	325	280	145	405	370	295	200	320	470	283	148	227	286	360	4419	100

All volumes calculated on recorded buckets of deposit. 1 bucket = 10 litres
No volume was recorded for Surface C5. The estimated 30 litres, is the average for Surface squares.

Twenty-three of the 31 identified taxa, which were common to all layers, occurred in frequencies greater than 50, i.e. the sum of seeds of a particular taxon for the total assemblage [all the second millennium AD layers] exceeded 50. Twenty of the taxa represented by more than 50 seeds were identified to species level (Table 4.5). Thirty-three taxa were represented by fewer than 10 seeds each and six taxa were represented by 10 to 30 seeds (Table 4.4). No species occurred in total frequencies between 30 and 50 (inclusive). Most of the taxa designated type numbers (Table 4.2) occurred in very low frequencies and except for three taxa were represented by one to three seeds in a single context. The results do not include the material from the pits because of evidence of modern contamination in some pits and the difficulty of determining the level from which the pits were dug.

4.2.2 Densities of Taxa

The densities of taxa that were represented by more than 50 seeds in the total assemblage were calculated to even out the effects of differing volumes (Table 4.7).

Whereas the highest frequency of *Harpephyllum caffrum* seeds was recovered from BSV, the highest density of *Harpephyllum caffrum* seeds was for Surface: 1.02 seeds per litre of deposit. This was the general trend for most taxa. The highest density of seeds for 63% of the taxa occurred in Surface, and in 73% of the cases, this was followed by BSV.

Calculations of density, which incorporate time as well as frequency and volume, were not made because of lack of precise dates for the layers. Nor was it possible to correct for bias introduced by differing sample sizes.

Table 4.7: Densities of second millennium AD seeds at Sibudu Cave, where total frequency per taxon > 50

	1			2			3			4			Total density	Total frequency
	layer	density	freq.	layer	density	freq.	layer	density	freq.	layer	density	freq.		
Apodytes dimidiata	Surface	0.05	22	BSV	0.02	45	Dung		1	BSS		1	0.02	69
Bridelia micrantha	BSV	0.03	75	Surface	0.03	14	Dung	0.1	2	BSS		2	0.02	93
Calodendrum capense	BSV	0.02	41	Dung	0.01	2	Surface		2	BSS		6	0.01	51
Canthium sp.	Surface	0.69	309	BSV	0.33	728	Dung	0.15	33	BSS	0.09	142	0.27	1212
Capparis tomentosa	BSV	0.02	31	BSS	0.01	29	Surface	0.01	6	Dung		0	0.01	66
Celtis africana	Surface	0.06	27	BSV	0.02	50	BSS	0.01	23	Dung		1	0.02	101
Celtis mildbraedii	Surface	0.05	24	Dung	0.03	7	BSV	0.02	55	BSS		2	0.02	88
Chrysophyllum viridifolium	BSS	0.03	53	BSV	0.02	42	Dung		1	Surface		1	0.02	97
Commiphora harveyii	Surface	0.29	129	BSV	0.1	217	Dung	0.02	4	BSS	0.02	24	0.08	374
Commiphora sp.	Surface	0.25	113	BSV	0.16	346	Dung	0.6	13	BSS	0.3	49	0.12	521
Cordia caffra	Surface	0.04	19	Dung	0.02	4	BSV	0.01	30	BSS	0.01	8	0.01	61
Croton sylvaticus	BSS	0.07	107	BSV	0.05	102	Dung	0.02	5	Surface	0.02	9	0.05	223
Drypetes arguta	BSV	0.02	53	Surface	0.02	9	BSS	0.01	16	Dung		0	0.02	78
Grewia occidentalis	Surface	0.02	9	BSV	0.01	31	Dung	0.01	3	BSS	0.01	13	0.01	56
Harpephyllum caffrum	Surface	1.02	458	Dung	0.9	202	BSV	0.8	1769	BSS	0.41	637	0.69	3066
Lannea edulis	Surface	0.03	15	BSV	0.02	33	BSS	0.01	13	Dung		1	0.01	62
Melia azedarach	Surface	0.23	103	BSV	0.04	87	BSS	0.01	11	Dung		1	0.05	202
Ricinus communis	BSS	0.26	400	BSV	0.08	167	Dung	0.06	13	Surface	0.04	16	0.13	596
Sclerocarya birrea	Surface	0.09	39	BSV	0.04	89	BSS	0.02	35	Dung	0.01	3	0.04	166
Sideroxylon inerme	Surface	0.12	53	BSV	0.02	50	Dung		1	BSS		4	0.02	108
Vanguerieae	Surface	0.19	85	BSS	0.13	45	BSV	0.12	255	Dung	0.03	6	0.09	391
Xylotheca kraussiana	BSV	0.02	32	BSS	0.01	21	Surf/Dung	0.01	6/3				0.02	101
Ziziphus mucronata	Surface	0.16	52	BSV	0.04	99	Dung	0.03	7	BSS	0.02	38	0.04	196

Ranking: 1 = highest density, 4 = lowest density

Density = seeds/volume, based on total seed frequencies and litres of deposit for each layer

CHAPTER 5

AGENTS OF ACCUMULATION AND REDISTRIBUTION OF SEEDS

Archaeologists have long recognised that sites that at first glance appear to be ancient living areas are not exclusively the result of human activities and that post-depositional disturbance by natural and animal action has inevitably affected the archaeological record. The challenge is to recognise agents of accumulation and agents of redistribution and their effect on the archaeological remains.

It is important to identify agents of accumulation in order to recognise better the habitats from which the fruits originated. A larger number of agents is likely to represent a wider variety of plant species and vegetation niches. Marula, a highly palatable species, is likely to have been brought in by people and a number of animals but never birds (D. Johnson pers. comm.). If birds were identified as the only agents it is likely that marula would be absent from the deposit. This absence would affect interpretations of vegetation history. Birds are likely to favour the accumulation of smaller fruits such as *Asparagus* spp.

People introduce a range of ‘non-food’ seeds thereby representing more vegetation niches. *Millettia grandis* and *Ricinus communis* are both present in the Sibudu assemblage and neither is a food source for humans or animals. They are likely to have been introduced by people for medicinal reasons, or to have fallen in from the cliff above the cave. The presence of *Ricinus communis* implies disturbance of the vegetation, most likely as the result of human activities. These examples illustrate how the range of human activities and the variety of agents will affect the absence or presence of seeds, which in turn provides clues about surrounding vegetation. Identification of agents of accumulation is necessary for informed interpretation of vegetation change.

Identification of agents of redistribution and disturbance is also important because it demonstrates that vertical disturbance can occur. Vertical disturbance can mix seeds between layers and so can mask vegetation change or stasis.

I first present the results of a literature search on the agents of dispersal of fruits. Secondly I interpret the Sibudu assemblage in relation to the results of the search. Then I discuss natural forces as agents of dispersal and artefacts as indicators of agents. Following this I describe details of an actualistic study to identify agents of seed accumulation. Finally, I discuss disturbance and redistribution of seeds and draw conclusions about agents of accumulation and redistribution of seeds.

5.1 Literature Search for Agents of Seed Accumulation

The details regarding agents of distribution are taken mostly from literature (Coates Palgrave 2002; Fox and Norwood Young 1982; Hutchings 1996; Ngwenya *et al.* 2003; Palmer and Pitman 1961; Pooley 1993 1998; Quin 1959; Shone 1979; Smith 1966; Van Wyk 2003; Van Wyk and Gericke 2000; Venter and Venter 1996, Watt and Breyer-Brandwijk 1932 1962). Ornithologists and bird watchers (D. Allen; D. Johnson; J. Sievers) have provided further information on the eating habits of birds (Appendix C) and I have done tasting tests on fruits.

To a large extent the literature deals with birds, monkeys and people as agents of dispersal of fruits and seeds. Mention is also made of, amongst other agents, bats, bushbabies, bushpigs, duiker, nyala, impala, baboons and elephants. Porcupines take fruits back to their burrows (Apps 1992:51-53) and because caves and rock crevices are important daytime refuges (Taylor 1998), porcupines could conceivably have brought seeds into Sibudu Cave. The faunal sample from the archaeological deposits contains porcupine as well as bush pig, cane rat, hyrax and a medium-sized rodent (Plug 2004), which indicates these animals were all probably in the vicinity of the cave, and were possibly, although not necessarily, agents of seed accumulation.

Whereas seeds introduced by animals, mostly in their droppings, will have been eaten, people will introduce ‘food’ seeds (after Lepofsky and Lyons 2003) and ‘non-food’ seeds that are from plants used for purposes such as medicine, ritual or decoration. Seed rain from natural forces such as wind, gravity and water also introduces 'non-food' seeds into a deposit.

5.1.1 Agents of Accumulation of Indigenous Seeds

The available literature regarding the agents of distribution of the indigenous taxa that have been identified from the second millennium AD layers at Sibudu indicates that three main agents, namely birds, monkeys and people, could account for the presence of most of the identified species in the archaeological assemblage (Figure 5.1). The exceptions were a small number of plant species for which I could find no published or other information.

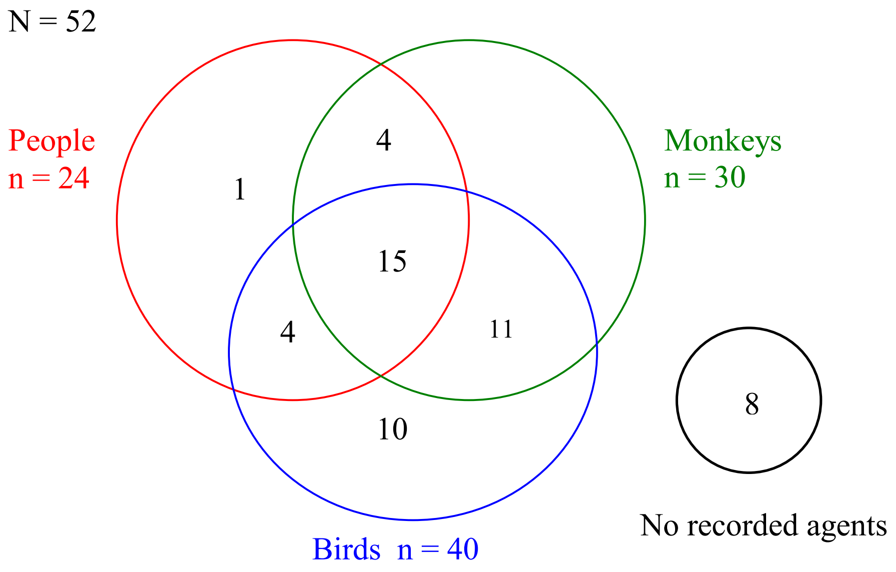

Figure 5.1: Agents of accumulation of identified indigenous taxa

Seventy-seven percent of the identified indigenous taxa could have been brought into the cave by birds. Forty-six percent of the taxa bear fruits that are eaten or used for other purposes by humans. *Millettia grandis* is the only species related to exclusively people as agents. People use *Millettia grandis* seeds ground and soaked in milk, to treat roundworm (Venter and Venter 1996:242). None of the identified seeds is dispersed by wind and because there is no evidence that the deposits were laid down by water (R.

Pickering pers. comm.), fruits that are dispersed by water e.g. *Cryptocarya latifolia*, must have entered the cave by other means.

5.1.2 Agents of Accumulation of Exotic Seeds

Although significant poisoning of humans apparently occurs only after large amounts of *Melia azedarach* (Syringa-berry) fruits have been ingested (Hutchings 1996:156), it is unlikely that humans collected the berries for food. In the East oil is extracted from the seeds for fuel and medicinal use but there is no record of this activity locally (Watt and Breyer-Brandwijk 1932:93). *M. azerdarach* seeds are likely to have been introduced to the cave by birds because most frugivores probably eat the fruit (D. Johnson pers. comm.). The fruit forms the staple diet of the grey go-away-bird in Johannesburg (*ibid*). *Melia* seeds could have been dropped by a closely related species, the purple-crested turaco, which has been observed (by me) in the vegetation at the mouth of the cave. Black-eyed bulbuls have also been observed on the cave margins and they eat *Melia* (Ward 1980:125). The *Melia* fruits could also easily have fallen off modern trees growing above the cave.

Birds do not eat *Ricinus communis* (D. Johnson pers. comm.). The seeds are toxic to humans in all but small quantities used for medicine, so it is likely that they would poison other mammals as well. The seeds could have fallen into the cave from above, or could have been brought into the cave by humans. *Ricinus communis* seeds are used as cures for toothache and mumps, as purgatives and to produce oils that are used as emollients (Van Wyk and Gericke 2000:22 210).

5.1.3 Discussion of Literature Search for Agents of Seed Accumulation

Three main agents of accumulation of seeds, namely birds, monkeys and people, could account for the presence of most of the identified fruit species from the archaeological assemblage and for this reason, other agents are not considered in detail. This does not negate their role as possible agents of accumulation of seeds in the Sibudu deposit.

The literature search on agents of accumulation of seeds indicates that it is extremely difficult, in the vast majority of cases, to pinpoint with any degree of accuracy the specific agent involved. The exact figures from the literature search should be viewed with some caution and the results should be assessed for the trends they indicate rather than in absolute terms. The trends are valid in spite of the inadequacies relating to studies of bird feeding habits and the lack of published records and comprehensive coverage of utilization or lack thereof of a number of plant species. Perhaps data on certain species has not been compiled or perhaps there are no known uses of the species by any living agent. I first examine issues relating to general inconsistencies in the data and then I discuss the bird data.

The literature on ‘what eats what’ is incomplete possibly because information on agents is not considered *de rigueur* or actively researched for plant species descriptions, but rather, it is included incidentally only when details are available. Inconsistencies or omissions are inevitable. Some examples follow. Birds and people eat *Bridelia micrantha* (Pooley 1993:218). No mention is made of monkeys although is it highly likely that if people eat the mitzeerie fruits, monkeys would too. The same would apply to the other three fruits, *Allophylus* sp., *Cordia caffra* and *Xylotheca africana*, which according to the literature are eaten by birds and people. Baboons, monkeys and birds eat *Celtis africana* fruits (Pooley 1993:64) and although no literature source records people eating the fruits, I have enjoyed delicious sweet dried *Celtis africana* fruits from a particularly large tree in Durban Botanic Gardens. [It is widely recognised that some individuals within a plant species may produce tastier fruits than others.] Humans and monkeys eat the fruits of *Uvaria caffra* (monkeys and I once shared the fruit from a profusely-fruiting specimen at Shongweni Resources Reserve), and it is likely that birds too would eat the small-fruit cluster-pear. Pooley (1993:96) states the *U. caffra* fruits are eaten by monkeys and children, an amusing and not uncommon association which probably stems from the observation that children, particularly herdboys, eat the widest range of indigenous fruits (Cunningham 1988:435).

The lack of detailed and comprehensive data in plant species descriptions, as outlined above, is also evident in bird studies where very little work has been done on the specific fruits eaten by frugivorous and omnivorous birds (D. Johnson pers. comm.). The broad literature survey (compiled by J. Sievers, see Appendix C) should prove to be a useful reference for other researchers as it is, to my knowledge, the first detailed specific review of the subject. Surprisingly, carnivorous birds can also introduce seeds to the deposit (D. Allen pers. comm.). A bird of prey, the lanner falcon, presently nests in the cliff above the cave. When lanners feed on frugivores e.g. doves, they discard the stomachs of their prey and these, which are likely to contain seeds, can fall directly down onto the deposit. This point is important because the lanner may deposit seeds from the stomach contents of birds that might otherwise not come near to the cave. It is not enough to identify the birds that eat particular fruits or nuts; it is also necessary to know whether these birds are likely to venture close enough to the cave to leave seeds in the deposit.

Inconsistencies in data and the lack of in-depth studies of the habits of birds in rock shelters are not the only problems. Language issues can also complicate descriptions of plant uses and agents of deposition in that one name may describe more than one plant species. This causes confusion in the translation of early travellers' records. Robert Struthers' hunting journal mentions 'the Intongwan tree of the fruit of which the Kaffirs make snuff boxes' (Merrett and Butcher 1991:51). The editorial note incorrectly identifies this tree as *Pouteria natalensis* (subsequently reclassified as *Englerophytum natalensis,* the Natal milkplum [Coates Palgrave 2002]), when it is correctly *Oncoba spinosa* the snuff-box tree. The isiZulu word *umThongwane* refers to four species: *Oncoba spinosa, E. natalense, E. magaliesmontanum* and *Cryptocarya woodii* (Pooley 1993).

It is clear that studies of literature alone are not sufficient to identify the agents of accumulation of seeds and that actualistic studies are needed to complement the data from the literature survey. A possible method to determine conclusively the agent of distribution of the seeds would be to demonstrate attributes of seeds deposited by specific agents. One could feed fruits to captive birds and observe resulting features on the seeds: for example, the endocarp of *Calodendrum capense* after a Cape parrot has broken it open for the kernel. Fruits fed to gnawing animals could be similarly studied. To identify whether people were agents, one could search in archaeological sites for durable materials that may have been used by people in the harvesting or preparation of indigenous fruits. For example, Rose Cottage Cave contained grindstones with plant residues on them (L. Wadley pers. comm.). A persisting problem is that even if one can show that the seeds were definitely introduced to the cave by a certain agent, it might not be possible to prove that it was the only agent.

In the following sections I shall examine natural forces as agents of accumulation and then discuss artefacts as indicators of agents of accumulation.

5.2 Natural Forces as Agents of Dispersal of Seeds

5.2.1 Wind

Strong winds affect the coastal belt of KwaZulu-Natal, shifting from predominantly N/NE to S/SW in response to seasonal cyclonic and anti-cyclonic activity (Turner and Plater 2004:221). Records from Durban International Airport (Ward 1980:10) indicate that the NE and SW winds occur with almost equal frequency over the year, although the NNE to ENE sector are more frequent during the latter part of summer (January to March). June is the calmest month although there is high frequency of calms and light winds from May to July. September has the greatest frequency of strong breezes and October has the lowest frequency value for calms and the highest velocity of winds. The strongest winds are S or SSW. By virtue of its WSW aspect, Sibudu Cave is largely protected from the NNE winds but the southerly winds swirl dust and cause unpleasant conditions in the cave, particularly when a long dry winter has led to the shedding of much of the foliage of the screening vegetation.

None of the identified seeds from the Sibudu assemblage is wind dispersed so aeroturbation (action of the wind) was probably not a major dispersal force except perhaps in conjunction with gravity.

5.2.2 Water

Coastal and hydrological systems within KZN are affected by ‘low-pressure systems moving up the coast and occasional cyclonic landfalls, for instance, Cyclone Demoina in 1984’ (Turner and Plater 2004:222). It is generally the SW wind that brings cold air and often rain (King 1982:35). It is surprising therefore, considering the very gentle angle of the ceiling, that the interior of the SSW-facing cave is protected from rain except in rare instances when there is a slight mist in the air towards the rear of the cave. Heavy rain will disperse seeds, especially on unvegetated slopes and when it has collected in gulleys, streams and rivers. Although Sibudu Cave was formed by water erosion there is no evidence to suggest that any of the second millennium AD deposits in the cave were laid down by water (R. Pickering pers. comm.) and water can thus be discounted as an agent of dispersal of seeds within the cave.

Organic material in deposits towards the rear of the cave is not well preserved. The distinct stratigraphic layering characteristic of the rest of the deposits also loses clarity towards the rear wall of the cave. Seepage of water may be responsible for this situation. Seepage of water is not likely to have introduced seeds but it does appear to have affected the preservation of organic remains.

5.2.3 Gravity

It is highly likely that many seeds fall into the deposit from the cliffs above the cave, and that the angle of their downward trajectory may be affected by strong winds.

5.3 Artefacts as Indicators of Agents of Seed Accumulation

5.3.1 The Relevance of Ethnographic Analogy to the Sibudu Assemblage

Lepofsky and Lyons (2003:1358) state that culturally significant properties of plants, for example, how well they preserve, how well they burn, and even how well they taste, are unchanging. This assumption of unchanging cultural perceptions underlies acceptance that plant usage that has been recorded amongst the descendants of the first agriculturists of southern Africa may have considerable antiquity. However, it is entirely likely that under conditions of stress plants that are presently ignored or are considered marginally palatable may have been harvested. Similarly, it is possible that tastes may differ among people and may have changed. It is likely that ethnographically recorded uses of indigenous plants amongst agriculturists have relevance back to at least 1300 AD because of the continuity of technological systems that has been recorded by other researchers (e.g. Huffman 2001; Maggs 1989; Whitelaw 1994).

5.3.2 Ethnographically Recorded Uses of Seeds

Extremely few non-cultigen seeds have recorded ethnographic uses. The only indigenous seeds from the Sibudu second millennium AD assemblage that have recorded ethnographic uses are *Sclerocarya birrea* and *Millettia grandis. Ricinus communis* is the only exotic seed found in the Sibudu assemblage that is used ethnographically. In contrast, many cultigens have edible seeds and the ethnographic use and preparation of these has received considerable attention e.g. *Sorghum* and other grains/grasses.

Although few fruits are collected for their seeds, many fruits are collected for the flesh that can be eaten fresh or processed for future consumption. It is likely that the indigenous fruits brought into the cave by people were mostly chosen for their flesh and that the seeds, with the exception of *Sclerocarya birrea,* were probably discarded. Non-food seeds could have been brought in for a number of reasons. They could have been brought in deliberately for medicine e.g. *Millettia grandis.* No seeds used specifically for ritual have been recovered from the deposits so it is unlikely that seeds were used for ritual purposes. Seeds could have been brought in unintentionally on kindling or firewood, for example, dried *Grewia* fruits on twigs, and dried *Canthium* fruits that remain on trees from season to season. Seeds could also have been brought in unintentionally on wood used for tools, for example, *Grewia* branches used as fire-sticks.

5.3.3 Artefacts used for the Processing of Fruits, Nuts and Seeds

Any foods that are harvested, processed, cooked or stored should leave residues on tools and in containers and residue analysis should give a broad indication of the food types. Often though, artefacts are multi-purpose and information from residue analysis may not be specific enough.

Although residues on pottery may not be specific, pottery can provide other indirect evidence of domesticated crops such as in the casts of *Pennisetum glaucum* or pearl millet seeds in potsherds found at Silver Leaves in the Mpumalanga lowveld (Klapwijk 1974). Pottery may bear yet further indirect evidence. Traditional preparation of finger millet (*Eleusine coracana*) in Western Uganda involves several episodes of roasting and the vigorous and constant stirring of the grains during heating results in a characteristic heavy abrasion pattern on the interior walls but not the base of relatively poorly fired pottery (Reid and Young 2000). These abrasions may be specific to finger millet preparation and may be dependent on the nature of the pottery. Detailed studies of the Sibudu pottery have not been made, but because it appears to be well fired it is unlikely to show such abrasions.

In a study of the Thembe Thonga agro-pastoralists of Maputaland, a wide variety of fruits (77 species), spinaches (27 species) and gums (2 species) was identified (Cunningham 1988). Of these only three species required special preparation with durable materials. Thorns and sharp slivers of bone were used to extract the kernels of *Parinari curatellifolia* and *Sclerocarya birrea caffra.* The skin of *S. b. caffra* was pierced with a short sharpened ungulate rib whilst making beer and the nuts were cracked on a stone slab with a stone hammer. *Strychnos* fruits were cracked open and the pulp was placed on woven laths and dried over a fire located inside a pit or inside a circular structure about 1m high also made of woven laths. A sharp flat instrument was used to remove the still moist pulp from the pips and after sun-drying the pulp was stamped in a wooden mortar, mixed with honey and then stored.

Both *Strychnos* sp. and *Sclerocarya birrea* are found at Sibudu and there are signs of human damage on bones from the second millennium AD layers at Sibudu. The bones are a rib fragment of a sheep/goat with a shallow cut mark and one edge smoothed either through wear or deliberate polish, a cattle scapula fragment with a shallow cut mark and a bone flake with one end polished, probably through use, to a roughly pointed shape (Plug 2004:155). The bones may have been used for a variety of purposes, including processing of fruit. Similar tools have been recorded for smoothing of hides and clay and so it is difficult to determine the specific uses of the Sibudu bone artefacts (I. Plug pers. comm.). Replication experiments could be useful to solve the question of the use of the bone tools.

I identified one *Acacia* thorn but as it had been handled it was not be suitable for residue studies. The characteristic Thembe Thonga 'marula grindstone' is not present at Sibudu although a shallow lower grindstone and a number of upper grindstones were recovered.

Lower grindstones with wide grinding areas were used to grind maize (T. Huffman pers. comm.). The Sibudu grindstone is not as large, heavy or as deeply grooved as an average maize grindstone and it is not out of place in pre-maize contexts (G. Whitelaw pers. comm.) The Sibudu grindstone came from BSV, a layer that predates the introduction of maize.

Yet further indirect ethnographic evidence can be found in locations used for the storage of foodstuffs, for example, pits, packed stone features and woven grain bins. A small piece of carbonized basketwork was found at Sibudu. It may have come from a woven basket used to carry milk.

5.4 Actualistic Study to Indicate Agents of Seed Accumulation

5.4.1 Aim

The aim of the study was to identify agents of seed deposition in the cave, specifically quantity and variety of seeds that were being brought into the cave by non-human agents. The assumption was that because the cave is not presently occupied by people nor visited by people who leave material evidence, fresh seeds would be present on the cave surface as a result of wind, falling from the cliff above, or the activities of birds, monkeys and small mammals. However, bits of fresh sugarcane stalk are occasionally found in the cave, and this suggests that people, perhaps children, are visiting the cave and leaving some evidence of their visits. Nonetheless it is reasonable to assume that people are playing a negligible role, if any, in the present accumulation of seeds.

5.4.2 Methods

An area of the cave that was not disturbed by excavation activities was selected and a 1m wide transect was set up perpendicular to the rear wall of the cave, from the rear wall of the cave to the drip line. Along the transect three $1m^2$ squares were marked out by an 8” nail at each corner. Square 1 was against the rear wall, square 2 was 5m from the rear wall and square 3 was 5m from square 2 (Figure 5.2). The squares were so positioned that square 1 was approximately level and situated the maximum possible distance from the drip line, square 2 was on slightly sloping ground and approximately half way to the drip line, and square 3 had the most sloping surface (from N to S) and was situated on the drip line.

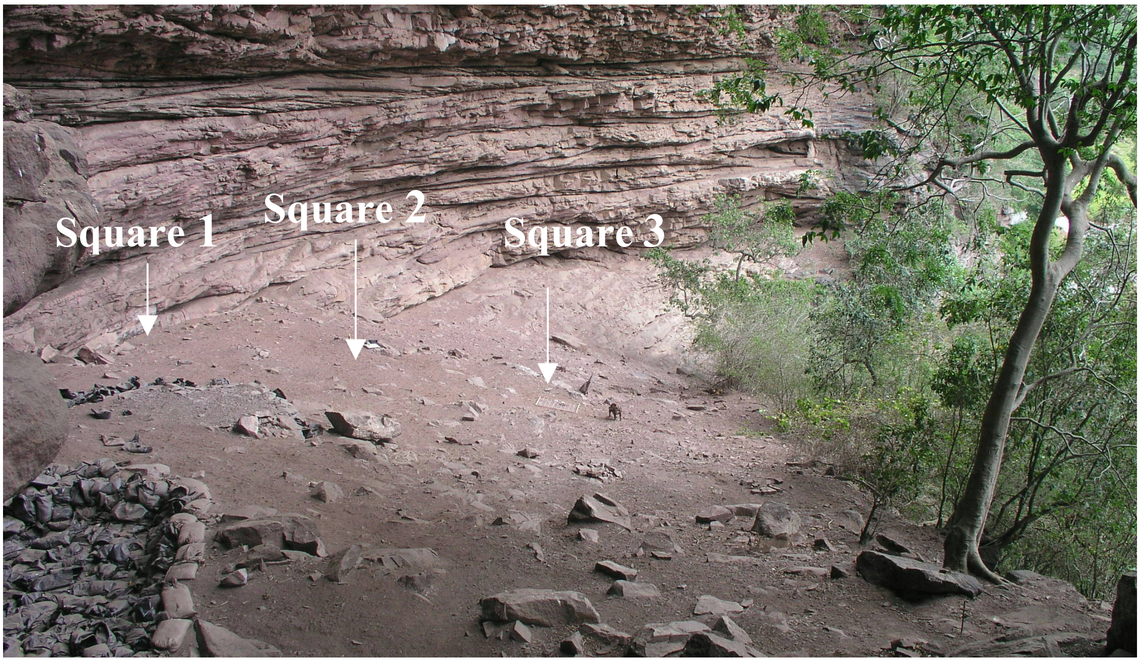

Figure 5.2: Location of squares selected for monthly plotting of seeds at Sibudu Cave

A 1m^2 grid with 10cm divisions was placed over each square and every seed visible on the surface within the grid divisions was plotted to the nearest centimetre, on a monthly basis from January 2003 until February 2004. The presence of ancient and fresh seeds was noted, as well as the absence of seeds that had previously been present.

5.4.3 Results and Discussion

Accumulation and Redistribution of Fresh Seeds

The regular monthly plotting of seeds on the surface of the cave has confirmed that non-human agents deposit the seeds of a number of species, namely *Antidesma venosum*, *Bridelia micrantha, Canthium* sp., *Celtis africana, Celtis mildbraedii, Commiphora harveyi, Cordia caffra, Cryptocarya woodii, Ekebergia capensis, Ficus* sp., *Harpephyllum caffrum, Manilkara discolor, Protorhus longifolia, Ptaeroxylon obliquum, Pupalia lappacea, Sideroxylon inerme, Strelizia nicolai, Strychnos gerrardii,* *Trichilia* sp. (probably *T. emetica*), *Uvaria caffra*, Vanguerieae, *Vepris lanceolata* and some small, unidentified but obviously wind-dispersed seeds. The *Ptaeroxylon obliquum* capsule and the other wind-dispersed seeds subsequently disappeared. Beyond the confines of the designated squares fresh *Drypetes arguta* and *Melia azedarach* seeds and a *Wrightia natalensis* pod were found. The rest of the cave surface was not investigated in detail but it appears that about 90% of fresh seeds that came into the cave were represented in the three chosen squares.

Spatial Patterns of Accumulation

At least 50% more of the taxa represented by fresh seeds were found at the entrance of the cave than were found at the rear of the cave. However, the unidentified windblown seeds were found in all squares and the single *Ptaeroxylon obliquum* capsule was found in square 1 at the rear of the cave.

Redistribution of Ancient Seeds

The concentration and the movement of seeds that were not fresh increased from the rear of the cave towards the drip line. Movement of seeds was erratic in terms of direction and distance, from a few centimetres up to 10 cm. There was no clear pattern to the distance and direction of the movement of the seeds. It appeared that the predominant movement was from north to south, the direction of slope. However, there was also movement upslope and deeper into the cave. I could find no statistical methods to test the validity of these observations.

Ancient seeds moved horizontally and vertically. For example in square 1, a *Rhoicissus tomentosa* seed first recorded in February 2003 disappeared until May; a *Canthium* sp. seed present in April 2003 was missing in May and reappeared in June. Although I did not quantify the trend it appeared that most seeds that disappeared did not reappear, at least not in the same position that they originally occupied. Because the ancient seeds were not marked in any way it was difficult to identify whether specific seeds had moved. For example, I could not tell whether the *Canthium* seed that appeared in the NE of square 1 in September 2003 was the same seed that had been about 80cm away in the SE of the square in August 2003. I felt more confident when movement was in the region of 10cm but even this confidence may be misplaced.

Variations in the Matrix of the Surface

The nature of the surface matrix varied between the rear and entrance of the cave. The matrix at the rear of the cave (square 1) had a fine silty appearance that showed up prints of humans, monkeys, birds and an unidentified small animal. However, the surface and depth of soft deposit varied at different times of the year. My footprints remained visible from March to April, and although there was a gusty wind during the July visit, my footprints from July remained visible in August. In September scouring was evident and the heads of the nails that had previously disappeared under soft silt were exposed by about 1cm.

The matrix in squares 2 and 3 was far coarser than in square 1 and although distinct footprints could not be seen in squares 2 and 3, there were often signs of disturbance, e.g. the movement of a 12 cm diameter piece of rock spall, and shallow indentations, possibly made by people walking by or the scuffling of animals.

Variations in the Monthly Frequencies of Seeds

Perhaps as a result of the matrix variation, the frequency of seeds visible on the surface varied from the rear of the cave to the drip line. For squares 1 and 3 the seed frequencies in August 2003 varied from 20 in square 1 (rear of cave) to 74 in square 3 (on the drip line). The seed frequency in square 3 increased to 102 seeds in September. Scouring by wind is likely to have caused this. Scouring was noted in square 1 in September. However the frequency presence for square 1 is reversed to that of square 3 and the seed frequencies in square 1 are 20 seeds in August and 17 seeds in September. The decreased frequency can be explained to a certain extent: the wind-borne *Ptaeroxylon obliquum* capsule and fresh *Commiphora harveyi* seed that arrived in August had gone by September and an unidentified seed had totally decomposed by September.

The total monthly frequencies often mask the accumulation and redistribution of seeds. For example, in square 1 the total frequency for both September and November is 17.

However, during the intervening months, two fresh and two ancient seeds had disappeared and four ancient seeds had appeared. The patterns varied for each square on a monthly basis. Because the main aims of the exercise have been fulfilled (Chapter 5.4.4. Conclusions) more detailed analysis of the accumulation and disappearance of all fresh seeds and the redistribution of all ancient seeds would not be profitable in terms of returns for time spent.

Various Agents Effecting Movement of Seeds

Wind

The matrix in square 1 against the rear wall of the cave provided a good example of the effect of the wind on the surface of the deposit. Scouring as well as accumulation of fine sediment occurred at different times of the year. It was not surprising therefore to note that ancient seeds were moving vertically (appearing and disappearing into the deposit) and horizontally on the cave floor.

Wind scouring is the most likely reason for the coarser matrix towards the front of the cave and removal by wind of much fine material resulted in the increased concentration of seeds in square 3 on the cave drip line. The slope in square 3 may have exacerbated the effect of the wind. In contrast, the slope of the surface in square 1 is almost horizontal. Experimental work and further observations could perhaps indicate the importance of the slope, whether the rear wall would cause a build-up of sand, act as a barrier to the wind and so increase turbulence, or whether there is less wind towards the rear of the cave.

Strong NE winds and occasionally SE winds during September to November occur along the coast of KwaZulu-Natal. These winds have exerted such a powerful influence that they have piled up high dunes, sometimes exceeding 150m in height (King 1982:35). By virtue of its WSW-facing aspect, the cave is largely protected from the NE winds. However, an occasional ‘southerly buster’, from the southwest, can cause swirling dust and unpleasant conditions in the cave (Chapter 5.2.1). As previously mentioned (Chapter 5.2.2), the SW wind brings cold air and often rain. Surprisingly, considering the very gentle angle of the ceiling, the interior of the cave is protected from rain except in rare instances when one might feel a slight mist in the air towards the rear of the cave. It is possible however that an occasional violent storm could cause down-slope washing of material in square 3.

Soil Invertebrates

In all squares ant lion burrows 3 to 5 cm deep and up to 10cm in diameter displaced seeds. Numerous millipede carapaces were found, particularly towards the rear of the cave. The wind might have blown in the millipede carapaces and any assessment of the role of millipedes in seed redistribution would be speculative.

Birds

Bird droppings containing fig seeds were found in square 3. Purple droppings containing *Bridelia micrantha* seeds were also found on the drip line but not in any of the designated squares. Bird footprints were seen right against the cave wall so it is possible that birds could have dropped seeds anywhere. As discussed earlier, detailed research into birds as agents will be useful.

Monkeys

It is likely that monkeys were dropping seeds, for example, *Strychnos* seeds. I have observed monkeys in Burman Bush, eThekwini Municipality, spit out the poisonous *Strychnos* seeds at least 50m from the nearest *Strychnos* tree. A *Strychnos gerrardii* grows directly above the southern entrance to the cave and fruits could have fallen from above. However, the hard outer casing would have to be broken first to expose the delicious pulp.

Rock Hyraxes

During the November 2004 field season rock hyraxes (dassies) were observed (L. Wadley pers. comm.) sitting in trees overhanging the small cave adjacent to the main Sibudu cave. The dassies were eating the leaves of the trees and it is plausible that they could drop seeds onto the cave floor.

5.4.4 Conclusions

The results and conclusions are tentative because of the low sample numbers (3 squares) and the relatively short observation and recording period. Nevertheless, I identified a range of agents of accumulation and I observed that the wind and other agents had a considerable effect on the redistribution of seeds, both vertically and horizontally.

Clearly agents other than people are bringing seeds into the cave and this is an important issue to consider in any palaeoethnobotanical study. The agents other than people are birds, wind, gravity, monkeys and possibly rock hyraxes.

The study highlighted another important issue, namely that there is much redistribution of seeds. The results did not conclusively demonstrate any patterns in the direction of movement of the redistribution of seeds.

The study of uninhabited caves or rock shelters as controls for interpreting the deposits in inhabited shelters is a technique that is rarely used (Watson *et al*. 1984:139). A useful sequel to my actualistic study would be to investigate agents of accumulation and the presence and variety of seeds in shelters that have no past or present evidence of human occupation.

5.5 Agents of Redistribution of Seeds

5.5.1 People as Agents of Redistribution of Seeds

The numerous pits dug into the MSA layers by people living in Sibudu Cave in the second millennium AD are testament to the disturbance of deposits by people. People also cause *occupational disturbance* simply by moving about on deposit during the routine activities of daily life (Hughes and Lampert 1977:135). Matthews (1965) estimates that a vertical zone of 30cm can be affected and that because this zone of disturbance moves upward as the deposit grows, the result is a profile in which depth grossly reflects age but with finer distinctions blurred by the process of mixing (Hughes and Lampert 1977:135). Stockton (1973) assessed the magnitude of vertical displacement of material in inland rock shelters that have, typically, fairly loose, dry sandy deposits largely free of organic material. Broken red glass spread evenly on the floor and buried to 5cm, trampled for a day, then excavated in 2-3 cm spits, was found to be distributed from the surface to a depth of 16cm, more than half the pieces having moved upward. Obviously this type of displacement can mask abrupt cultural changes. The size of the glass pieces was not specified and it is difficult to assess the applicability of Stockton's results to the movement of seeds that will have different densities, not as much cutting power, and varying sizes. However, the presence of *Ricinus communis* in BSS may be an example of the downward movement of seeds.

Interestingly, in some cases (as possibly with *Ricinus communis*) artefacts can indicate disturbance. For example, at the Emberton Way midden a sherd in the surface layer was found to fit a reconstructed Matola pot from Layer 4 (Horwitz *et al.* 1991). Although the authors did not elaborate on the mechanisms of this movement, studies of the 'size effect' may provide a clue.

Studies of the 'size effect' suggest that re-use of artefacts and natural site formation processes, such as sedimentation and erosion, result in the disproportionate occurrence of 'large' artefacts on the surface of sites. If items of several kinds are distributed in a site, the probability that any item will be visible on the surface is directly proportional to its gross size (Baker 1978). These results are tentative and refer to open sites. Nevertheless, the effects of trampling and scuffing, referred to as treadage and scuffage by Stockton, are likely to depend on the size and shape of artefacts and the angle at which they are lying (Stockton 1973). A soft sandy deposit is less likely to offer resistance to a small object than a large one and a large flat object is more likely to be trampled into the deposit if it is lying vertically, than if it is lying horizontally. Larger artefacts are more likely to be scuffed, smaller and sharp narrow artefacts are more likely to sink deeper than spherical objects. Actualistic studies could demonstrate how accurately Stockton's postulations reflect the movement of seeds. In the studies the specific gravity of the artefact should also be considered because specific gravity may be a significant factor in post-depositional processes (J. Scott pers. comm.).

5.5.2 Rodents and Soil Invertebrates as Agents of Redistribution of Seeds

The literal translation of the isiZulu word for rodent, *isilwane esiququdayo*, is 'an animal that gnaws or grinds' (Doke *et al.* 1977). The presence of rodent activity in Sibudu Cave is indicated by the gnawing marks, presumably to expose the encased seed, that were observed on *Chrysophyllum viridifolium, Commiphora woodii, Grewia occidentalis, Harpephyllum caffrum, Melia azedarach, Sideroxylon inerme, Sclerocarya birrea*, *Ziziphus mucronata,* Cucurbits and Vanguerieae in the Surface, BSV and BSS layers. Rats and/or mice were a problem for agriculturalists and Gardiner describes (1836:116) in 1835, a granary 'daubed on the outside with a composition, which will not bear analysing, in order to exclude rats as well as the rain.' The domestic cat, as a solution to the rat-problem, had apparently already been introduced to Zululand via the Thonga from the Portuguese, probably in pre-Shakan times, i.e. late 18th century (Bryant 1929 in Merrett and Butcher 1991) and Fynn apparently gave a cat to Shaka (Merrett 1995:26). 'Mice' were a serious problem and cats so sought after that in 1855 the intrepid Victorian trader Catherine Barter was able to exchange two white cats for a cow (Merrett 1995:26). Whitelaw (pers. comm.) has speculated about the rat, *Rattus rattus*, and whether it 'piggybacked' (his expression) agriculturists as they moved south. Feely (pers. comm.) thinks *R. rattus* may have come as a stowaway on early trading vessels.

Rodents in general were obviously a serious problem for agriculturists and rodent burrows are still a problem for archaeologists. There have been a number of reports on the effects of burrowing activity on archaeological deposits, many of them summarized by Fowler *et al.* (2004) in their study of Ndondondwane, a large late first millennium AD settlement. The burrowing species and its lifestyle, the intensity of use and the type of use of the burrow, e.g. for birthing, shelter, nesting, hibernation, are all aspects that need to be considered. Rodent burrowing activities depend on the substrate suitability and availability of food (either insects, underground insect larvae and worms, bulbs, etc). They also bury food and of possible relevance to this study is their burial of seeds. Smit (1999:9) has reported on the relationship between rodents and *Acacia* seeds and says that the burial of seeds by rodents may contribute towards the spread of some woody species. *Acacia tortilis* and *A. nigrescens* seeds chewed by rodents also exhibit a greater germination than unchewed seeds.

Rodents are probably most destructive to archaeological sites under grassland vegetation and cause ‘horizonization’, that is, large objects sink below the rodent zone and smaller objects, which are more frequently affected, are carried towards the surface (Bocek 1986:589). Horizontal homogenization, or soil mixing, by rodents is considered sufficiently limited to preserve the general spatial structure of the site (Bocek 1986:601).

Soil invertebrates such as earthworms, crustacea and insects also contribute to stratigraphic mixing but affect smaller particle sizes (Bocek 1986:589). Numerous millipede carapaces are found on the surface of Sibudu shelter and their segments are also recovered from the second millennium AD deposits. Millipedes consume live and dead organic matter and are likely to have been active in the vegetation-rich BSV layer, possibly even reducing some seeds to fine organic matter. Millipedes can burrow up to 30cm in soil (Redman and Hamer 2003) and this may also have had an effect on movement of seeds between layers at Sibudu Cave.

No obvious burrows were observed during excavation at Sibudu. There are no obligate cave-dwelling mammals that are burrowers but there is no reason why rodent moles and other small mammals should not make burrows in relatively open caves like Sibudu (P. Taylor pers. comm.).

5.6 Conclusions on Agents of Accumulation and Redistribution

‘Plant distributions on archaeological sites are affected by planned and unplanned cultural activities and by natural forces’ (Popper and Hastorf 1988:5). It is essential to account for non-cultural sources of patterning before one can address the issue of cultural sources of patterning. Cultural sources, as well as natural and animal sources, all introduce bias. Recognition of this bias is essential for valid interpretation of the data. It is possible to identify the taxa that were favoured but it is impossible to identify all the taxa that were being discriminated against, i.e. not being introduced, without knowledge of the surrounding vegetation. Proxy data is necessary for an accurate reconstruction of the vegetation.

In classic vegetation studies both the range of taxa and the abundances within the taxa are important. Particular agents favour particular taxa, e.g. wind accumulates wind-dispersed seeds and the absence of these agents will result in the absence of the taxa. A wide range of agents will accumulate particularly tasty fruits and abundances within taxa are dependent on the range of agents involved. For example, people, monkeys, baboons, birds, and a range of small and larger mammals will accumulate *Harpephyllum caffrum.* Identification of the agents is essential to differentiate whether abundances are the result of agent bias or are due to increased availability within the catchment area of the site, i.e. vegetation change. The same principle applies to decreases in abundances. Alternatively, the changes in abundances may be due to change of behaviour of the agents.

This study identified agents of disturbance and redistribution. Post-depositional effects of agents are relevant because of the implications for mixing of deposits. Different agents affected the deposit in different ways. People had a large influence on the mixing of deposits both through direct actions easily identified by the numerous pits and through trampling and scuffing, which is less easily traced and quantified. Rodents ate and possibly moved the seeds. Millipedes probably played a part in seed decomposition and disturbed the deposits. I echo Wood and Johnson (1978:317) that 'the term *in situ*…. is probably more optimistic than realistic' and I re-iterate that identification of agents is necessary to clarify disturbance and redistribution processes and the accumulation of seeds.

CHAPTER 6

DISCUSSION OF RESULTS

An archaeobotanical analysis of past vegetation involves the acceptance of a number of assumptions and biases. The assumptions are that representation factors are invariant over time, i.e. that taxa are consistently over- or underrepresented, that the presence and abundance of taxa in past vegetation can be estimated from abundances of taxa in the deposit, that modern analogues exist for past vegetation types, that tolerances and preferences of taxa have not changed and that we are fully able to understand the processes that govern present-day vegetation (Roberts 1989:21). Furthermore there will always be bias, determined by what comes into the site and what does not, post-depositional disturbance, recovery efficiency, differential preservation, sampling and so forth. The biases are unavoidable but acceptance of the assumptions needs some discussion.

There is little alternative but to accept that ‘the present is the key to the past’ and that the same processes and natural laws prevailed in the past as those we can now observe or infer from observations. This concept, first applied to geology by James Hutton, and developed by Sir Charles Lyell into the doctrine of Uniformitarianism, does not imply the same rate, intensity or identical processes as operated in the past. However, it is generally accepted that the degree of correlation between ancient and modern processes decreases as the time interval increases. I accept that the principle of Uniformitarianism, or Actualism, is appropriate for interpretations of second millennium AD seed data from Sibudu Cave.

However, there are serious taphonomic issues in the assumption that the sample assemblage reflects the deposited assemblage, which reflects the death assemblage, which reflects the life assemblage (the target population), which is the vegetation that existed in the surrounds of the cave while the occupational debris was being deposited.

Because of the unavoidable biases that are present due to sampling, recovery, preservation and identification factors, I find it difficult to accept that the presence and especially, the abundance, of taxa in past vegetation can accurately be estimated from the presence and abundances of the identified species. Unfortunately there is no solution to this problem and one has to take a pragmatic approach.

The stated aim of this study is to identify vegetation change through the analysis of seeds recovered from the second millennium AD layers. Vegetation change can be identified by the absence or presence of marker species, variations in the co-occurrence of certain species (communities) and by changes in the abundance of a species. These issues will be discussed in this chapter.

6.1 Interpreting Vegetation History by the Absence/Presence of Taxa

An analysis of the absence/presence of individual species provides no persuasive evidence to suggest that there has been any change in the vegetation in the Sibudu area over the last 1000 years. Although the great majority of species that occur in South Africa are scarce and localized (Acocks 1988:1), the species which have been recovered from the second millennium AD layers at Sibudu, with one exception *Celtis mildbraedii*, are neither scarce nor strictly confined to one type of vegetation.

All the species identified from Surface, Dung, BSV and BSS have either been recently recorded in the environs of Sibudu Cave (own observations; G. Nichols pers. comm.; SANBI 2004; D. Styles pers. comm.) or are found in habitats which occur close to the cave such as forest, forest margins and riverine vegetation (Table 6.1). In the following section I will discuss the richness of taxa i.e. how many taxa are present in each layer relative to the other layers. Then the implications of the presence of selected individual species will be assessed in terms of vegetation change. Finally I will deal with the distributions of other species in the context of the layers in which they occur.

Table 6.1 Habitats of species from second millennium AD layers at Sibudu Cave

	forest	coastal forest	dune forest	riparian forest	forest margins	identified nr. Sibudu
Adenia gummifera		*	*			
Antidesma venosum					*	DS
Apodytes dimidiata	*	*	*		*	DS
Bridelia micrantha		*		*		GN
Calodendrum capense	*			*		GN
Capparis tomentosa	*			*		GN
Carissa bispinosa	*					GN
Celtis africana	*	*		*	*	GN
Celtis mildbraedii	*					GN
Cf. *Chaetachme aristata*	*					
Chrysophyllum viridifolium	*	*				
Commiphora harveyi	*	*	*			GN
Commiphora woodii	*	*				GN
Cordia caffra		*		*		
Croton sylvaticus		*				GN
Cryptocarya latifolia				*		
Cryptocarya woodii	*			*		GN
Dalechampia capensis						GN
Drypetes arguta		*				GN
Ekebergia capensis	*	*		*		
Embelia ruminata	*					SANBI
Grewia occidentalis	*				*	DS
Harpephyllum caffrum	*					GN
Helinus integrifolius						
Hippobromus pauciflorus				*	*	DS
Justicia campylostemon	*					GN
cf. *Kraussia floribunda*				*	*	GN
Lannea edulis						
Manilkara discolor		*				GN
Millettia grandis		*			*	GN
Protorhus longifolia	*			*	*	GN
Pupalia lappacea					*	GN
Pyrenacantha cf. scandens	*					GN
Rauvolfia caffra	*			*		
Rhoicissus digitata		*	*		*	GN
Rhoicissus tomentosa	*					GN
Sclerocarya birrea					*	DM
Sideroxylon inerme		*	*			GN
Syzygium cordatum	*			*		GN
Trema orientalis					*	GN
Uvaria caffra	*	*				GN
Vepris lanceolata	*			*		GN
Xylotheca kraussiana	*					GN
Ziziphus mucronata	*					DM

Based on Pooley (1993 1998).

The final column indicates the source of the record in the Sibudu area: DS = David Styles; DM = Don McCulloch; GN = Geoff Nichols; SANBI = PRECIS data, Pretoria; Blank Space = forest, forest margin or riverine species that have not recently been recorded in the area but are found in habitats such as presently occur in the Sibudu area. *Lannea edulis* is not a forest species but it is likely to occur near Sibudu (G. Nichols, pers. comm.)

6.1.1 Frequencies of Taxa as an Indication of Vegetation Change

The richness or raw number of taxa that occur in the second millennium AD deposits varies from layer to layer (Tables 4.4 and 4.5). Percentage ratios of the richness of a particular layer with respect to the total assemblage range from 82% for BSV, 72% for Surface, 61% for BSS to 42% for Dung. Sampling bias, namely the greatest volume of deposit from a layer (Table 4.6), is a likely explanation for the preponderance of taxa in BSV. Similarly the high preponderance of unidentified taxa in BSV is highly likely to be a sampling bias because the unidentified taxa occur in very low frequencies and the larger the sample the more likely one is to recover rare taxa (Cochrane 2003).

If sampling bias was the only explanation one would expect the second highest frequency of taxa to be from BSS, which yielded the second largest volume of deposit. Because this is not the case further explanation must be sought. If preservation were the issue one would expect richness to decrease from the Surface to BSS. Although this is not the pattern, preservation could still be an issue and preferential preservation conditions in BSV could account for the high degree of preservation in BSV. Anaerobic conditions favour the preservation of organic material and ‘occasionally it appears that anaerobic conditions can occur in non-waterlogged situations’ (Dimbleby 1977:20). Dimbleby’s suggestion is hypothetical rather than based on scientifically observed data. If his supposition were verified by actualistic studies the results would have relevance for the preservation in BSV. It is possible that the thickly compacted and consolidated vegetable matter that constituted the Dung layer prevented the diffusion of oxygen into BSV and thus prevented aerobic decay in BSV.

A further possible reason for the high frequency of taxa from BSV and BSS can be sought in the ‘Clarke Effect’ (Schiffer 1983 in Miksicek 1987). The ‘Clarke Effect’ states that the diversity of artefacts recovered from a site is directly related to the length of occupation of a site: the longer a site is occupied, the greater the range of activities that will be carried on at that site, and the greater the diversity of plant remains that will be preserved. This may be directly applied to archaeobotanical assemblages (Miksicek 1987:229-230). The continued occupation of the cave for about 150 years from about AD 1000 (Chapter 1.4 Stratigraphy and Dating) is an added possible reason for the wide range of taxa recovered from BSV and BSS.

The relative richness between the layers can be explained by sampling and preservation factors. More importantly, richness is concerned with the frequency of taxa, not the specific identities of individual taxa. Two different vegetation types may have similar richness but totally different constituent species and so, even though some vegetation types are much richer than others, richness is not an appropriate diagnostic tool for the identification of vegetation change.

6.1.2 Implications of the Presence of Selected Species with Respect to Vegetation History

Celtis mildbraedii

The very rare and localized *Celtis mildbraedii* (Red-Fruit White-stinkwood) is presently found in Coastal Lowland Forest and Coastal Scarp Forest (Boon and Symmonds 2001) and its occurrence in all the second millennium AD layers at Sibudu suggests that the vegetation of the Sibudu area has been Coastal Lowland Forest or Coastal Scarp Forest (as defined by Pooley 1993) for at least the last 1000 years. The species occurs in a mesic environment (Moll 1992:169) that could have been provided by the Tongati River or by persistent high rainfall. A southern aspect growing position would also enhance moisture availability.

A magnificent specimen of *Celtis mildbraedii* grows presently at the entrance to the cave. This single tree is one of six small and scattered communities of *C. mildbraedii* in KwaZulu-Natal (Boon and Symmonds 2001). *C. mildbraedii* is considered endangered in KwaZulu-Natal because of its low frequency, apparent lack of recruitment and severely fragmented populations (Boon and Symmonds 2001:31). The local populations are relicts of widespread forests and lie on the southern-most limits of a range that extends northwards into East Africa.

In terms of evolutionary history, *C. mildbraedii* in KwaZulu–Natal appears to be retreating from maximum range and vitality (the mature stage) and, losing vitality and competitive ability, it has entered the relictual stage of disjunct distributions in refuges (as defined by Van Wyk and Smith 2001:13). The ‘ageing’ and eventual extinction of a taxon appears to be caused both by external factors, for example, sudden climatic change and increased competition from other species, and internal factors, for example, the inability to adapt to changing conditions and genetically mediated reproductive failure (Van Wyk and Smith 2001:13). Certainly the steep Sibudu cliff can be considered a refuge but whether it is a refuge from climatic change or from over-exploitation is debatable.

Lannea edulis

Lannea edulis is found in open, rocky grassland and bushveld (Schmidt *et al.* 2002). According to the PRECIS data sheets (SANBI) *L. edulis* occurs in quadrant 2930D, i.e. possibly 6-8km from the cave. Furthermore, as both Coastal Scarp and Coastal Lowland Forests include grasslands and rocky outcrops *L. edulis* could occur not far from Sibudu Cave. It is common on the escarpment edges of forest near grassland (G. Nichols pers. comm.) and its possible local extinction could be due to extensive farming activities. Although it is a grassland and bushveld species the presence of *L. edulis* at Sibudu cave throughout the second millennium AD is compatible with Coastal Scarp/Coastal Lowland Forest vegetation throughout this time.

Sclerocarya birrea

The presence of *Sclerocarya birrea* in all layers is not surprising because it is so highly prized as a food by humans. It is also eaten by monkeys and other mammals but never by birds (D. Johnson pers. comm.). One would expect marula densities to be closer to those of the wild-plum (*Harpephyllum caffrum*), which is not as tasty, nutritious or versatile as the marula. The lower marula densities (0.04/litre vs. 0.69/litre for the wild-plum) have two possible explanations: different agents of accumulation or preservation factors. Whereas people, monkeys and baboons were probably the only agents bringing in marula, birds as well people, monkeys and apes, were probably bringing in the wild-plum and this would account for the higher frequencies of the wild-plum. In terms of preservation of identifiable remains in the deposit, it is possible that fewer marula endocarps survived because they were hammered and broken open to remove the oil- and protein-rich kernels. Cunningham (1988) has documented the ethnographic use of characteristic grindstones and bone picks for the crushing and removal of marula seeds, but none of these artefacts has been identified.

A third possible explanation for the low *Sclerocarya birrea* frequencies could be that marula was scarce in the Sibudu area. Presently *S. birrea* is seldom found above 1000m and although the controlling factor in its distribution is frost, it can survive high temperatures. It is best suited to drier areas receiving between 200 and 800mm of rain and its well-developed root system allows it to survive all except extremely severe droughts. It likes deep, sandy soil. Shone (1979) suggests the possibility that the distribution of *S. birrea* has changed, that the Thukela River appears to be the southern boundary of the species and that the tree becomes very scarce southwards. Nichols (pers. comm.) disputes that marula is scarce south of the Thukela and Whitelaw (pers. comm.) says it is reasonably common along the Mgeni River. Shone (1979:41) suggests that trees south of Zululand, i.e. the Thukela river, were 'spread by the Blacks'. However, Whitelaw (pers. comm.) who has found carbonized marula endocarps in the Mgeni Valley south of Sibudu in a first millennium AD agriculturist site (Mzuluzi phase i.e. from 600 AD) doubts that 'Blacks' who arrived in the region only 200 years earlier were responsible for spreading marula south of the Thukela.

Sclerocarya birrea is not found in the MSA deposits at either Sibudu Cave (Wadley 2004) or Umhlatuzana Rock Shelter (Kaplan 1990). The uncarbonized marula in the MSA at Sibudu is almost certainly intrusive. At Umhlatuzana it is found only in Layer 1, a layer that contained much pottery and so presumably is not older than 2000 years. At Shongweni Cave too *S. birrea* is recent and although two 'scraps' of *S. birrea* were found in the Lower Occupation strata, Davies suggests they may be contaminants from a nearby disturbance (Davies 1975:647). It is curious that such a delicious fruit is not found before the first millennium AD in deposits south of the Thukela and the issue deserves further research.

In terms of this study *S. birrea* has no vegetation history implications, because it is present in all layers. As with most species, *S. birrea* is present in greatest density in the Surface layer. The *S. birrea* endocarp is particularly hardy so it can be argued that preservation should be just as good in BSS as in Surface. People are the likely agents for deposition of *S. birrea* and if preservation as an issue is discounted, the higher density of *S. birrea* in Surface is most probably anthropomorphic. It is not possible to know whether this is an indication of changing collection strategies or increased availability of the species. Increased availability might simply mean more individuals had been planted, if as Shone suggested, they were deliberately planted (Shone 1979). Alternatively, increased availability could mean that conditions were becoming more favourable for the species. As the favoured conditions are hot and dry and the present-day distribution is as far south as the Mkomazi River in hot and wet situations, and particularly along the Mlazi and Mgeni Rivers, the suggestion of increasingly hotter and drier conditions does not hold.

6.1.3 Implications of the Presence of Other Species with Respect to Vegetation History

The persistent presence of the Tongati River is a major factor to be considered in interpretations of the vegetation history around Sibudu Cave. Even if a river is not obviously flowing it provides a source of seeped water. This moisture may be from distant catchments and thus riparian vegetation cannot be considered representative of the area beyond river valleys. Because of the persistent presence of the Tongati River, species that occur in riverine habitats, and have been identified from the second millennium AD layers at Sibudu, are of little use to highlight vegetation change. These species are *Allophyllus* sp., *Bridelia micrantha, Calodendrum capense, Capparis tomentosa, Celtis africana, Cordia caffra, Cryptocarya latifolia, Cryptocarya woodii, Ekebergia capensis, Hippobromus pauciflorus,* cf. *Kraussia floribunda, Protorhus longifolia, Rauvolfia caffra, Syzygium cordatum* and *Vepris lanceolata* (Pooley 1993). Furthermore, *Adenia gummifera, Embelia ruminata* (SANBI 2004), *Commiphora woodii, Croton sylvaticus, Grewia occidentalis, Harpephyllum caffrum, Millettia grandis*, *Trema orientalis* and *Trichilia* sp. (Moll 1992) all occur in riverine habitats, although they grow in other environments too.

If one considers purely the absence/presence of a species one can further discount species that occur throughout the deposit, i.e. *Apodytes dimidiata, Celtis mildbraedii, Chrysophyllum viridifolium, Commiphora harveyi, Drypetes arguta, Lannea edulis, Sclerocarya birrea, Sideroxylon inerme, Uvaria caffra, Xylotheca kraussiana* and *Ziziphus mucronata.* The remaining species occur either singly, i.e. *Carissa bispinosa,* cf. *Chaetachme aristata, Dalechampia capensis, Helinus integrifolius, Justicia campylostemon, Manilkara discolor, Pyrenacantha* sp. *scandens, Rhoicissus digitata* and *Tribulus* sp., or in very low frequencies e.g. *Rhoicissus tomentosa* (2), A*ntidesma venosum* (9) *Pupalia lappacea* (12). These species will be discussed separately with respect to the layers in which they occur.

Species Restricted to the Surface Layer

The indigenous species that occur exclusively in Surface are *Dalechampia capensis, Embelia ruminata, Helinus integrifolius, Manilkara discolor, Millettia grandis* and *Rhoicissus digitata.* They occur in very low frequencies (Table 4.4).

Dalechampia capensis is a twining perennial herb in open woodland and I have seen it growing on forest margins in Burman Bush. *Embelia ruminata* is a scandent shrub recorded on the banks of the Mhlanga River in Hawaan Forest (SANBI 2004). *Helinus integrifolius* is a sprawling climber with widespread distribution in bushveld and rocky wooded places. It has not been recorded near Sibudu Cave but its presence in the present-day vegetation of the area is highly likely (G. Nichols pers. comm.). The woody climber *Rhoicissus digitata* is common on coastal dunes, but is also widespread up to 900m in grassland and bush and on forest margins. Although some form of support is not a pre-requisite for these species, they are commonly found growing in forest, often on forest margins and the implications of these species descriptions are that there was probably some support for climbers provided by riverine bush and forest such as presently occurs in the area.

Manilkara discolor was represented by a single testa. Although the seed had disintegrated, the colour and surface texture of the testa suggested it was very fresh and likely to be a recent contaminant from trees that presently grow in the valley near the cave. Some Sapotaceae (Milkwood) seeds have robust testa e.g. *Chrysophyllum viridifolium* and *Sideroxylon inerme*. These two species are found throughout the deposit. Other Sapotaceae seeds do not have strong testa e.g. *Englerophytum natalensis* and *Manilkara discolor* and once the seeds are parasitized the testa break up. This could account for the absence of *Manilkara discolor* in layers older than Surface.

Millettia grandis is presently abundant on the south facing slopes around the cave and the single fragment of pod that was found was extremely well preserved. Like the single

Manilkara discolor, *Millettia grandis* is also probably a recent contaminant. Because *Millettia grandis* is not eaten by birds, monkeys or people and because the seed is used in crushed form for medicinal purposes (Venter and Venter 1996:242), it is possible that evidence of *M. grandis* would be scarce throughout the deposit and its presence would be the result of a chance distribution by wind or gravity.

Species Restricted to the Surface and BSV Layers

Ekebergia capensis, Psydrax sp. and *Rauvolfia caffra* are exclusive to Surface and BSV but provide no valuable insights about vegetation change. *Ekebergia capensis* is widespread and occurs in riverine vegetation (Pooley 1993). Its absence in Dung is likely to be because of the small sample size and its absence in BSS may be due to preservation. The testa is thin and the seed decomposes easily. The *Psydrax* sp. seeds could not be identified to species level and thus provide little interpretive value. *Rauvolfia caffra* is a species of riverine vegetation (MacDevette *et al.* 1989:10; Pooley 1993) so its presence in Surface and BSV is easily explained. One whole seed was found in each of these layers, but because the volume of deposit from BSS was three times that of Surface, its absence in BSS cannot be due to sampling bias. The one *Rauvolfia* seed and four fragments were found in BSV E3, which had a large pit, so they may not be in context. Whatever the case, the low frequencies of *Rauvolfia caffra* suggest that not too much emphasis should be placed on their presence.

Species Restricted to the Dung Layer

The matrix of the Dung layer was almost exclusively animal dung and the smallest volume of deposit, in comparison to all the layers, was from Dung. These two facts are likely to be the reason that Dung did not have as many species as the other layers. Thus the absence of a species, e.g. *Antidesma venosum, Pupalia lappacea, Protorhus longifolia* and *Vepris lanceolata*, which occurred in all layers except Dung, is not significant.

Tribulus sp. was exclusive to Dung. *Tribulus terrestris* (Afrikaans: *duwweltjie* = little devil) is an annual prostrate herb that occurs in grassland, disturbed areas (Pooley 1998), on dunes and on riverbanks (G. Nichols pers. comm.). Because *Tribulus* *terrestris* is the only *Tribulus* species recorded from Natal (Pooley 1998:276) it is probable that the single *Tribulus* seed that was recovered is of the widely spread *T. terrestris* species, and that the seed was inadvertently brought into the cave attached to an animal. Although 'The Zulus lay the thorny fruit, on which is smeared snake venom, at the entrance of kraals to prevent the entry of undesirables' (Watt and Breyer-Brandwijk 1932:85), it is unlikely that the seed was deliberately brought into the cave.

Species Restricted to the BSV Layer

The species exclusive to BSV do not provide convincing evidence of vegetation change. They occurred as single seeds or in frequencies less than 10 and their presence in BSV and no other layers may simply be a sampling bias because 50% of the total volume of deposit was removed from BSV. Furthermore they occur in riparian vegetation or are widespread which indicates broad ecological tolerances.

It is inadvisable to place much value on the presence of species represented by a single seed whose identification is uncertain e.g. cf. *Chaetachme aristata*, cf. *Kraussia floribunda,* and cf. *Pavetta* sp. The other species that occur exclusively in BSV are forest species or climbers that occur either in riverine vegetation or are extremely widespread. Although *Carissa bispinosa* is characteristic of Mistbelt Forest (Pooley 1993), it is an extremely widespread scrambling shrub of forest and scrub forest and I have noted it often in coastal forest. MacDevette *et al.* (1989:10) list it as a cosmopolitan species. *Justicia campylostemon* is a forest shrub also of widespread distribution. *Pyrenacantha* sp. *scandens* is a widespread climber in forest. *Hippobromus pauciflorus* is found in riverine vegetation. Although the *Trichilia* seeds were not identified to species level both *T. dregeana* and *T. emetica* are found in riverine vegetation (Moll 1991). *Trema orientalis* is a common pioneer in watercourses (*ibid*).

Species Restricted to the BSV and BSS Layers

Single *Asparagus* spp. seeds were recovered from BSV and BSS respectively. *A. sauveolens* and *A. falcatus* have been recorded in the Sibudu area (G. Nichols pers. comm.) *A. sauveolens* is an erect or occasionally scrambling shrub that occurs in bushveld and thicket and has wide distribution in South Africa (Pooley 1998:104). Its vernacular name, the Bushveld Asparagus, suggests it is characteristic of the bushveld, but its contemporary presence around Sibudu illustrates that it also occurs in thicket situations found in riverine bush and fringing forest. *A. falcatus,* the Large Forest Asparagus, also has a wide distribution although it appears to be restricted to low-lying areas (SANBI 2004). It occurs on forest margins and in thicket (Pooley 1998). The *Asparagus* seeds found in the deposit could also be *A. plumosus,* which has been recorded in the Hawaan Forest on the southern banks of the Mhlanga River (SANBI 2004). Because these three *Asparagus* species are widespread, and more importantly, because the seeds could not be identified to species level, their presence does not contribute to vegetation change interpretation.

Cussonia sp. also occurs only in BSV and BSS. Only *C. zuluensis* has been recorded near the cave (G. Nichols pers. comm.) but *C. spicata* is found near Verulam (SANBI 2004). *C. spicata* is widespread throughout KwaZulu-Natal whereas the distribution of *C. zuluensis,* which is common in Zululand, appears not to extend much south of Durban. Because both species occur in bushveld and forest or forest fringing situations (Pooley 1993) the interpretive value of the *Cussonia* seeds is not great. The six *Rhus* seeds that were found in BSV and BSS provide similarly inconclusive evidence.

Species Restricted to the BSS Layer

Rhoicissus tomentosa was the only species exclusive to BSS. It grows presently on the cave dripline and because it is widespread in forests throughout KwaZulu-Natal (Pooley 1993) it cannot be taken as a good indicator of any vegetation change. The presence of two *R. tomentosa* seeds in BSS suggests that there was forest in the vicinity of the cave.

6.2 Interpreting Vegetation History by the Absence/Presence of Communities of Indigenous Species

Terms used to categorize vegetation by composition and hierarchy vary enormously. Different authors use different terms synonymously and this contributes to the complexity of vegetation studies (*vide* Van Wyk and Smith 2001). Generally a number of plant communities make up a vegetation type that is classified within a biome. I will use the vegetation type classifications of Pooley (1993) and Acocks (1988) in an attempt to interpret change in the vegetation history in the Sibudu area over the last 1000 years.

6.2.1 Pooley's (1993) Characteristic Forest Species and the Sibudu Assemblage

Sibudu presently lies in Coastal Scarp Forest (G. Nichols pers. comm.), which is a transitional vegetation type where Coastal Forest merges imperceptibly with Mistbelt Forest on the mainly south- and east-facing slopes of high coastal escarpments (Pooley 1993:11). This is an apt description for the assemblage of archaeologically recovered taxa, which contains elements characteristic of Coastal Lowland Forest, Coastal Scarp Forest and Mistbelt Forest (Table 6.1). For example, *Antidesma venosum, Bridelia micrantha, Celtis africana, Protorhus longifolia, Trema orientalis* and *Xylotheca kraussiana* are all characteristic of Coastal Lowland Forest. *Chrysophyllum viridifolium* and the rare *Celtis mildbraedii* are also found in Coastal Lowland Forest. On the other hand *Calodendrum capense, Carissa bispinosa, Celtis africana, Cryptocarya woodii* and *Vepris lanceolata* are characteristic of Mistbelt Forest. Furthermore, *Millettia grandis* is characteristic of Coastal Scarp Forest.

There are other species, *Hippobromus pauciflorus*, *Rauvolfia caffra*, *Trichilia* sp. and *Ziziphus mucronata*, that are not characteristic of Coastal Scarp *per se* or Coastal Scarp as a mix of species characteristic of Coastal Lowland Forest or Mistbelt Forest. *Hippobromus pauciflorus* and *Ziziphus mucronata* are characteristic of Deciduous Woodland/Bushveld but *Hippobromus pauciflorus* can also be found on forest margins (Pooley 1993) and *Ziziphus mucronata* is often found in alluvial soils along rivers; it is said to indicate the presence of underground water (Coates Palgrave 2002:666) and is ubiquitous across southern Africa. I have recorded both *Ziziphus mucronata* and *Hippobromus pauciflorus* in Coastal Lowland Forest. The presence of *Rauvolfia caffra*, and *Trichilia* sp., can be attributed to the Tongati River as *Rauvolfia caffra* and *Trichilia emetica* (likely to be the *Trichilia* recovered archaeologically) are characteristic of riverine or fringing forest (Pooley 1993). So, although these species are not characteristic of Coastal Scarp Forest, their presence is easily explained.

Table 6.2: Species characteristic of forest types, from second millennium AD layers at Sibudu Cave

					Pooley 1993			Acocks 1988	
					Coastal	Coastal	Mistbelt	Typical	Coast-belt
	Surface	Dung	BSV	BSS	Lowland	Scarp		common	less common
Antidesma venosum	*		*	*	*				
Apodytes dimidiata	*	*	*	*					*
Asparagus sp.			*	*				*	
Bridelia micrantha	*	*	*	*	*				
Calodendrum capense	*	*	*	*			*		
Carissa bispinosa			*				*	*	
Celtis africana	*	*	*	*	*		*	*	
Cf. *Chaetachme aristata*			*						*
Croton sylvaticus	*	*	*	*				+	
Cryptocarya latifolia	*	*	*	*					*
Cryptocarya woodii	*	*	*	*			*		*
Cussonia sp.			*	*					*
Ekebergia capensis	*		*						*
Grewia occidentalis	*	*	*	*				*	
Harpephyllum caffrum	*	*	*	*				*	
Helinus integrifolius	*							*	
Justicia campylostemon			*						*
Millettia grandis	*					*		+	
Protorhus longifolia	*		*	*	*			+	
Rhoicissus tomentosa				*				*	
Syzygium cordatum	*			*					+
Trema orientalis			*		*				*
Uvaria caffra	*	*	*	*				*	*
Vepris lanceolata	*		*	*			*	*	
Xylotheca kraussiana	*	*	*	*	*				

* = presence

+ = definitive of the forest type

The species descriptions apply to species from the entire archaeological assemblage comprising all the second millennium AD layers. However, components of the individual layers indicate a similar pattern. Except for *Trema orientalis*, all the Coastal Lowland species that occur in Surface occur in BSV and BSS as well. Their absence from Dung is not significant due to the small sample size of Dung. *Millettia grandis,* the only recovered species characteristic of Coastal Scarp Forest, is found only in Surface. Its exclusive presence in Surface has been explained elsewhere (Chapter 6.1.3). The characteristic Mistbelt Forest species, *Calodendrum capense, Celtis africana, Cryptocarya woodii* and *Vepris lanceolata,* with the exception of *Carissa bispinosa,* are all found in Surface, BSV and BSS. *Carissa bispinosa,* characteristic of Mistbelt Forest and *Trema orientalis,* characteristic of Coastal Lowland Forest, are both found exclusively in BSV, and can indicate the presence of Coastal Scarp Forest, because Coastal Forest (Pooley 1993) is a merging of Coastal Lowland Forest (*Trema orientalis*) and Mistbelt Forest (*Carissa bispinosa*).

Ziziphus mucronata, a species characteristic of Deciduous Woodland /Bushveld, is found in all layers including Dung. Deciduous Woodland occurs at lower altitudes and is typical of lower rainfall areas. Another species characteristic of Deciduous Woodland /Bushveld, *Hippobromus pauciflorus* (represented by 3 seeds), is exclusive to BSV. The fact that it presently occurs in the Sibudu area (Coastal Scarp Forest vegetation) stresses the importance of not placing too much reliance on a single poorly represented species to indicate a particular habitat or vegetation regime. Both *Z. mucronata* (Coates Palgrave 2002:666) and *H. pauciflorus* (Pooley 1993:292) are found along rivers, a more likely reason for their presence in the Sibudu deposits than a Deciduous Woodland/Bushveld environment.

Valley Bushveld (Pooley 1993:17) is found in hot dry river valleys and a characteristic species is *Commiphora harveyi*, which grows presently at the cave entrance and is found throughout the second millennium AD deposits. North of Sibudu cave, Valley Bushveld of Acocks Type 23, (Acocks 1988:59) occurs along the Tongati River. On Acocks's distribution map Valley Bushveld extends all the way to the ocean along the larger Mgeni and Thukela Rivers and it is possible that Valley Bushveld could have extended all the way to the ocean along the Tongati River too. However, the persistent presence of *Commiphora harveyi* in the deposits does not suggest any change in vegetation or climatic conditions over time.

6.2.2 Acocks's (1988) Vegetation Types and the Sibudu Assemblage

The presence in the second millennium AD Sibudu assemblage of a number of species of general occurrence in Acocks's Typical Coast-belt Forest (Table 6.1) indicates that Typical Coast-belt Forest was likely to be present throughout this time. *Millettia grandis* and *Protorhus longifolia* are dominant in Typical Coast-belt Forest and the presence of *Croton sylvaticus* and *Syzygium cordatum* support this interpretation (Acocks 1988:16).

However, there is a basic flaw in the approach of a simple correlation of species characteristic of different vegetation types, as defined by Pooley (1993) and Acocks (1988), and species absent or present in the second millennium AD layers at Sibudu. The flaw is that the element of quantification has to be considered, an argument that will be developed in the following section.

6.3 Abundances of Indigenous Taxa

The distinction between qualitative and quantitative assessments is often blurred because of the quantification of different taxa (as opposed to frequency within taxa) in absence/presence analysis. Furthermore, within taxa under consideration for qualitative assessment, the frequency of seeds can be important: interpretations based on the presence of a single seed are not as convincing as those based on the presence, for example, of 20 seeds. The preceding discussion of absence/ presence data ignored the frequency of seeds of each taxon. Often the cited taxa that occurred exclusively in certain layers were represented by very low numbers. The low frequency and exclusive presence of taxa in layers may be related factors. The taxa represented by higher frequencies of seeds invariably occurred in more than one layer.

Quantification of species is basic to the concept of veld types that describe South African vegetation. Acocks's veld types are broad units based on botanical composition, practical considerations (farming potential), and the relative importance of members of a group of species, i.e. the abundance of a particular species in the community, within a specified area (Acocks 1988). Acocks's veld types can allow quite a wide botanical variation but the variation is limited to the relative importance of members of a group of species occurring through the area of the veld type. Notwithstanding the considerable problems related to the quantification of seeds and the interpretation of such results, seeds were counted (Tables 4.4 and 4.5) and their densities were calculated (Table 4.7).

6.3.1 Frequencies and Densities of Taxa in Different Layers

The seeds with the highest frequencies were invariably found in all layers (Table 4.5). Only *Cryptocarya latifolia*, *Grewia occidentalis* and *Uvaria caffra*, which occurred in all layers, did not occur in frequencies greater than 50 seeds for the total assemblage (Table 4.4). The frequency of *Cryptocarya latifolia* would probably have been higher if different criteria had been used for quantification.

To even out the influence of different sample sizes (different volumes of deposit removed from each layer) and their effect on the frequencies of seeds, the densities of taxa that were represented by more than 50 seeds in the total assemblage were calculated (Table 4.7). The general trend for most taxa was that the highest density of seeds occurred for the species that had the highest frequency.

The period over which the sediments were deposited is also an important dimension in density calculations (e.g. Jerardino 1995). Unfortunately the dating of the layers is not precise enough to do this.

6.3.2 Vegetation Type and Habitat Associations

As stated previously, quantification of species is basic to the determination of the different vegetation communities that constitute Acocks's veld types and Acocks (1988) has listed the most commonly recorded species in decreasing order with respect to abundance within predetermined areas. Dominant species, the vegetation profiles (vertical structure) and common climatic conditions and ecological processes are also basic to the veld type definitions by Low and Rebelo (1996).

Acocks lists trees, and shrubs and climbers, according to 'general occurrence' (species which occur in 50% or more of his samples) and less general occurrence (percentage not specified). The relative abundance of a species in these groups is an estimate of the number of each plants of each species that can be expected per morgen in typical samples of the veld types.

No modern vegetation types as defined by Acocks are reflected in either the frequency or density rankings of the archaeologically identified species. This is not surprising, because patterns based on correlations of abundance of species from the archaeological assemblage, and Acocks's veld types are unlikely to be accurate or meaningful, given the number of variables that introduce bias to the abundance of archaeological taxa.

Nevertheless, use of Acocks's relative abundance lists in a general way indicates that there has been little or no change throughout the last 1000 years. Of the 45 indigenous taxa from the deposit that have been identified to species level, 21 (47%) are on Acocks's lists of common or less generally occurring plants for Typical Coast-belt Forest (Type 1a) and only 38% (8/21) are common to all layers. However, percentages of Typical Coast-belt Forest species within each layer are generally quite similar (Table 6.2) Surface 39%, Dung 35%, BSV 44% and BSS 44%, particularly when one considers the lower volumes of deposit in Dung and Surface (5% and 10% of the total excavated volume).

Table 6.3: Identified species from second millennium AD layers at Sibudu Cave that occur frequently in Typical Coast-belt Forest (Acocks 1988)

	A	S	%
Surface	14	36	39
Dung	8	23	35
BSV	17	39	44
BSS	14	32	44

A = species common to a) Acocks's lists of generally occurring and less common species of Typical Coast-belt Forest, and b) indigenous species identified archaeologically
S = total number of identified indigenous species from the Sibudu layer
% = A/S x 100/1

A Chi-square test for the equality of the 4 populations (Surface, Dung, BSV and BSS) was calculated on a SPSS computer package. It gave a Chi-square value of 0.64. The associated p value was 0.887, which is clearly not significant (H. Moolman pers. comm.). The conclusion is that there is no significant difference between the populations of the four layers, Surface, Dung, BSV and BSS. The statistical test thus supports the intuitive assessment that there has been no significant change in the vegetation in the Sibudu area over the last 1000 years.

6.4 Deciduous vs. Evergreen Taxa

Wadley (2004) has used the approach of comparing the numbers of deciduous vs. evergreen species as a method of documenting vegetation change. Because many species have distribution ranges across a variety of habitats it is useful to consider their temperature and moisture tolerances and their reaction to stress with respect to these important climatic parameters. Extremes of temperature and moisture availability and the timing and length of combinations of temperature and moisture availability are important. The shedding of leaves during adverse conditions is the major method of coping with these stresses and thus an increase or decrease in deciduous species, semi-deciduous and evergreen species could indicate changes in the climatic regime. Many species, however, may behave either as deciduous or evergreen depending on the prevailing conditions. Nevertheless, some species, for example, *Albizia,* are always deciduous (B. Page pers. comm.). Conversely, *Podocarpus* is perhaps the only tree in South Africa that is fully evergreen (*ibid)*. The comparison of deciduous vs. evergreen species for the identification of vegetation change at Sibudu is less helpful for the 1000 years comprising the second millennium AD layers than for the approximately 40 000 years comprising the MSA layers. This is because of the nature and timing of allogenic (extrinsic causes) vegetation change.

As previously mentioned (Chapter 1.5.1 Factors that Influence Vegetation), whereas limiting factors of temperature and moisture availability may exert influence over germination of plants and growth of juveniles over a shorter period, the survival of mature specimens capable of reproduction when the cycle becomes more favourable again, determines that there is no major vegetation change over longer periods. It has been suggested that changed conditions need to exist for longer than 1000 years for any permanent vegetation change to be effected (Van Wyk 2003). This argument is applicable to all vegetation assessments and not exclusively to the argument of evergreen vs. deciduous species.

6.5 Exotic species and cultigens

6.5.1 Exotic Species

***Melia azedarach* (Syringa-berry)**

Smith (1966:414) suggests this invasive alien was probably introduced from India at an early date (not specified) and says that it was recorded in cultivation in the Cape at about 1800. It was first recorded as naturalized in KwaZulu-Natal in 1894 (Bromilow 2001:78). *Melia azedarach* invades savanna, roadsides, wasteland and riverbanks. The drupes, when freed from their flesh and skin, may be dried and fashioned into ornamental necklaces (*vide* Durban Beachfront).

It is not impossible that south-moving agriculturists obtained *Melia azedarach* through trade on the East Coast. However, the absence of any documented use for the plant other than for the contemporary tourist industry, suggests that people did not deliberately introduce this vigorous declared invader.

Melia azedarach is commonest on the Surface and is the only species whose density values correspond with the seed numbers in ranking order, that is, Surface has the most seeds and highest density of seeds, followed by BSV, BSS and Dung (Tables 4.5 and 4.7). It is highly unlikely that *M. azedarach* is anything other than a recent introduction to the area. The seeds could have been brought in by birds (Chapter 5.1.2 Agents of Accumulation of Exotic Seeds) or could have dropped into the cave from a modern tree on the hilltop. The presence of *M. azedarach* in all the second millennium AD layers, and in decreasing frequency from Surface to BSS, is possibly a good illustration of the movement of seeds into the deposit.

***Ricinus communis* (Castor-oil plant)**

This annual herb, softly woody shrub or small tree up to 4m comes from tropical east and northeast Africa (Henderson 2001:139) and is an invader of riverbanks and disturbed soils. A dose of one to one and a half seeds is commonly prescribed as a purgative by traditional healers (Watt and Breyer-Brandwijk 1962). The seeds are the commercial source of castor oil for medicinal and industrial use (Hutchings 1996:170). Castor oil is used as a purgative and in creams, ointments, clear soaps and lipstick (Van Wyk and Gericke 2000:22). Although the seed is highly toxic due to the presence of ricin, which is amongst the most toxic compounds known, ricin is not present in the oil (Van Wyk and Gericke 2000:22). The seed must be broken or chewed to release ricin and as few as two seeds are fatal to children (Hutchings 1996:169). The seeds are ground and boiled to extract oil, which is used for toothache (Van Wyk and Gericke 2000:210). The seeds are not popular purgatives in Sotho or Zulu traditional medicine but leaf infusions, either orally or as enemas, are used for stomach ache (Van Wyk *et al.* 2000:164). Necklaces for the tourist industry are also made out of the attractive seeds (Durban Beachfront).

Ricinus communis is a declared invader that is competitive in watercourses (Henderson 2001:139) where presumably it is spread by water because it is not eaten by birds or other animals. *R. communis* is present in all the second millennium AD layers and it is not inconceivable that it was introduced to southern Africa by agriculturists when they moved southwards. Gardiner (1836:87) writing of his travels in 'Zoolu' country in 1835 states ' The castor-oil tree, and the indigo plant, are indigenous' which indicates that *R. communis* was probably naturalized by this time. [The 'indigo plant' is probably *Indigofera confusa*, the v*erfbossie* (Afrikaans for 'little paint bush'). It is indigenous and it is used for dye (Pooley 1998:388)]. The presence of *R. communis* in all layers may, however, be the result of burrowing or other post-depositional movement of the deposits, rather than an indication of an early introduction to southern Africa.

Ricinus communis is not unusual in deposits predating the 19th century. It has been found in cave deposits elsewhere in KwaZulu-Natal namely Umhlatuzana Rock Shelter (Kaplan 1990), Border Cave and Shongweni South Cave (Deacon 1986 reporting from unpublished material) as well as in caves in the western Cape (Deacon 1986). AMS dating of the seeds themselves could determine the veracity of an early introduction of *R. communis* (Deacon 1986:9).

It is interesting that the highest frequency and density of *Ricinus communis* seeds is found in BSS, followed by BSV, Dung and Surface and it contrasts with the frequency occurrence of the other exotic, *Melia azedarach*. The *R. communis* frequency pattern is a direct result of the highly anomalous frequency of *R. communis* seeds in BSS E2 and BSS E3. Although there are *R. communis* seeds sparsely scattered throughout BSS, 317 of the 400 *R. communis* seeds in BSS are from E2 and E3. More *R. communis* seeds (257) were found in BSS E2 than for the Surface, Dung, and BSV layers together (196). There are pits in both E2 and E3 but the possibility of contamination from the pits is an unlikely explanation for the high *R. communis* frequencies in BSS E2 and BSS E3 because the pit in BSS E2 yielded very few seeds at all (6) and of these only two were *R. communis*, and the pit in BSS E3 yielded one *R. communis* seed out of a total of 12 seeds. The anomalous pattern remains an enigma.

6.5.2 Cultigens

The dearth of primary archaeobotanical evidence of agricultural produce and plant use across the African continent has been noted (e.g. Reid and Young 2000) and has been attributed to factors such as the manner in which the food plants are processed and the conditions prevailing at sites. Considering the excellent preservation of indigenous seeds in the second millennium AD layers at Sibudu, cultigens, except for cucurbits, are surprisingly scarce. However, cultigens are also scarce at Umhlatuzana Rock Shelter, 35 km west of Durban, which yielded one *Zea mays* (maize kernel) and four Cucurbitaceae seeds from layers with pottery indicating first and second millennium AD occupation (Kaplan 1990). Conversely, the situation at Shongweni Cave, about 10 km from Umhlatuzana is quite different. Although there is no published quantification of the seeds, the first and second millennium AD layers at Shongweni clearly yielded a far richer variety and quantity of cultigens (Davies and Gordon-Gray 1977), namely, *Eleusine coracana,* (African finger millet), *Pennisetum glaucum,* previously *P. typhoides* and *P. americanum* (bulrush or pearl millet), *Sorghum bicolour* (sorghum, *amabele* (isiZulu)), *Citrillus lanatus* (tsamma melon), and *Lagenaria siceraria* (calabash or bottle gourd).

Whereas the relative lack of grains preserved in open sites can be attributed to preservation issues, the lack of identified grains at Sibudu is difficult to explain. Various grains have different temperature and moisture tolerances (National Research Council 1996) and their presence is useful for climatic interpretations. The remains of crops and crop history deserve greater in-depth study in southern Africa but the relative lack of primary evidence at many sites hampers such a study.

Arachis hypogaea, originally from Brazil and now cultivated widely throughout the tropics (Fox and Norwood Young 1982:201), was reported in cultivation in Natal before 1830 (Smith 1966:235). *A. hypogaea* is known as monkey nut, peanut or groundnut, and is a seed that is formed in an underground pod. It is similar to and has replaced the African groundnut or jugo bean (*Vigna subterranea*) in many rural areas (Van Wyk and Gericke 2000:28). Although the fragment of the pod was found in BSV it is yet possible that it is a modern contaminant.

Prunus persica (peach) from China and *Vitis vinifera* (grape) domesticated somewhere between south-eastern Europe and India, are both popular fruits. *Prunus persica* grows under a very large range of conditions. *Vitis vinifera* is susceptible to fungal diseases in areas of high summer rainfall and needs a cool to cold winter to induce dormancy (Reader's Digest Association of South Africa 1984). These climatic tolerances are likely to be irrelevant as both *Prunus persica* and *Vitis vinifera* are present in Surface and are possibly modern contaminants.

Cucurbits are able to grow under a range of climatic conditions but do not flourish if conditions are too moist (F. Jolles pers. comm.). They are generally grown as companion crops in between maize, although not in the Msinga area of KZN (*ibid).* A local farmer, John Dasa, is currently producing modern commercial varieties of cucurbits on the banks of the Tongati River opposite Sibudu Cave. Cucurbits are abundant throughout the second millennium AD layers and deserve more in-depth investigation, in future studies.

CHAPTER 7

DISCUSSION OF PROXY DATA

Archaeology is an eclectic study and it is fortunate for archaeologists that there are data from a diverse range of disciplines that can be used as proxy evidence for corroboration of interpretations of specific archaeological studies. Often a single strand of evidence is not convincing, but when the trends from various sources are considered together it is possible to get a clearer picture of what happened in the past. 'Confidence in our ultimate conclusions is best reinforced by finding consistent patterns in the majority of independent inferences' (Drennan 1966: 95). This applies particularly to botanical analyses and in this section I will discuss how the evidence from other studies relates to the Sibudu material and can be used to understand and interpret the Sibudu material. The evidence comes from studies of ethnobotany, fauna, pollen, tree-rings, stable isotope and other climatic indicators and includes the ecology of people, vegetation and changing climatic conditions.

7.1 Contributions from Ethnobotanical Studies

Cunningham (1988) has discussed present-day (1980s) gathering of wild plants foods by Thembe Thonga agro-pastoralists with specific reference to interpretation of economic activities at coastal plain agriculturist archaeological sites. This pioneering study is valuable for the insights it gives into the type of durable materials used for the preparation and processing of plant foods that might, in the absence of preserved plant remains, provide the only archaeological evidence for use of the plants (see Chapter 5.3.3 Artefacts used for the Processing of Fruits, Nuts and Seeds). Indigenous foods contribute diversity and valuable nutrients to the diet and good health of rural people (Van Wyk and Gericke 2000) and Cunningham (1988: 444) suggests that the equal role played by food gathering and agriculture in Thembe Thonga society is applicable to precolonial agriculturists.

Cunningham's work is useful for indicating the range of wild plants that are used and the relatively small number of these that are taken home for consumption. It is possible that seeds in archaeological deposits may represent no more than 18% of indigenous plants used as food by people. Pooley (1980), in a study of the various plant species used by the people of Maputaland, recorded whether the plants were for home consumption, were eaten *in situ,* or both. In a sample of 106 plants, only 27% were brought home as food and only 18% of the plants remained when species collected for their leaves, stems and roots were excluded from the total 'take-away' package,

Cunningham's subsequent and more detailed study of the Thembe Thonga also indicated that a relatively small number (26 out of 77 i.e. 34%) of the total available fruit species was collected for home consumption (Cunningham 1988:435) but that most spinach species were taken home and cooked. Interestingly, whereas Pooley (1980) records that 14 Rubiaceae species (including the delicious fruits of *Vangueria infausta, Lagynias lasiantha* and *Canthium inerme*) were eaten *in situ* and not one taken home, Cunningham (1988:435) states that *Canthium inerme* was taken home and that *Vangueria infausta* was a stored fruit, with increased value between July and September when agricultural production was low. There are no indications that Vanguerieae were stored at Sibudu. Cunningham's added reason for the storage of *Vangueria infausta*, because fewer fruiting species were available between July and September, is reflected in the seasonality data for the Sibudu assemblage that shows far fewer species represented in the months June to September.

Other comparisons between Thembe Thonga data and the Sibudu archaeological assemblage are also interesting. They suggest that a number of species that are found in the Sibudu assemblage, and that are eaten by people, were not brought into the cave by people. Species in the Sibudu assemblage that are eaten *in situ* in Maputaland and not taken home for consumption are *Antidesma venosum, Capparis tomentosa, Carissa bispinosa, Cordia caffra, Kraussia floribunda, Rhoicissus digitata, Uvaria caffra, Xylotheca kraussiana* and *Ziziphus mucronata.* Some of these species occur in relatively high densities in the Sibudu assemblage e.g. *Ziziphus mucronata* and Cunningham's results, if applicable to the Sibudu situation, suggest that people were not the agents of accumulation of these species in the cave. Fruit size was probably not a factor to the

Sibudu visitors because *Ziziphus mucronata* is not much different in size to *Canthium inerme,* which was selected for home consumption in Maputaland and is probably the *Canthium* species found at Sibudu. Cunningham does not elaborate why one and not the other species is selected for home consumption in Maputaland and why, for example, four *Canthium* species are eaten *in situ* in Maputaland and only *Canthium inerme* is taken home. Direct comparisons with the Sibudu assemblage are tricky. Cunningham's study is useful for its information on artefacts used in the processing of foods (Cunningham 1988) and in providing an indication of the low number of available fruiting species that are selected for home consumption. They indicate that if people were the only agents of accumulation of seeds the archaeological assemblage would reflect a much-reduced sample of the living assemblage.

7.2 Proxy Data from Faunal Studies

Only a limited sample of bone from the second millennium AD layers has been analysed and the results are combined for the various layers (Plug 2004) so that it is not possible to trace potential vegetation differences indicated by faunal presence, during the second millennium AD. A larger sample and faunal identifications for individual layers will allow for such a study. A larger sample is also likely to introduce a wider range of species.

Amongst the 273 specimens identified by Plug (2004) are domesticated cattle, which are the most common animals represented in the assemblage, sheep/goat, chickens and a possible pig (Table 7.1). Small bovids dominate (59%) the bovid assemblage (Plug 2004:155) and because these predominantly prefer forest and bush, the indications are that this may have been the dominant vegetation of the area.

Table 7.1: Faunal remains from the second millennium AD layers at Sibudu Cave. (After Plug 2004)

Species	NSIP	MNI
cf. *Homo sapiens sapiens,* human	2	1
Atilax paludinosus, water mongoose	17	1
cf. *Atilax paludinosus*	1	1
Equus burchelli, zebra	4	2
Equus sp.	1	
Procavia capensis, hyrax	12	3
Potamochoerus porcus, bushpig	5	1
Sus/Potamochoerus porcus, pig/bushpig	1	1
Suid	3	
Ovis/capra, sheep/goat	6	2
Bos taurus, cattle	41	5
cf. *Bos taurus*	8	1
Cephalophus monticola, blue duiker	32	4
cf. *Cephalophus monticola*	1	
Cephalophus cf. *natalensis,* red duiker	3	2
cf. *Sylvicapra grimmia,* grey duiker	2	1
Pelea capreolus, grey rhebuck	3	1
Pelea/Redunca, rhebuck/ reedbuck	6	1
Bovid small	21	2
Bovid medium-sized non-domestic	6	1
Bovid medium-sized indeterminate	19	1
Bovid large non-domestic	15	3
Bovid large indeterminate	14	1
Hystrix africaeaustralis, porcupine	1	1
Thyronomus swinderianus, cane rat	7	1
Rodent, medium-sized	1	1
Gallus domesticus, domestic fowl	6	1
cf. *Gallus domesticus*	4	1
Bird indeterminate	4	3
Reptile indeterminate 1	1	1
Unionidae	4	2
Marine gastropod	1	1
Perna perna mussel	2	1
cf. *Perna perna*	5	1
Veneridae	1	1
Marine bivalve	12	1
Marine mollusc	1	1
Total	273	52
Fragments not identified	999	
Total sample	1272	

The following descriptions of the distributions and habits of the indigenous fauna are taken from a number of sources (Apps 1992; Mills and Hes 1997; Smithers 1983; Stuart and Stuart 1997; Taylor 1998). The water mongoose and greater cane rat are associated with reeds in the vicinity of water. The Tongati River clearly provided this for them. Bush pigs live in forest and riverine vegetation and although they occupy a wide range of habitats from sea level to 400m, access to water and dense cover is a requirement. Similarly, the red duiker and the blue duiker live in dense forests and thickets. The grey duiker lies up in dense vegetation for most of the day and prefers savanna woodland, thickets and open bush country. Nevertheless it has a wide habitat tolerance. Porcupines also use a wide range of habitats, forests, woodlands, savannas, grasslands and deserts, wherever sufficient rock or scrub cover is present. They are nocturnal and will move up to 16km from their burrows along established pathways. Caves and rocks are important daytime shelters. Significantly, they are absent from the interior of forests. Rock hyraxes presently favour the cliffs around the cave and the size of their colony is apparently dependent on how much shelter the rocks provide. Men with packs of hunting dogs that I have seen near the cave on more than one occasion are probably part of the reason that most of the species described above are not seen around Sibudu today.

The habitat preferences of the grey rhebuck and zebra are anomalous. Grey rhebuck (*Pelea capreolus)* are seldom found below 1400 amsl in KwaZulu-Natal. They are associated with rocky hills, rocky mountain slopes and mountain plateaux with good grass cover (Smithers 1983:652) and high rainfall montane areas and broken hills country in areas receiving less than 100mm precipitation per annum (Stuart and Stuart, 1997:146). They are described as browsers (Apps 1992:165), grazers (Smithers 1983:653) and selective feeders that predominantly browse (Mills and Hes 1997: 274) but occasionally take grass (Stuart and Stuart 1997:146). According to Plug (2004:157) grey rhebuck indicate drier than present Sibudu conditions and an open savanna environment.

Zebra (*Equus burchelli*) are a savanna species partial to open areas of woodland, open scrub and grassland where water is available. They are exclusive grazers with a strong preference for short, fresh grass, especially after a burn or rain shower. They move to wherever food and water is available. They do not occur in forest and avoid areas of dense woodland except in transit. Although there are records of sightings of zebra during historical times (Plug, 2004), zebra have not been recorded in the Sibudu area during recent times. However, the presence in the Sibudu seed assemblage of the grassland species *Lannea edulis* throughout the last 1000 years suggests a suitable habitat for zebra. *L. edulis* is a suffratex adapted to a fire regime and the fires it survived would have encouraged the growth of fresh green grass favoured by zebra.

Both grey rhebuck and zebra occur in the MSA layers at Sibudu. The presence of pits and numerous MSA artefacts in the second millennium AD deposits attests to much mixing and it is possible that these species are out of context in the Iron Age layers. However cattle (*Bos taurus*) like zebra are grazers and this leads to speculation on whether grazing was locally available or whether the cattle (and zebra) were brought back to the cave from further afield. Marine resources were brought at least 11km and it is possible that meat was also transported. Determination of the reason for human presence in the cave could provide possible answers to this question.

If people were not grazing cattle in the area their reasons for visiting the cave may be related to ritual and initiation or refuge. The artefacts in the cave suggest more than mere visiting: there are hut floors, pottery, upper and lower grindstones, many glass beads, many wood shavings, much evidence of worked wood and even some burnt basketwork (Wadley and Jacobs 2004). Hut floors are present in BSV and BSS and were probably laid down over a period of continued occupation of 100 to 150 years starting in the early years of the second millennium AD. There are many furnaces in the immediate vicinity of the cave and the people who worked them may have used the cave for shelter. Unfortunately the pottery associated with the furnaces is not diagnostic. Some of the furnace sites have recent blue, green and white beads. If these beads are associated they suggest a recent date for some of the furnaces. This would imply that the furnaces are not contemporary with the hut floors in the cave.

7.3 Proxy Data from Tree Ring Studies

Detailed climatic records are available for KwaZulu-Natal only from the end of the 19th century. Dendroclimatological analysis provides an independent source of climatic data for the period before records were made (Hall 1976). Not much dendroclimatology has been done in southern Africa and the lack of suitable specimens for corroboration prevents the establishment of well-dated and clear series similar to those of Europe and North America.

Tree-rings document activity and inactivity in tree growth. In different areas different factors may limit growth: in some cases rainfall may be the dominant control, whereas in others it may be temperature. Usually it is a complicated combination of the two (Tyson 1986:57). Tyson says that tree-ring variation should be taken to indicate growth in benign climatic conditions and retardation in harsher environments.

A *Podocarpus falcatus* trunk from the Karkloof Forest 25 km NE of Pietermaritzburg has provided a tree-ring series dating back to the 14th century (Hall 1976). Because Karkloof is subject to only occasional frosts and low temperatures, Hall considered precipitation to be the limiting factor on growth. The periods of exceptionally low growth in the 19th century all correspond with severe famines recorded in oral histories and because these famines seem to have affected the full extent of KwaZulu-Natal Hall suggests that the findings from the Karkloof can be applied to a larger part of the summer rainfall area.

The error for the Karkloof specimen is of the order of 10% from 1600 onwards; before that it may be up to 20% (Tyson 1986). Nevertheless the records indicate a spectrum of fluctuations with peaks at 14, 18 and 21 years from 1760 onwards. The 18-year peak is predominant and may be related to a rainfall oscillation of similar wavelength (Tyson 1986). Tree-rings from another *Podocarpus falcatus* of similar age from Knysna, which experiences year-round rainfall, also show a periodicity of 18 years (Thackeray 1996; Thackeray and Potze 2000). Harsh conditions of such relatively short duration are unlikely to affect the long-term composition of the vegetation and it is unlikely that indigenous seeds in the archaeological record would reflect such short-term variation.

Furthermore, there may exist a time-lag between conditions indicated by tree-ring studies and conditions indicated by seed data. For example, wetter conditions may promote the germination and establishment of certain plants but these plants will only produce significant quantities of seeds on reaching maturity, up to thirty years after the onset of changed conditions (B. Page pers. comm.). During a wetter phase the tree canopy may increase or even close in situations such as forest clearings, so that plants adapted to establishment in sunlight, such as forest pioneer species, will be prejudiced and species adapted to germination and growth in shady conditions will increase (*ibid*).

In the summer rainfall regions of South Africa, from at least the early 14th century until the mid-16th century, clear below normal growth conditions prevailed in response to the general cooling associated with the occurrence of the Little Ice Age elsewhere in the world (Hall 1976). The change from below normal to above normal growth conditions occurred around 1570 and temperature appears to be the predominant control of tree growth at this time (Tyson 1986). Enhanced growth from about 1760 until about 1860 was punctuated by short periods of greatly reduced rainfall around 1800, 1823/4 (not as pronounced) and 1846/7, and was followed by a period of retarded growth until 1915. Growth around 1880 was as low as the lowest rate during the Little Ice Age. The implications of this dendroclimatological data will be discussed in the summary of all the proxy data (Chapter 7.8).

7.4 Proxy Data from Pollen Studies

The pollen record at Sibudu is poor (L. Wadley pers. comm.) and a possible reason for this is that pollens are destroyed in over-dry conditions (Goodwin 1959:27 35). However, a study of pollens in the Mdlanzi Swamp, north of St. Lucia and about 5km from the Indian Ocean provides data of a comparable time (Turner and Plater 2004). At Mdlanzi swamp there were significant changes in the relative frequencies of sedges, grasses and ferns, and plants indicative of wetland and aquatic habitats such as *Nymphaea lotus* and *Typha.* However, overall tree pollen types, which were poorly but consistently represented throughout the last 1500 years, showed little variation. The authors state that this lack of variation suggests that forest structures changed during the infilling of the swamp, perhaps due to the large-scale forest clearance in the ‘Early Iron Age’ that initiated swamp sedimentation (Turner and Plater 2004:228).

Significant environmental disturbance occurred at Mdlanzi swamp around AD 1500-1600 when low water levels caused by drought or artificial drainage were followed by fire (Turner and Plater 2004:227). Dendroclimatological data suggest that this was a time of decreased rainfall (Hall 1976). The risk and incidence of fires is increased during drought and either this natural phenomenon or deliberate fire management by agriculturists led to a period of non-devastational burning. Significantly, tree pollens show hardly any variation during this time. The implication is that trees, and hence fruits and seeds from trees, might not be good indicators of short-term climatic fluctuations. Alternatively, it is the proximity of the Mdlanzi stream and nearby Mkuze River that may have provided moisture for trees and masked the effect of harsher conditions. This is a possible scenario for Sibudu too.

7.5 Proxy Data from Stable Isotopes and Other Climatic Indicators

Stalagmite-derived oxygen and carbon stable isotopes provide a robust signal for palaeoclimatic reconstruction in the summer rainfall region of southern Africa (Holmgren *et al.* 2003). High-resolution data from stalagmites in the Makapansgat Valley indicate a period of medieval warming from 1.2 to 0.6 ka and a cool dry event associated with the Little Ice Age between AD 1500 and 1800 (*ibid*). Maximum cooling was at AD 1700. The data also showed ~ 1.0 ka and ~100-year oscillations in climate.

The Makapansgat speleotherm data reinforced conclusions reached in a widely inclusive summary of environmental proxy data (Tyson *et al.* 2001). Although the summary had identified the period of medieval warming and the Little Ice Age with slightly different dates: AD 900 to AD 1300 and AD 1300 and AD 1800, the overall trend was the same. At AD 1250 when maximum warming occurred the climate was estimated to be 3-4°C warmer than at present. At the maximum cooling at AD 1700 the mean annual daily maximum temperatures were about 1° C cooler than at present. Sudden, abrupt and highly variable conditions occurred throughout both periods but especially in the period of medieval warming when there were oscillations in annual mean daily maximum temperature of 2-3°C in a few decades. Cited data from a range of sources across southern Africa indicate that the Little Ice Age was a widespread event and like the period of medieval warming is linked to the expansion and contraction of the atmospheric circumpolar vortex. Shorter events such as the ~100-year oscillations may be due to solar activity.

7.6 Ecology of People, Vegetation and Changing Climatic Conditions

Human-plant relationships are dynamic. The natural environment provides humans with a particular set of resources that have ecological limits and exploitation potential and humans' economic and cultural systems will influence how they react to these. In turn, humans will affect the environment. The ecological approach that considers interrelationships between people and all organic and inorganic aspects and processes of the environment has been integral to agriculturist research in KwaZulu-Natal since the 1970s.

Agriculturists moving into southern Africa needed tsetse-fly free grazing for their animals, land for planting crops and timber for firewood, building and charcoal for ore smelting. Their crops also had particular climatic requirements and because of this, locations of agriculturist sites provide evidence for past climates (Huffman 1996). Agriculturists in turn made an impact on the vegetation.

The pioneer agriculturists in KwaZulu-Natal appear to have preferred an environment of Coastal Forest within a few kilometres of the Indian Ocean and the deep sandy soils of the valleys of major rivers within mixed bushveld vegetation (e.g. Hall 1980 1981; Maggs 1980a 1980b 1989). Climatic restraints, arable soil, and the proximity of wooded environments and ore sources were primary determinants of settlement location (Whitelaw and Moon 1996). Favoured settlement locations in Transkei further reveal a preference by the earliest agriculturists for east-facing slopes and fertile dolerite-derived soils (Granger *et al.* 1985).

Second millennium AD settlement was away from valley bottoms towards hilltops and expansion into thorn scrub and grassland areas. The lack of timber for fuel and construction had practical and socio-economic consequences such as the use of stone for building and reliance on trade for metal goods (Maggs 1980b). In Transkei however, it may have been the lack of ore (Whitelaw 1991) rather than the lack of timber as tentatively suggested (Feely 1987) that limited iron production. Edaphic factors such as declining soil fertility rather than climatic or vegetation constraints have also been cited as settlement determinants in the lower Thukela basin (Van Schalkwyk 1994/95), although conditions such as sufficient summer rainfall, year-round grazing, timber for building and fuel were essential basics. Millets, sorghum, cowpeas and cucurbits are relatively drought resistant but require adequate summer rainfall to grow and significantly no early agriculturist sites are found beyond the southern limits of the summer rainfall regime (Maggs 1980b:9). The climatic tolerances and preferences of cultigens were also noted in studies at Shongweni Cave (Davies and Gordon-Gray 1977) and further afield (Huffman 1996). The influence of fluctuations of rainfall on grain production and the resulting imbalance between people and resources has even been cited as an important factor in the nineteenth century upheavals known as the *Mfecane* (Huffman 1996:59). Clearly there exists a complicated interplay of numerous factors in past ecological interrelationships. It is often difficult to identify the definitive factors. It may be that comparatively small-scale changes in the circumstances of agriculturists may be central to the understanding of their ecology (Hall 1976:695).

It is necessary to identify the effects that agriculturists had on the vegetation so that changes that were caused by their various economic and social activities are not interpreted in terms of climatic variables. The mixed farmers presumably employed a ‘slash and burn’ approach to clear the coastal forest and bush for agriculture and grazing (Maggs 1980a 1980b; Hall 1981). Further clearance would be needed when the productivity in these relatively poor sandy soils declined (Maggs 1980a:87). The continual clearing of small patches of primary vegetation and the gradual replacement by secondary vegetation would have encouraged grassland and scrub development (Moll 1976).

Within forests themselves there was probably selective felling of young saplings for the construction of huts and kraals. A report by Assistant Conservator of Forests, Fourcade, in 1889 (in Palmer and Pitman, 1961) states that young saplings were preferred for the building of huts and kraals as they were straight and made the best wattles. Up to 1000 wattles were used to construct a single hut that on average needed to be replaced every 30 years. Cunningham and Davis (1997:482) report that 2000-3000 hardwood laths are used to construct homes in the sand forest zone and Delegorgue (1990:160) reports that 3000 wattles were used in the construction of a hut belonging to an important chief. This estimate might be accurate and might not reflect Delegorgue's occasional *penchant* for exaggeration and inaccuracies. An example of this *penchant*: Delegorgue (1990:262) says 'not more than 10 *makanos* [= marula; *amaganu* is the isiZulu word for marula fruits (Doke *et al.* 1977)] are sufficient to produce a state of intoxication in man'. His description of elephants intoxicated by marula (Delegorgue 1990:262) may have contributed to the myth that elephants become intoxicated by rotten marula fruits.

Young saplings were also harvested for firewood. Fourcade (in Palmer and Pitman, 1961:25) reported that young wood was preferred for firewood because of the greater labour involved in harvesting large trees. The harvesting of young wood for firewood and building meant that the forests were denuded of young growth. The effect this would have had on forest regeneration is self-evident. The impact of harvesting on older trees was also severe, particularly for the manufacture of charcoals for fuel for firing furnaces and iron ore smelters. Research at a site near Palaborwa indicates that nearly 7000 hardwood trees would have been used to produce the approximately 180 metric tons of slag produced from six furnaces at the site (Van der Merwe and Killick 1979).

Agriculturists also altered the natural fire regime. Regular fires, which occur naturally in late winter or early spring (Moll 1976), are necessary to keep grasslands healthy and also to restrict bush encroachment (Cowling *et al.* 1997; Smit 1999). However, fires that occur as often as two or three times a year change the grassland composition (Van Wyk and Smith 2001). Fires lit in late summer and autumn, and again in winter, to encourage the growth of green grass for stock, are likely to have encouraged the replacement of *Themeda triandra* by *Aristida junciformis,* which is less palatable and nutritious.

The relationship between the relative areas covered by grass and trees in savannas is a dynamic relationship influenced by a number of factors. 'The ecological factors of particular interest in savannas are the strong coupling of the vegetation structure and function to sporadic driving variables such as rainfall, fire and herbivory, and the inherent instability of the competitive relationship between the two main vegetation components [grass vs. trees]' (Cowling *et al.* 1997:274). 'A principal factor in the tree-grass interactions is fire, which with browsing, acts as a restriction to the dominance of trees over grasses' (Cowling *et al.* 1997:271). Thus 'large scale successional sequences in savannas are mostly associated with human disturbances, such as sustained heavy grazing or clearing for agriculture or settlement' (Cowling *et al.* 1997:272). It would appear that, notwithstanding the modern interferences, human influences in the Sibudu area may be of considerable time depth and it is quite likely that the effects of iron-smelting and an agricultural economy, comprising permanent settlements, gathering of fuel and housing materials, planting of crops and grazing of livestock have been operative in the Sibudu area for at least 1000 years.

The impact of the pioneer farmers in destabilising the landscape may have been severe and large scale forest clearance early in the first millennium AD has been suggested as a reason for swamp sedimentation at Mdlanzi wetland, northern KwaZulu-Natal (Turner and Plater 2004). Farmers had a continuing impact on the vegetation and much later, in 1835, Rev. George Champion observed changes in vegetation where huts and kraals had been previously abandoned (Booth 1967:17).

In the Eastern Cape Feely (1980) observed secondary effects on vegetation previously assumed to be in a relatively undisturbed natural state and Hall (1984) in Zululand also recorded the considerable effect of human land use on the composition of woodland and grassland. Present-day 'wilderness areas' such as the Umfolozi/Hluhluwe Game Reserve in KwaZulu-Natal are not pristine and have been subjected to the sustained influence of pre-colonial farmers (Granger *et al.* 1985). A significant part of the structure and diversity in 'undisturbed' savannas is the result of human disturbance and fire-setting over the ages' (Blackmore *et al.* 1990 in Cowling *et al.* 1997:272).

Even the descriptions of the vegetation recorded by early travellers are likely to reflect an altered landscape. Travelling between the 'Umhlali' and the 'Um-Tongati' rivers in 1836 the Rev. George Champion wrote (Booth 1967:17):

> 'We saw two or three large trees the only ones on our journey that might suffice for planks & boards. The timber for these purposes is said to be found at a greater distance from the coast…. Generally on ascending each rise of ground a fine champaign would

> stretch out before us fringed in the distance by woody hills. A plant very much resembling the banana abounds.‘

Between the ‘Umgeni’ and ‘Umhlote’ rivers Champion reports (Booth 1967:14-15) ‘patches of mimosa bush’ in grassland and that ‘after leaving the Umhlali we passed thro’ a country of fine rolling land, with scarcely a bush on it and covered with high grass’ (Booth 1967:18). Gardiner (1836:110), the previous year, also noted high grass ‘which often rises to the head of a person on horseback’ north of the ‘Umslutie’. Smith in 1832 described long and short grass north of the Mgeni river and a savanna-like vista of undulating grassland interspersed with copses of *Acacia* and deep wooded kloofs (Kirby 1955:40). He said that wood, sometimes as extensive clumps and sometimes as solitary trees, covered about15% of the area. The ‘*Mimosa’* were described as small in size, which may indicate the development of *Acacia* scrub probably as the result of agriculturist activities. *Acacia* scrub occurs as secondary vegetation growth after the removal of primary vegetation (Moll 1976).

The antiquity of this savanna type vegetation is unclear but it is clear that whatever the effect of the pioneer farmers there is no evidence that alien species were replacing indigenous ones. ‘The impact on the environment seems to have been in terms of clearing and redistribution rather than replacement’ (Deacon 1986:14). ‘Woody components of the Coastal Forest and Valley Bushveld types may be much more resilient to human use than botanists have suspected hitherto’ is the conclusion drawn by Feely (1985) from his observations of the present-day persistence of these vegetation types in the vicinity of archaeological sites.

Vegetation change in terms of degree is supported by Hall’s work in Zululand. In low-lying riverine valleys in Hluhluwe Valley *Acacia robusta/Spirostachys africana* woodland was felled in the first millennium AD. It regenerated following the disuse of the area by farming communities and during the second millennium AD mature woodlands again became established (Hall 1984). An initial reduction in species diversity as a result of over-exploitation of resources was restored when the harvesting was discontinued for a suitable length of time. Observations based on archaeological remains, species diversity and the population structure of the dominant species, *Euclea divinorum*, indicated more recent exploitation on higher-lying land and an earlier stage of succession in the restoration of the original vegetation. A thousand years of no occupation by farmers is cited as 'ample time' for vegetation to recover in Transkei (Prins 1994/1995:185).

Some authors, such as Cunningham (1988:445) have considered 'the positive selective influence' of agriculturists on favoured (high-yielding, palatable, synchronous fruiting) fruit-bearing species because of 1) their maintenance in agricultural fields for fruit and shade despite the clearing of other vegetation for agriculture e. g. *Sclerocarya birrea caffra, Trichilia emetica, Manilkara concolor, M. discolor, Strychnos spinosa, S. madagascariensis*; 2) the dispersal and subsequent germination at homestead sites of popular fruit species able to germinate on exposed sites (commonly *Trichilia emetica* and *Sclerocarya birrea caffra*); 3) changes in sex ratios and possibly changes in the fruit production of the popular dioecious fruit-bearing species *Trichilia emetica* and *Sclerocarya birrea caffra* caused by selective felling of male plants or female plants with low fruit yields; and 4) deliberate burning of coastal grassland, savanna and palmveld to induce fruiting of favoured edible species (*Salacia kraussii, Parinari curatellifolia, Eugenia capensis albanensis*) and to increase the abundance of annual and perennial spinaches on soils disturbed by agricultural clearing. The influence of deliberate selection has also been observed in Transkei where analogy to Cape Nguni customs suggests that various isolated trees found in atypical situations are associated with second millennium AD sites e.g. *Erythrina caffra, Euphorbia triangularis, Ficus natalensis, Aloe bainsii* and *Zanthoxylum* sp.. Hall (1984) too demonstrated a positive selective influence in the Mflozi Valley of Zululand where secondary communities that followed human settlement provided more productive grazing. Abandoned sites in grasslands dominated by *Themeda triandra* were colonised by early seral stoloniferous grasses such as *Urochloa mosambicensis* and *Digitaria longifolia.* These grasses are far more palatable than *T. triandra* and were maintained by selective grazing by cattle and later, in the game reserve, by non-domesticated fauna.

Clearly, the influence of agriculturists on vegetation is more complex than is generally accepted (Feely 1985) and has to be considered in any evaluation of the effects of climatic changes on the vegetation. The conclusions that can be drawn from the studies outlined above are that over most of the last two millennia agriculturists exerted a considerable and sustained influence on the vegetation. However, until the large-scale introduction of a wide range of exotics by European settlers (Wells *et al.* 1986), this influence did not alter to any major extent the community of species, but rather the abundance of particular species within the communities. This constitutes a serious problem for the archaeologist, because it is often these abundances that are studied in the archaeological assemblage for indications of vegetation change. Hall's studies (1984) particularly, illustrate the impact of anthropomorphic as opposed to environmental influences and complexities of interpretation based on species diversity and abundance. Because the variables affecting abundances are so unpredictable and inconstant, the results from seed data abundances cannot provide reliable information for postulating past vegetation and climatic changes.

7.7 Management of Vegetation by Fire and Other Means

The antiquity of the use of fire to create fresh pastures and stimulate the growth of desirable plants is less easy to demonstrate than the antiquity of the regular use of fire in caves for social purposes such as cooking, warmth and protection. Many plants in southern Africa are fire-adapted and in some cases fire-dependent for propagation but this does not necessarily imply a long history of people deliberately setting fire to the veld. Nevertheless, as indicated in the previous section, the use of fire is a common strategy employed by agriculturists to the clear land for pasture and crop planting and to stimulate grass growth and one can assume that pioneer agriculturists in southern Africa used fire for these purposes.

Fire is one of the major factors in determining the relative woody plant/grass ratio in savanna. The reasons for bush encroachment are complex and are due to long term overgrazing and the exclusion of sporadic hot fires and browser herbivores (Smit 1999). Agriculturists can be implicated in all these factors. Although climatic conditions do influence the incidence of fire, regular fires started by the farmers would prevent the build-up of the excessive amounts of dry vegetable material that fuel hot fires.

Whereas the antiquity of the deliberate use of fire as a land management tool has been studied, the management of indigenous resources by other means has not been as thoroughly investigated. Shone (1979) suggested that *Sclerocarya birrea* was deliberately propagated and more recently Milewski (2004) has suggested that spekboom, *Portulacaria afra*, was deliberately planted by pastoralists in the past. 'Live fences' of spekboom would form a shelter against wind and predators and also provide a source of nourishment and moisture for corralled livestock. Zulu also eat the pleasantly acidic leaves (Palmer and Pitman 1961). The implications of Milewski's suggestion have relevance to the possible management and spread of other indigenous plants. The agriculturists cultivated exotic plants and there is no reason why they should not have deliberately planted species indigenous to southern Africa in areas in which they did not naturally occur. Both *Portulacaria afra* and *Euphorbia tirucalli,* 'kraalmelkbos', have been planted so widely that it is difficult to determine whether they occur naturally in an area or not (Coates Palgrave 2002).

7.8 Summary and Implications of Proxy Data

The bulk of the second millennium AD Sibudu assemblage, namely BSV and BSS, predates the dendroclimatological evidence but coincides with the period of medieval warming identified from other climatic proxy data. Maximum medieval warming is estimated to be 3-4°C warmer than at present and sudden, abrupt and highly variable conditions with oscillations in annual mean daily maximum temperature of 2-3°C occurred in a few decades. These fluctuations are likely to have had a marked effect on cultivated species and the socio-economic dynamics of communities that relied on agriculture. They are unlikely to be reflected in the record of indigenous species, particularly long-lived adult perennial plants, which are the major components in the Sibudu assemblage. Whereas seed production and establishment, seedling survival and adult growth and productivity may be severely restricted, seed banks and the number of adult plants may not be affected over decades or even a century or more. Certainly a mean annual fluctuation of 2-3°C in the mild type of climate presently experienced is unlikely to have produced severely limiting temperatures. The effects of a possible high summer aridity index would have been counteracted by moisture supplied by the Tongati River and by the south-facing valleys, which because of their cool aspect and deep forest cover, would have retained more moisture.

During the last millennium changes in temperature were most extreme during the period of medieval warming and no change from this time to the present is evident in the seed data. Finer resolution of the layers and the dating of the Dung layer is needed to confirm whether the period of minimum precipitation postulated by the dendroclimatological data is represented in the Sibudu deposits. Although people may not have been using the cave at this time, it is unlikely according to the results of the actualistic study, that seeds were not continuously being deposited in the cave. Present-day observations of dried leaves and other vegetation that collect in the cave suggest that deposit would be building up, although possibly very slowly except where obstacles existed. The dried vegetation tends to collect around rocks, and obstacles on the cave floor such as the remains of huts are likely to have caused a build-up of material. Because of the excellent preservation conditions in the cave, the wind and rain are unlikely to have caused rapid decay of the structures.

CHAPTER 8

CONCLUSIONS

The evidence from analysis of the fruits, nuts and seeds from the second millennium AD layers at Sibudu Cave does not indicate that there has been any change in the vegetation within foraging distance of the cave within the last 1000 years. It is possible that there were short-term variations in response to the sudden, abrupt and highly variable conditions of temperature and precipitation that have been identified for this period elsewhere in southern Africa. These variations could have been masked by depositional history, differential preservation and recovery, and identification difficulties, as well as the influence of the perennial Tongati River. Short-term fluctuations in climatic conditions are unlikely to be reflected in indigenous seed assemblages and this study recommends that an archaeobotanical study of indigenous seeds would be of greater value for the investigation of periods longer than 1000 years.

To my knowledge this is the first dissertation dedicated to the detailed analysis of seeds from an archaeological site in South Africa and it introduces a number of issues that need attention. First, it is imperative that comprehensive comparative collections be compiled specifically for archaeobotanical identifications. Secondly, archaeologists in southern Africa need to be made aware that archaeobotany is a specialised discipline, which requires specific approaches to sampling and recovery of remains. Thirdly, there is a vital need for the establishment of a corpus of methods and theory to ensure that the results of archaeobotanical analyses within southern Africa can be compared among sites.

Qualitative assessments of seed remains can be of immense use when a marker species is identified and can be cited as evidence for change in vegetation. When no marker species is identified, interpretation is more difficult, because vegetation studies rest predominantly on the relative abundances of species and within species and the grouping of species into communities. Relative abundance and community composition may be severely compromised in archaeological samples, which are biased by variations in agents of deposition, preservation and other post-depositional processes, recovery and difficulties of identification. The situation is further complicated by the position of Sibudu Cave in a savanna biome. Savannas cover a large part of southern Africa and exhibit much variation in the relative amounts of grass and tree cover. It is likely that vegetation variations around Sibudu would be in the proportion of lower strata vs. canopy cover (grass vs. bush and trees) rather than a change in species composition. A further problem is that remnant species may remain and not be recognised as such, thus indicating the presence of a regime no longer present. The lone *Celtis mildbraedii* at the entrance of the cave is testament to this situation.

An assessment of the species composition indicates no marked variation between the surface that represents the present-day vegetation regime and an approximately 150-year occupation about 1000 years ago. This suggests that plants that presently grow in the remnants of indigenous vegetation in the Sibudu area are of the same range of species as the vegetation that existed at that time. Various interpretations are that 1) it is not possible to decipher vegetation change within a period of 1000 years, i.e. indigenous species, as indicated by the presence or absence of seeds, do not reflect short-term fluctuations as opposed to permanent change in environmental conditions; 2) the record from Sibudu is not detailed enough for identification of short-term vegetation change; 3) the material is biased by the proximity of the Tongati River; 4) the material is missing from the deposit because of the circumstances of deposition, preservation, recovery and identification; or 5) changing climatic conditions during the second millennium AD were not severe enough to exert any major influence on the vegetation because of the mild regime they were imposed upon.

‘Absence of evidence is not evidence of absence’ (Sagan 1996) and because proxy data indicate that there have been climatic shifts during the last 1000 years one must either look to refining the archaeological data in terms of stratigraphy and dating or accept that it is not possible to identify short-term vegetation shifts from indigenous seed remains, particularly when climatic variations take place within a mild climatic regime. I believe that it may be possible to identify vegetation change in sites not compromised by the proximity of a river and river valleys.

Climatic variables aside, it is highly unlikely that agriculturists moving into southern Africa would not have changed the landscape through exploitation of trees for firewood, building or smelting purposes, clearing of land for agriculture, the grazing of their herds and the use of fire to promote the growth of fresh green grass. If vegetation change during the second millennium AD were identified from indigenous seed remains a further challenge would exist in the need to demonstrate that climatic changes rather than anthropomorphic influences were the determinants of the vegetation change.

APPENDIX A

RECOMMENDATIONS ON METHODS

These recommendations are basic instructions and suggestions for successful archaeobotanical analysis. They are by no means comprehensive and it is imperative that manuals such as Pearsall (2000) be consulted for further details. I first summarize the recommendations and subsequently I elaborate upon them.

RECOMMENDATIONS:

1. Identification: look at size, shape and definitive features and inspect a number of examples before making an identification.
2. Collection of seeds: collect fresh and weathered seeds from a number of localities and environmental regimes.
3. Collection of vouchers to accompany seeds: follow accepted botanical procedures.
4. Excavation: collect standard size samples following the same sampling method for each sample; clearly record the sampling methods that are used.
5. Recovery: use fine dry sieving for dry loose or sandy deposits; when flotation is used, sort through the ‘heavy fraction’ (non-floating) material as well.
6. Detailed recording of methods: all methods concerning identification, collection, excavation, processing, quantification and statistical tools used must be clearly detailed to facilitate comparison with other samples and sites.

1. *Identification*: To identify a seed one looks for size, shape and definitive features such as the hilum and texture. The analyst needs to inspect a number of seeds before the species or taxa become familiar. Although definitive features remain constant, seeds vary to a considerable degree in size and shape. It is necessary therefore to collect fruits from a number of different localities and different climatic conditions. In the summer of

2003/2004 *Asparagus densiflorus* produced fruits far larger than the previous summer and some of these had two or three seeds. Whereas the earlier sample led to the conclusion that the seeds were always round, in 2003/2004 seeds were distinctly flattened on one or more sides depending on how many were present in the fruit.

Sometimes seeds need to be broken to reveal features evident on the archaeological examples e.g. *Xylotheca kraussiana* has a distinctive, albeit variable, shape and it was only when freshly dried seeds were broken that it was possible to identify the 'hidden hilum' that was evident in the archaeological examples.

2. *Collection of seeds*: Collect all parts of the fruiting structures. Collect fresh seeds from ripe fruits as well as seeds that have been weathered by natural means. *Harpephyllum caffrum* endocarps recovered archaeologically are more easily identified by comparison with modern endocarps that have been exposed to the weather for a season or more, than by comparison with fresh endocarps that have had their flesh removed and been dried indoors. In most instances, unless the seed is from a ripe fruit it will not be mature and fully formed. Seeds from many taxa are damaged by parasites while still on the tree. Contamination of the samples also occurs when previously imperceptible parasites hatch some time after collection.

In this study, the problems of shrinkage and distortion (due to charring) were avoided because only uncharred seeds were analysed. A comparative collection needs burnt and broken seeds. Pearsall (2000) provides details on the charring of seeds.

3. *Collection of accompanying vouchers*: Collections of vouchers must be made according to accepted botanical procedures (Victor *et al.* 2004). Voucher specimen data are essential in the event of taxonomic revision. The required accompanying data, such as the situation of the specimen and its aspect, are important.

4. *Excavation*: Matters relating to sampling are discussed in detail in the main text.

5. *Recovery techniques*: Recovery techniques are discussed in detail in the main text. Water sieving does not increase the recovery rate of seeds for dry loose deposits.

Repeated handling of the seeds when they are wet and fragile can cause breakage and disintegration; water sieving is not recommended for dry dusty deposits.

6. *Recording*: Rather record too much than too little, especially on the polystyrene trays that I recommend for use to spread out the seeds to dry. A ballpoint pen works well on the trays and the following details are essential: date of collection, scientific name of the seed collected and location of collection. This information can then easily be linked with notes taken in the field.

APPENDIX B

DESCRIPTIONS OF THE FRUITING STRUCTURES USED TO DEFINE SEED COUNTS

Different parts of the fruiting structures of plants are preserved in the archaeological record and these form the basis of 'seed' counts. In this appendix I describe the definitive features that are characteristically preserved for the uncarbonized remains of various taxa. I also explain what constitutes individual counts of certain taxa, elaborate on patterns of breakage for particular taxa and indicate how these relate to my fragmentation index (a three-tier classification system used for quantification of whole seeds and fragments of seeds). Most of the seeds in this study fall into the category equal to or greater than (≥½) half a seed.

Fruiting structures, the fragmentation index and individual counts are also discussed in the Preface; in Chapter 2.2 Recovery and Identification of Seeds; and in Chapter 3: 3.2 Identification of Seeds and 3.3.1 Determination of Absolute Counts.

Fruits are ripened ovaries containing seeds. The pericarp or wall of the ripened ovary may be fused or be divided into epicarp, mesocarp and endocarp (Leistner 2000:753). In fleshy fruits such as drupes the pericarp is the outer 'rind', the mesocarp is the middle succulent layer and the endocarp is the hard or stony inner layer. In the case of drupes the hardened endocarp is usually the only part of the fruit that is preserved archaeologically. I have referred to a hardened endocarp as a stone although a stone is technically the endocarp plus the seed (Leistner 2000:755). The testa is the outer coat of a seed (Leistner 2000:758).

APPENDIX B

The fruiting parts used for the identification of species that are found in the second millennium AD layers at Sibudu are listed below (~ indicates an exotic species).

Adenia gummifera	testa
Allophylus	stone
Antidesma venosum	stone
Apodytes dimidiata	stone; often breaks exactly in half
~ *Arachis hypogaea*	capsule
Asparagus spp.	testa
Bridelia micrantha	stone
Calodendrum capense	testa; black and angular, no regular breakage pattern
Canthium spp.	stone; very seldom found whole; usually split or disintegrating around the hilum; seldom breaks exactly into half and fragments are clearly smaller or larger than half a seed
Capparis tomentosa	testa; variation in shape makes it difficult to identify what constitutes half a seed; fragments are mostly classified as less than half a seed (<½) because of this uncertainty
Carissa bispinosa	testa
Celtis spp.	stone
Chrysophyllum viridifolium	testa
Commiphora spp.	stone; residual division inside the stone often preserved
Cordia caffra	stone
Croton sylvaticus	testa
Cryptocarya spp.	hardened receptacle
Cucurbitaceae	gourd fragments and testa
Dalechampia capensis	testa
Diospyros sp.	endosperm
Drypetes arguta	stone
Ekebergia capensis	stone
Embelia ruminata	stone
Grewia occidentalis	stone
Harpephyllum caffrum	stone
Helinus integrifolius	stone
Hippobromus pauciflorus	stone

Justicia campylostemon	capsule
Kraussia floribunda	stone
Lannea edulis	stone
Manilkara discolor	testa
~ *Melia azedarach*	stone, seldom without some disintegration
Millettia grandis	a small velvety fragment of the valve of the legume was the only evidence of this species in the Sibudu assemblage
Pavetta sp.	stone
Protorhus longifolia	testa
~*Prunus persica*	stone
Psydrax sp.	stone
Pupalia lappacea	capsule
Pyrenacantha cf. *scandens*	stone
Rauvolfia caffra	stone
Rhoicissus spp.	testa
Rhus spp.	stone
~*Ricinus communis*	testa
Sclerocarya birrea	stone and opercules or lids (Leistner 2000:752); the opercules are noted to indicate presence and not used for quantification; stones are seldom whole
Sideroxylon inerme	testa
Syzygium cordatum	endocarp
Strychnos spp.	gourd fragments and testa
Trema orientalis	stone
Tribulus sp.	mericarp
Trichilia sp.	testa
Uvaria caffra	testa
Vanguerieae	stone; description as for *Canthium* spp.
Vepris lanceolata	testa
~*Vitis vinifera*	testa
Xylotheca kraussiana	testa; fragments <½ a seed are difficult to identify
Ziziphus mucronata	stone

APPENDIX C

FRUITS, NUTS AND SEEDS EATEN BY VARIOUS BIRD SPECIES

Scientific Name	Common Name	Bird/Tree No.
Allophylus natalensis	Dune False-currant	426
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Antidesma venosum	Tassel-berry	318
Peliperdix coqui	Coqui Francolin	188
Scleroptila shelleyi	Shelley's Francolin	191
Pternistis natalensis	Natal Spurfowl	196
Pternistis afer	Red-necked Spurfowl	198
Numida meleagris	Helmeted Guineafowl	203
Guttera edouardi	Crested Guineafowl	204
Turtur chalcospilos	Emerald-spotted Wood-Dove	358
Turtur tympanistria	Tambourine Dove	359
Treron calvus	African Green-Pigeon	361
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Bycanistes bucinator	Trumpeter Hornbill	455
Tockus alboterminatus	Crowned Hornbill	460
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Trachyphonus vaillantii	Crested Barbet	473
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574

Apodytes dimidiata	White-pear	422
Numida meleagris	Helmeted Guineafowl	203
Columba arquatrix	African Olive-Pigeon	350
Pycnonotus tricolor	Dark-capped Bulbul	568
Zoothera guttata	Spotted Ground-Thrush	578
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769
Azima tetracantha	Needle-bush	
Creatophora cinerea	Wattled Starling	760
Boscia albitrunca	Shepherds-tree	122
Treron calvus	African Green-Pigeon	361
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Bycanistes bucinator	Trumpeter Hornbill	455
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Bridelia micrantha	Mitzeerie	324
Treron calvus	African Green-Pigeon	361
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464
Trachyphonus vaillantii	Crested Barbet	473
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Burchellia bubalina	Wild-pomegranate	688
Tockus alboterminatus	Crowned Hornbill	460

Calodendrum capense	Cape-chestnut	256
Columba arquatrix	African Olive-Pigeon	350
Aplopelia larvata	Lemon Dove	360
Poicephalus robustus	Cape Parrot	362

Cassia abbreviata	Long-tail Cassia	212
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Bycanistes bucinator	Trumpeter Hornbill	455
Tockus alboterminatus	Crowned Hornbill	460
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471

Celtis africana	White-stinkwood	39
Columba arquatrix	African Olive-Pigeon	350
Turtur tympanistria	Tambourine Dove	359
Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Turdus olivaceus	Olive Thrush	577
Amblyospiza albifrons	Thick-billed Weaver	807

Croton sylvaticus	Forest Croton	330
Columba arquatrix	African Olive-Pigeon	350
Streptopelia semitorquata	Red-eyed Dove	352
Turtur tympanistria	Tambourine Dove	359
Aplopelia larvata	Lemon Dove	360
Treron calvus	African Green-Pigeon	361
Bycanistes bucinator	Trumpeter Hornbill	455
Ploceus bicolor	Dark-backed Weaver	808

Cussonia natalensis	Rock Cabbage-tree	562
Onychognathus morio	Red-winged Starling	769

Cussonia spicata	Cabbage-tree	564
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Creatophora cinerea	Wattled Starling	760
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Diospyros lycioides	Bluebush Star-apple	605
Treron calvus	African Green-Pigeon	361
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464
Trachyphonus vaillantii	Crested Barbet	473
Pycnonotus tricolor	Dark-capped Bulbul	568
Onychognathus morio	Red-winged Starling	769
Diospyros whyteana	Bladder-nut	611
Columba arquatrix	African Olive-Pigeon	350
Columba delegorguei	Eastern Bronze-naped Pigeon	351
Treron calvus	African Green-Pigeon	361
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570

Ehretia rigida	Puzzle-bush	657
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Ekebergia capensis	Cape-ash	298
Columba arquatrix	African Olive-Pigeon	350
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Bycanistes bucinator	Trumpeter Hornbill	455
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Lamprotornis corruscus	Black-bellied Starling	768
***Ficus* sp.**		
Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Ficus abutilifolia	Large-leaved Rock Fig	63
Columba arquatrix	African Olive-Pigeon	350
Treron calvus	African Green-Pigeon	361
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Gallirex porphyreolophus	Purple-crested Turaco	371
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769

Ficus ingens	Red-leaved Fig	55
Columba arquatrix	African Olive-Pigeon	350
Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769
Ficus salicifolia	Wonderboom Fig	60
Columba arquatrix	African Olive-Pigeon	350
Treron calvus	African Green-Pigeon	361
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Oriolus oriolus	European Golden Oriole	543
Oriolus larvatus	Black-headed Oriole	545
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Ficus sur	Broom-cluster Fig	50
Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371

Ficus sycomorus	Sycomore Fig	66
Columba arquatrix	African Olive-Pigeon	350
Columba delegorguei	Eastern Bronze-naped Pigeon	351
Streptopelia senegalensis	Laughing Dove	355
Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Bycanistes bucinator	Trumpter Hornbill	455
Tockus alboterminatus	Crowned Hornbill	460
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769

Flueggea virosa	Whiteberry-bush	309
Streptopelia senegalensis	Laughing Dove	355

Grewia occidentalis	Cross-berry	463
Tauraco corythaix	Knysna Turaco	370
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471

Harpephyllum caffrum	Wild-plum	361
Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464

Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769
Kiggelaria africana	Wild-peach	494
Columba arquatrix	African Olive-Pigeon	350
Aplopelia larvata	Lemon Dove	360
Poicephalus robustus	Cape Parrot	362
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769
Lannea schweinfurthii	False-marula	363
Dendroperdix sephaena	Crested Francolin	189
Numida meleagris	Helmeted Guineafowl	203
Guttera edouardi	Crested Guineafowl	204
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464
Trachyphonus vaillantii	Crested Barbet	473
Macaranga capensis	River Macaranga	335
Columba delegorguei	Eastern Bronze-naped Pigeon	351
Olea capensis	Ironwood	618
Columba arquatrix	African Olive-Pigeon	350
Poicephalus robustus	Cape Parrot	362
Zosterops capensis	Cape White-eye	796
Olea europaea	African Olive	617
Columba arquatrix	African Olive-Pigeon	350
Poicephalus robustus	Cape Parrot	362
Tauraco corythaix	Knysna Turaco	370

Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Turdus olivaceus	Olive Thrush	577
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769

Pappea capensis	Jacket-plum	433
Treron calvus	African Green-Pigeon	361
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769

Pittosporum viridiflorum	Cheesewood	139
Dendroperdix sephaena	Crested Francolin	189
Numida meleagris	Helmeted Guineafowl	203
Guttera edouardi	Crested Guineafowl	204
Columba arquatrix	African Olive-Pigeon	350
Streptopelia semitorquata	Red-eyed Dove	352
Streptopelia capicola	Cape Turtle-Dove	354
Lybius torquatus	Black-collared Barbet	464
Trachyphonus vaillantii	Crested Barbet	473
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Lamprotornis nitens	Cape Glossy Starling	764
Onychognathus morio	Red-winged Starling	769

Podocarpus falcatus	Small-leaved Yellowwood	16
Columba arquatrix	African Olive-Pigeon	350
Columba delegorguei	Eastern Bronze-naped Pigeon	351

Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Podocarpus latifolius	Broad-leaved Yellowwood	18
Columba delegorguei	Eastern Bronze-naped Pigeon	351
Treron calvus	African Green-Pigeon	361
Prunus africana	African Almond	147
Tauraco corythaix	Knysna Turaco	370
Protorhus longifolia	Red-beech	364
Columba arquatrix	African Olive-Pigeon	350
Columba delegorguei	Eastern Bronze-naped Pigeon	351
Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769
Rapanea melanophloeos	Cape-beech	578
Guttera edouardi	Crested Guineafowl	204
Columba arquatrix	African Olive-Pigeon	350
Treron calvus	African Green-Pigeon	361
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471

Rauvolfia caffra	Quinine-tree	647
Columba arquatrix	African Olive-Pigeon	350
Columba delegorguei	Eastern Bronze-naped Pigeon	351
Treron calvus	African Green-Pigeon	361
Bycanistes bucinator	Trumpeter Hornbill	455
Tockus alboterminatus	Crowned Hornbill	460
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574

Rhamnus prinoides	Shiny-leaf	452
Dendroperdix sephaena	Crested Francolin	189
Pternistis natalensis	Natal Spurfowl	196
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769

Rhoicissus digitata	Baboon Grape	456,2
Columba arquatrix	African Olive-Pigeon	350

Rhoicissus revoilii	Bushveld Grape	456.3
Columba arquatrix	African Olive-Pigeon	350
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371

Rhus chirindensis	Red Currant	380
Columba arquatrix	African Olive-Pigeon	350
Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371

Trachyphonus vaillantii	Crested Barbet	473
Pycnonotus tricolor	Dark-capped Bulbul	568
Zosterops capensis	Cape White-eye	796
Rhus gueninzii	Thorny Karee	384
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Schotia brachypetala	Weeping Boer-bean	202
Poicephalus robustus	Cape Parrot	362
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Sideroxylon inerme	White Milkwood	579
Columba arquatrix	African Olive-Pigeon	350
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Lamprotornis corruscus	Black-bellied Starling	768
Strelitzia nicolai	Coastal Strelizia	34
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769
Syzygium cordatum	Water Berry/Umdoni	555
Turtur tympanistria	Tambourine Dove	359
Treron calvus	African Green-Pigeon	361
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Bycanistes bucinator	Trumpeter Hornbill	455
Trema orientalis	Pigeonwood	42
Columba arquatrix	African Olive-Pigeon	350
Columba delegorguei	Eastern Bronze-naped Pigeon	351
Streptopelia semitorquata	Red-eyed Dove	352
Turtur tympanistria	Tambourine Dove	359
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769

Trichilia emetica	Natal-mahogany	301
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Bycanistes bucinator	Trumpeter Hornbill	455
Tockus alboterminatus	Crowned Hornbill	460
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769

Vangueria infausta	Velvet Wild-medlar	702
Columba arquatrix	African Olive-Pigeon	350
Columba delegorguei	Eastern Bronze-naped Pigeon	351
Treron calvus	African Green-Pigeon	361
Poicephalus robustus	Cape Parrot	362
Poicephalus cryptoxanthus	Brown-headed Parrot	363
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Bycanistes bucinator	Trumpeter Hornbill	455
Tockus alboterminatus	Crowned Hornbill	460
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471

Vepris lanceolata	White-ironwood	261
Columba arquatrix	African Olive-Pigeon	350
Columba delegorguei	Eastern Bronze-naped Pigeon	351
Streptopelia semitorquata	Red-eyed Dove	352
Tauraco corythaix	Knysna Turaco	370
Gallirex porphyreolophus	Purple-crested Turaco	371
Trachyphonus vaillantii	Crested Barbet	473
Pycnonotus tricolor	Dark-capped Bulbul	568
Onychognathus morio	Red-winged Starling	769

Ximenia caffra	Sourplum	103
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
Pogoniulus bilineatus	Yellow-rumped Tinkerbird	471
Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Cinnyricinclus leucogaster	Violet-backed Starling	761
Lamprotornis nitens	Cape Glossy Starling	764

Lamprotornis corruscus	Black-bellied Starling	768
Onychognathus morio	Red-winged Starling	769
Zanthoxylum capense	Small Knobwood	253
Colius striatus	Speckled Mousebird	424
Urocolius indicus	Red-faced Mousebird	426
Lybius torquatus	Black-collared Barbet	464
Stactolaema leucotis	White-eared Barbet	466
Pogoniulus pusillus	Red-fronted Tinkerbird	469
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Pycnonotus tricolor	Dark-capped Bulbul	568
Phyllastrephus terrestris	Terrestrial Brownbul	569
Phyllastrephus flavostriatus	Yellow-streaked Greenbul	570
Andropadus importunus	Sombre Greenbul	572
Chlorocichla flaviventris	Yellow-bellied Greenbul	574
Ziziphus mucronata	Buffalo-thorn	447
Peliperdix coqui	Coqui Francolin	188
Dendroperdix sephaena	Crested Francolin	189
Pternistis natalensis	Natal Spurfowl	196
Numida meleagris	Helmeted Guineafowl	203
Guttera edouardi	Crested Guineafowl	204
Gallirex porphyreolophus	Purple-crested Turaco	371
Centropus burchellii	Burchell's Coucal	391
Lybius torquatus	Black-collared Barbet	464
Creatophora cinerea	Wattled Starling	760

No Specific Fruits, Nuts or Seeds were recorded in the Literature, for Diets of the following Frugivorous and Omnivorous Birds:

Scientific Name	Common Name
Corythaixoides concolor	Grey Go-away-bird
Apaloderma narina	Narina Trogon
Dendropicos fuscescens	Cardinal Woodpecker
Campephaga flava	Black Cuckooshrike
Corvus capensis	Cape Crow
Corvus albus	Pied Crow
Corvus albicollis	Whitenecked Raven
Lioptilus nigricapillus	Bush Blackcap
Turdus libonyanus	Kurrichane Thrush
Zoothera gurneyi	Orange Ground-Thrush
Monticola rupestris	Cape Rock-Thrush
Cercomela familiaris	Familiar Chat
Thamnolaea cinnamomeiventris	Mocking Cliff-Chat
Cossypha dichroa	Chorister Robin
Cossypha natalensis	Natal Robin

Cossypha caffra	Cape Robin
Pogonocichla stellata	White-starred Robin
Cercotrichas leucophrys	White-browed Scrub-Robin
Hippolais icterina	Icterine Warbler
Acrocephalus palustris	Marsh Warbler
Apalis flavida	Yellow-breasted Apalis
Muscicapa striata	Spotted Flycatcher
Muscicapa adusta	Dusky Flycatcher
Muscicapa caerulescens	Ashy Flycatcher
Melaenornis pammelaina	Southern Black Flycatcher
Bradornis pallidus	Pale Flycatcher
Sigelus silens	Fiscal Flycatcher
Laniarius ferrugineus	Southern Boubou
Tchagra tchagra	Southern Tchagra
Telophorus olivaceus	Olive Bush-Shrike
Passer domesticus	House Sparrow
Ploceus ocularis	Spectacled Weaver
Ploceus xanthops	Golden Weaver
Ploceus subaureus	Yellow Weaver
Ploceus xanthopterus	Southern Brown-throated Weaver
Estrilda astrild	Common Waxbill
Sernus canicollis	Cape Canary
Crithagra scotops	Forest Canary
Crithagra sulphuratus	Brimstone Canary
Crithagra gularis	Streaky-headed Seedeater

NOTE

These lists were compiled by J. Sievers and follow the taxonomic classification and nomenclature used in the third edition of Keith Coates Palgrave Trees of Southern Africa (Coates Palgrave 2002) and the seventh edition of Roberts' Birds of Southern Africa (Hockey *et al.* in press). The information on the fruits, seeds and nuts eaten by birds, was compiled from the references listed below. Most of the references are specific to this appendix and are not included in the main list of references.

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