A reconstruction of the Late Holocene environment using archaeological charcoal from Klasies River main site cave 1, southern Cape

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

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ABSTRACT

In this study, late Holocene environmental conditions around Klasies River cave 1, Tsitsikamma Coast, are reconstructed using archaeological charcoal that is dated to 2300 BP. The microanatomy of the archaeological charcoal remains was studied in detail under high-resolution stereomicroscopy and compared with woody species from the contemporary Tsitsikamma landscape. The results indicate that the archaeological landscape supported woody vegetation species that are adapted mostly to year-round and summer rainfall conditions. The archaeological woody species assemblage includes two species, *Protorhus longifolia* and *Hibiscus* cf. *tiliaceus,* that do no occur on the Tsitsikamma Coast today; they occur further north along the east coast of South Africa. The presence of both these species in the archaeological wood assemblage seems to indicate that current environmental conditions around the site are no longer suitable for their growth. Wood vulnerability indices were also calculated from measurements of the vascular microstructure of the archaeological species. These indices indicate that some archaeological species were highly vulnerable to water scarcity. This implies that woody vegetation at Klasies River 2300 BP grew under conditions with higher rainfall and less aridity relative to the present. While there is a suggestion that the late Holocene vegetation is different and the environment more mesic, this cannot be argued with certainty due to the small sample of charcoal in this study.

ACKNOWLEDGEMENTS

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CHAPTER 1: GENERAL INTRODUCTION

1.1 Site setting

The Klasies River as well as the eponymous archaeological main site is located in the southern Cape on the Tsitsikamma Coast, Eastern Cape Province, South Africa. The site is made up of four caves: cave 1, 1a, 1b and 2, and it is renowned for a rich archaeological record stretching back to 100 000 years ago which includes evidence of early anatomically and behaviourally modern humans (Singer & Wymer 1982; Deacon 1993; Wurz 2008; 2016). The cave sequence was granted National Heritage status in recognition of the significance of this rich archaeological record. The main site is situated in a densely vegetated, well-watered environment characteristic of the Tsitsikamma Coast. This coast lies 10 km south of the Tsitsikamma Mountain range and extends for c. 150 km from east to west between Cape St Francis and Plettenberg Bay. An abundance of marine and terrestrial resources currently attracts people to the area and is likely to have done so in the past too.

Previous investigations into the archaeological deposits of cave 1 have confirmed the presence of Later Stone Age (LSA) communities during the late Holocene (Singer & Wymer 1982; Binneman 1995). Between 1967 and 1968 two superimposed shell middens, named Lower and Upper Middens, were excavated and termed LSA phase I and phase II respectively by Singer and Wymer (1982). These middens (now dated to between 4800 and 2300 BP), accumulated during different occupational periods in the late Holocene. The homogeneous nature of the Upper Midden's deposit and lack of sharp breaks within suggest that this midden, the focus of this study, developed rapidly over centuries, rather than a longer period (Singer & Wymer 1982: 120). The Upper Midden (corresponding to LSA II) may thus be analysed as a single unit. The LSA II from Klasies River cave 1 has been re-dated using C14 dating. The dates obtained are slightly younger than those previously published by Singer and Wymer (see Table 1.1). Singer and Wymer (1982) obtained a date of 2795±85 BP for the bottom of the Upper midden, and a date of 2525± 85 for the surface. The new dates vary from 2451 – 1932 cal BP (Nami *et al.* 2016). In this dissertation, the probable mean of 2340 or 2300 cal BP (Nami *et al.* 2016: 4) is used. The excavation of the Upper Midden in cave 1 revealed a high concentration of organic remains and artefacts compacted within aeolian sand and dark soils (Singer & Wymer 1982). Cultural debris associated with the LSA includes lithic artefacts, bone tools and organic residues of both terrestrial and marine food resources (Singer & Wymer 1982). The collection of woody plants is indicated by the presence of charcoal found in hearths and the collection of edible plant foods such as seeds, nuts, fruit and roots are suggested by quern stones and rubbers (Singer & Wymer 1982).

TABLE 1.1 *The calibrated and uncalibrated radiocarbon dates of the LSA phase II at Klasies River cave 1. Illustration after Nami et al. (2016: 4 (Table1))*

Cultural attribution	**Depth**	**Type of sample**	**Laboratory reference**	**BP**	**Calibration BP**
LSA II	Layer 1	Charcoal	GX-0969	2525±85	X
	-150 mm from current surface	Shell	Poz-64222	2655±30	2451–2280 (mean prob. = 2340) (marine 13 curve - Delta R = 400) 2276–1932 (mean prob. = 2084) (marine 13 curve - Delta R = 615)
LSA II	Surface of Layer 7	Shell	GX-0971	2795±85	x

In 1984, Binneman (1995) conducted a small 1m^2 excavation in cave 1, west, adjacent to Wymer's excavation. He sampled the contents of the Upper and Lower Middens to compare the cultural and subsistence activities of the site with those of other sites in the general area, for example Cape St. Francis coastal sites as well as Nelson Bay Cave, Havens Cave, Boomplaas Cave, and Kabeljous River Mouth Shelters (Binneman 2001; 2006/2007). Binneman (1995) found similar remains to those reported by Singer and Wymer (1982). Binneman's excavated material included cultural material such as lithic tools, bone tools, ochre stained cobbles, ornaments as well as marine and terrestrial food resources and burnt wood (Binneman 1995).

Singer and Wymer (1982: 120) associated the LSA cultural remains to Strandloper activity. Binneman (1995, 2001) classified the LSA stone tools as the Kabeljous Industry that was also identified at other sites in the southern Cape. In the latest revision of the Stone Age sequence of South Africa and Lesotho, Lombard and colleagues (2012) classified the Kabeljous Industry under the fifth phase of the LSA techno-complex called the ‘final Later Stone Age’. This phase, dated to between 100 and 4000 years ago, is characterised by the absence of pottery, variability in the macro-lithic assemblages and a hunter-gatherer economy (Lombard *et al.* 2012).

Alternating warm and cool periods prevailed over the last 4000 years (Kirsten 2014). The relationship between LSA activity and these climatically variable conditions along the southern Cape, as in other LSA sites in southern Africa, is poorly understood due to a lack of well-dated contextual data (Mitchell 2005). The new research at Klasies River seeks to expand the knowledge of the Stone Age societies who visited the site, as well as to understand the environmental background against which the cultural material was deposited in the main site (Wurz 2016). The LSA deposit is investigated in this study to complement and supplement the environmental conditions previously inferred from shellfish remains (Binneman 1995; Mosweu 2016) and soil sediments (Butzer 1978). An analysis of charcoal remains from the site will provide environmental data that can be used to understand the conditions against which the documented cultural developments took place.

Climatic parameters (or changes thereof) such as temperatures and precipitation, which affect moisture availability, are reflected in the distribution of woody taxa and wood physiological structure. Different woody species and features may be correlated with different environmental conditions and thus be used effectively to describe archaeological landscapes or environments (Prior & Price-Williams 1985; Scholtz 1986; Esterhuysen & Mitchell 1996; Cartwright & Parkington 1997; Allott 2006; Cartwright 2013). Although environmental conditions do not dictate human behaviour, they may influence the seasonality of site occupations and resource availability which in turn may be reflected in social relations and networks (Mitchell 2016).

1.2 *Archaeological charcoal and environmental interpretation in southern Africa*

The use of charcoal to describe past environments in southern Africa has grown significantly since the pioneering studies (Prior & Price-Williams 1985; Scholtz 1986; Tusenius 1986; February 1992; Shackleton & Prins 1992; Esterhuysen & Mitchell 1996; Cartwright & Parkington 1997; Allott 2006; Cartwright 2013; Chikumbirike 2014;

Bamford 2015; Lennox *et al.* 2015). For example, changes in the presence of woody species recovered as charcoal at Sibudu Cave were interpreted as evidence of climatic changes which took place from 60 000 to 50 000 years ago (Allott 2006). Allott (2006) noted that riverine and forest taxa dated to 60 000 years ago were replaced by more bushveld species around 50 000 years ago. In another charcoal study, Scholtz (1986: 101) argued that the occupation phases during the terminal Pleistocene at Boomplaas Cave may be related to 'adverse conditions' and consequently the charcoal remains may reflect the climatic conditions at the time.

At Wonderwerk Cave, charcoal remains dated to around 14 000 years ago were analysed and indicated slightly wetter climatic conditions relative to the present (Bamford 2015). This was inferred from the presence of two woody species, *Berchemia discolor* and *Halleria lucida,* which occur in more mesic situations (Bamford 2015). At Rose Cottage Cave and Tloutle Rock Shelter, Esterhuysen and colleagues (1999) found that cooler mesic conditions from the early Holocene (12 000 to 10 000 BP) were replaced by dry conditions towards the mid-Holocene (8500 and 7200 BP) before the prevalence of moist conditions from c. 6500 BP. This was inferred from a comparison of the relative abundance of woody taxa identified from charcoal remains and their modern distribution (Esterhuysen *at al.* 1999).

February (1992; 1993) used charcoal remains from archaeological sites in the summer rainfall regions, southern uKhahlamba-Drakenberg, of South Africa to understand the relationship between wood anatomy and climate of the last 2000 years. He interpreted the results as indicating that changes in rainfall could be made by comparing the vascular structure of charcoal samples of the same species through time (February 1992: 43). The application of this method is restricted to certain species. Using the vessel tangential diameter of *Protea* sp. from Mhlwazini Cave and Collingham Shelter, February (1992; 1993) suggested that there was a decrease in rainfall from ±2300 BP to 1300 BP, followed by generally low rainfall levels between ±1300 BP and 300 BP before an increase at 200 BP.

Today, burnt wood preserved in archaeological contexts is used to investigate a wide range of questions about southern African prehistoric societies such as the harvesting of wood sources for use as fuel (Scholtz 1986; Tusenius 1986; Esterhuysen & Mitchell 1996; Cartwright 2013; Chikumbirike 2014), medicine (Lennox & Bamford 2014; Lennox *et al.* 2015) and building material (Chikumbirike 2014). The environmental data gathered from archaeological wood/charcoal like other data is, however, distorted by many site formation processes, and anthropogenic activity plays a crucial role in the presence and abundance of charcoal in archaeological assemblages (Prior & Williams 1985; Scholtz 1986; Tusenius 1986; Shackleton & Prins 1992; Esterhuysen & Mitchell 1996; Cartwright & Parkington 1997).

Cultural behaviour plays a role in the harvesting of wood, selection of woody species and fires made for different purposes (Pote *et al.* 2006; Madubansi *et al.* 2007; Shackleton *et al.* 2007; Matsika 2013). For example, Pote and colleagues (2006) found that amongst contemporary societies there is active selection of woody species for fuelwood, construction timber and wood piles constructed to signify culturally specific messages in rural Eastern Cape. Furthermore, people often collect wood in the immediate vicinity rather than travel for long distances (Tusenius 1986; Shackleton & Prins 1992; Esterhuysen *et al.* 1999; Marston 2009). This is known as the "Principle of Least Effort" according to which all organisms, including humans, will adopt a method that utilises the minimum energy to achieve a goal (Shackleton & Prins 1992: 632). Applied to the past, this suggests that prehistoric societies collected most of their firewood in the immediate surroundings of their living spaces.

The chemical composition of wood plays an important role in the preservation of different woody species over time (Thery-Parisot *et al.* 2010). Preservation of charcoal remains in archaeological sites depends on several other factors, for example, the size of the wood burnt, the moisture content of the wood, as well as the intensity of fires that produced charcoal (Chrzazvez *et al*. 2014). Some charcoal remains may not survive post-depositional processes in the sites as a result of the fragility of the burnt remains (Thery-Parisot *et al.* 2010). Asouti (2006), for example, explains that moisture, re-firing, exposure and trampling may affect the preservation of archaeological charcoal.

Regardless of of the various biases affecting the charcoal assemblages, the taxonomic identification of the charred wood remains recovered from any site may reflect to some extent the presence of woody taxa in the vicinity of the site and may still provide an insight into the prevailing environmental conditions (Tusenius 1986; Shackleton & Prins 1992; Esterhuysen *et al.* 1999).

1.3 Rationale and aims of this study

Rationale

Archaeological research on the LSA sequence of Klasies River cave 1 has yielded valuable information about the activities of the people that visited the site during the late Holocene (Singer & Wymer 1982; Binneman 1995). As stated above, the influence of the fluctuating southern Cape climate on these people is relatively poorly understood. An analysis of charcoal remains from the LSA deposit is likely to provide an insight into the environmental conditions that may have occurred around Klasies River main site around 2300 BP. The results will contribute towards understanding the relationship between the Late Holocene environment in the southern Cape and the behaviour of coastal societies during this period. The results of the study will also provide new Late Holocene environmental data that can be compared with other environmental proxies along the southern Cape.

Aims

The aims of this study are:

1. To collect a contemporary sample of the common woody species in the immediate vicinity of the cave to use as a comparative collection.
2. To use the comparative collection to identify, where possible, a sample of the wood or charcoal in the Upper Midden of the LSA deposit at Klasies River Cave 1.
3. To measure xylem vessel characteristics in a subsample of the identified LSA charcoal and compare these with measurements made on a contemporary sample of woody species, to make a statement on changes in moisture availability through time.
4. To make statements on Late Holocene environmental conditions using both the charcoal identifications and the measurements of xylem anatomy.

CHAPTER 2: BACKGROUND

Introduction

This chapter begins with a description of the contemporary environment at Klasies River, including a brief review of woody vegetation and the common woody species around the site. Secondly, the late Holocene environmental data from the site as well as neighbouring sites are reviewed to contextualise the archaeological charcoal sample of the study.

2.1 Contemporary environment

2.1.1 Geology and topography

The Tsitsikamma Coastal platform is situated between the Indian Ocean to the south and the Tsitsikamma Mountains, which are part of the Cape Fold Belt, to the north. The coastal platform in which the Klasies River caves are situated consists of quarzitic sandstones from the Cape Supergroup (Thamm & Johnson 2006).

The caves at Klasies River main site were cut by wave action on the sandstone cliff during different sea levels (Deacon & Geleijnse 1988). For example, Cave 1 was cut when the seal level was 9 m higher than the present coastal watermark (Singer and Wymer 1982: 35). Presently, the caves lie on the face of a 60 to 100 m cliff on the seaward margin of the coast (Butzer 1978; Singer & Wymer 1982). The sediments within the stratigraphy of the caves indicate the deposition of quartzite-derived sands over thousands of years. Most of this sand is aeolian or reworked beach sand, while some is derived from disintegrated fragments of the roof and walls of the cave (Singer & Wymer 1982: 39; Deacon & Geleijnse 1988: 6). The deposition of the sand is associated with the transgression and regression of the shore line during the Pleistocene epoch (Singer & Wymer 1982). These events also correlate with different sea levels (Deacon & Geleijnse 1988). In cave 1 of main site, the deposition of the weathered sand occurred in the Late Pleistocene leading to the layering of the strata with archaeological material (Singer & Wymer 1982).

The soils of the area surrounding the Klasies River caves weathered from Table Mountain Sandstone (Mucina & Rutherford 2006; Thamm & Johnson 2006) and derive from two types of palaeo-soils: the Formosa and Brakkloof type soils (Helgren & Butzer 1977). Formosa soils derive from the intensively weathered quartzite bedrock of the Late Tertiary (Helgren & Butzer 1977). The Brakkloof soils are a product of an erosional gully system during the mid-Pleistocene. The lithology of the Tsitsikamma Coast contains quartz-dominant horizons of clay sediments from the Quaternary weathering regimes (Helgren & Butzer 1977). These regimes are described by Helgren and Butzer (1977) as reflecting the soil development during the late Tertiary and mid-Pleistocene. The implication of these processes is that weathering of the southern Cape landscape was accompanied by morphoclimatic and biogeographic changes presented by the paleoenvironmental conditions (Helgren & Butzer 1977).

Today, the Tsitsikamma flora grows on the quarzitic-sandstone sediments presently called the Algoa Group or Cenozoic Algoa Group (Mucina & Rutherford 2006). These sediments occur in a series of unstructured shallow clay, silt and coarse sandy layers which are generally known as slow nutrient recycling soil types (Mucina & Rutherford 2006). Shallow marine sandstones and coastal dunes characterise these soil types in the Tsitsikamma Coast. These are currently classified under the Nanaga Formation (Mucina & Rutherford 2006; van Wijk *et al.* 2017). The development of the soil substrates of this formation include the aeolian Plio-Pleistocene deposits as well as the Holocene sand dunes (van Wijk *et al.* 2017).

2.1.2 Ocean currents

The climate in the southern Cape of South Africa is influenced by the ocean currents from the Indian and Atlantic Oceans. The Agulhas Current transports warm, saline water from equatorial parts of the Indian Ocean southward to the Polar Regions (Tyson & Preston-Whyte 2000). These converge with the Atlantic waters south of South Africa's coast (Tyson & Preston-Whyte 2000). The warm surface temperatures related to the Agulhas Current influence the circulation systems and the easterlies that distribute rainfall over the eastern parts of south Africa (Tyson & Preston-Whyte 2000). The

Agulhas Current has the major role in distributing moisture in the summer rainfall region in the east and across South Africa's interior (Cohen & Tyson 1995).

The Benguela System, on the south-west of southern Africa is part of the South Atlantic anticyclonic gyre (Cohen & Tyson 1995; Tyson & Preston-Whyte 2000). The Benguela Current originates from the Benguela system in the Atlantic Ocean and has a general northward movement, distributing the nutrient-rich cold waters from the Antarctic to the west coast of southern Africa (Tyson & Preston-Whyte 2000). The wind systems associated with this current often bring cold front conditions over southern Africa.

2.1.3 Climate

The southern Cape coast, including the Tsitsikamma Coast, is situated within the region of overlap between the tropical and temperate climate systems and experiences a humid mesothermal climate (Butzer 1978; Tyson & Preston-Whyte 2000). The definitive marker of this region is the occurrence of rainfall throughout the year (Chase & Meadows 2007). Geographically the year-round rainfall zone (YRZ) stretches from the west coast in Namibia across the south-west interior of South Africa and covers the entire southern Cape coast (Fig. 2.2) (Chase & Meadows 2007).

The main drivers of the climate in the YRZ include the influences of the South Atlantic anticyclones associated with the winter rainfall zone (WRZ). The YRZ is also influenced by the summer rainfall zone (SRZ) climate that is a result of the interaction of warm moisture from the Indian Ocean (transported by the easterlies), the Intertropical Convergence Zone and the Subtropical High-Pressure Cell (Tyson & Preston-Whyte 2000). The YRZ receives rainfall throughout the year and currently has a bimodal peak which corresponds to the rainfall peaks (and seasonality) of both the WRZ and SRZ (Chase & Meadows 2007: 105). This implies that the YRZ has no extended dry season.

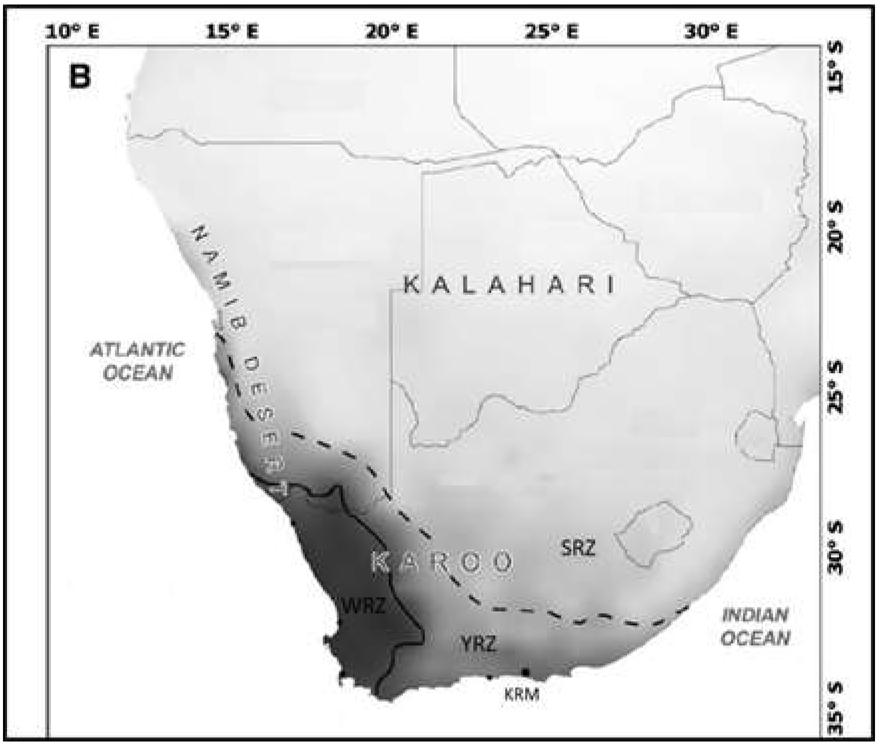

FIG. 2.1 *Rainfall zones over southern Africa, WRZ= Winter Rainfall Zone, YRZ= Year-Round Rainfall Zone and SRZ= Summer Rainfall Zone (Source: Chase & Meadows 2007: 104).*

2.1.4 Temperature and precipitation

The present mean temperatures and precipitation levels of the southern Cape vary due to the physiography of the area (Ryano 2014). Topographical features such as the mountain ranges and valleys act as barriers to the distribution of some atmospheric conditions (Ryano 2014). As previously defined, the Tsitsikamma Coast is located between Cape St Francis, located 47 km east of Klasies River main sites, and Plettenberg Bay which is 95 km west of the site within the southern Cape coast (Fig. 2.3).

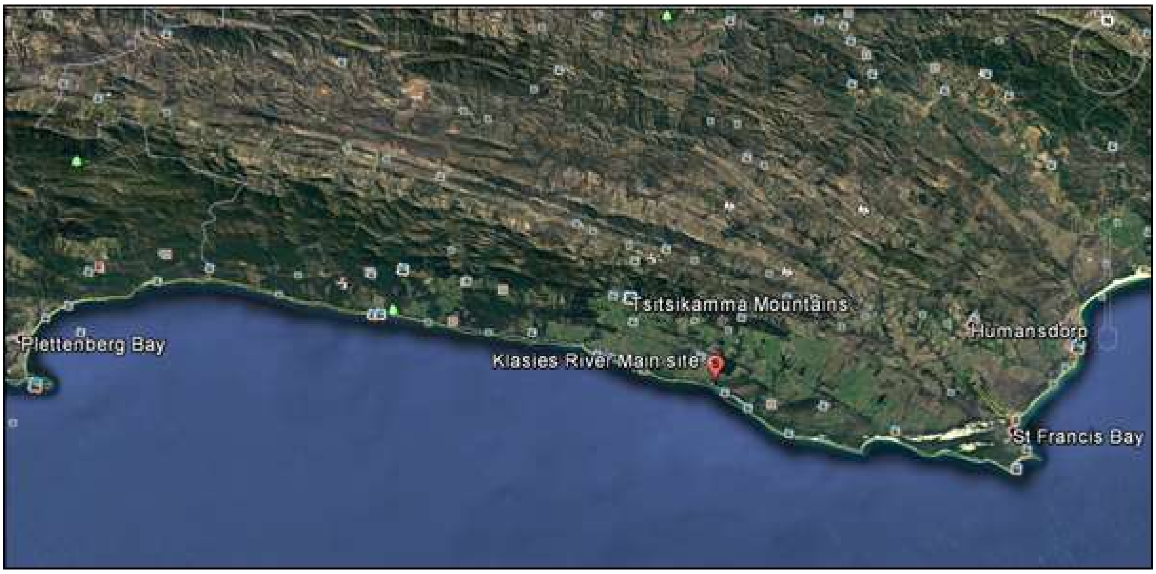

FIG. 2.2 *The Tsitsikamma Coast, southern Cape (Google Earth Image accessed: 28 November 2016).*

Figure 2.4 has meteorological data recorded for Cape St Francis, the eastern boundary of the study area, while Figure 2.5 has the data of the western boundary, Plettenberg Bay (34° 12" S 23°E). The meteriological data of the Tsitsikamma Coast (34° 12" S 24°E) is given in Figure 2.6. The meteorological data presented in this study was accessed from the Climate Information Platform (CIP) via the University of Cape Town's link: *http://www.csag.uct.ac.za/* (du Plessis 2015). This platform integrates climatic data recorded from the Global Historical Climatology Network (GHCN) dataset, the World Meteorological Organisation (WMO) as well as meteorological archives in many different countries. The GHCN dataset comprises of daily climate data, with emphasis placed on records of main elements of precipitation and temperature (Menne *et al.* 2012: 897). The records are integrated with the datasets of the WMO surface stations which record monthly climate summaries (Menne *et al.* 2012) and local (national) meteorological archives.

Towards the eastern part of the Tsitsikamma Coast, climatic records from the Cape St Francis Coast indicate that this area experiences mild temperatures with a mean minimum and maximum of 10˚ C and 23 ˚C respectively; precipitation is distributed throughout the year (http://www.csag.uct.ac.za/). Records from the 19^{th} century to the beginning of the 21^{st} century, indicate maximum temperatures during the summer months from December to February and maximum rainfall during the winter months from June to August (Fig. 2.4) (http://www.csag.uct.ac.za/).

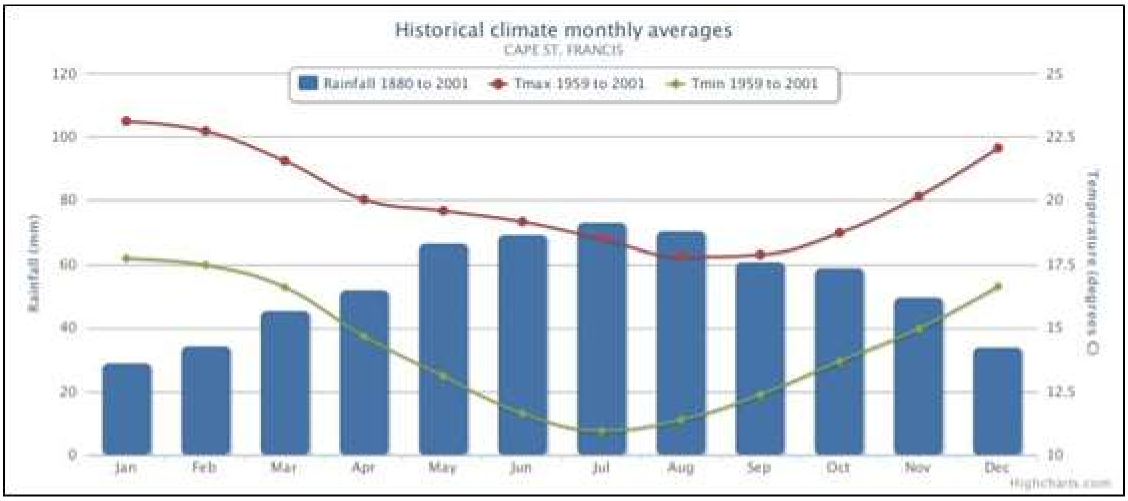

FIG. 2.3 *The rainfall and temperature trends of Cape St Francis (Source: Climate Information Platform (CIP), Climate Systems Analysis Group (CSAG), University of Cape Town: http://www.csag.uct.ac.za/)*

On the western boundary of the study area, Plettenberg Bay (34° 12" S 23°E), the rainfall is also distributed throughout the year with peaks recorded in August and November/December respectively (Fig. 2.5) (http://www.csag.uct.ac.za/). Similarly, within the Klasies River locality (34° 12" S 24°E), rainfall occurs throughout the year. In the last 14 years, the maximum monthly average rainfall recorded for this area is in August followed by November (Fig. 2.6) (http://www.csag.uct.ac.za/). On average, the annual rainfall on the Tsitsikamma Coast and the neighbouring areas is well above 800 mm (Cowling & Richardson 1995; Cowling & Pierce 2009). This is most evident in the occurrence of vegetation that is adapted to conditions with high rainfall levels (Cowling & Richardson 1995; Mucina & Rutherford 2006).

Effective Moisture Availability

The overall water budget for vegetation depends on how much of the precipitation is evaporated from the ground (Jury 2012: 2). Precipitation may consist of rainfall, fog, dew, frost and snow (Schultze 1997), although not all these forms of precipitation occur in the Klasies landscape. Mean Annual Potential Evaporation (MAPE) is determined by climatic variables such as wind strength, temperature, as well as the general air

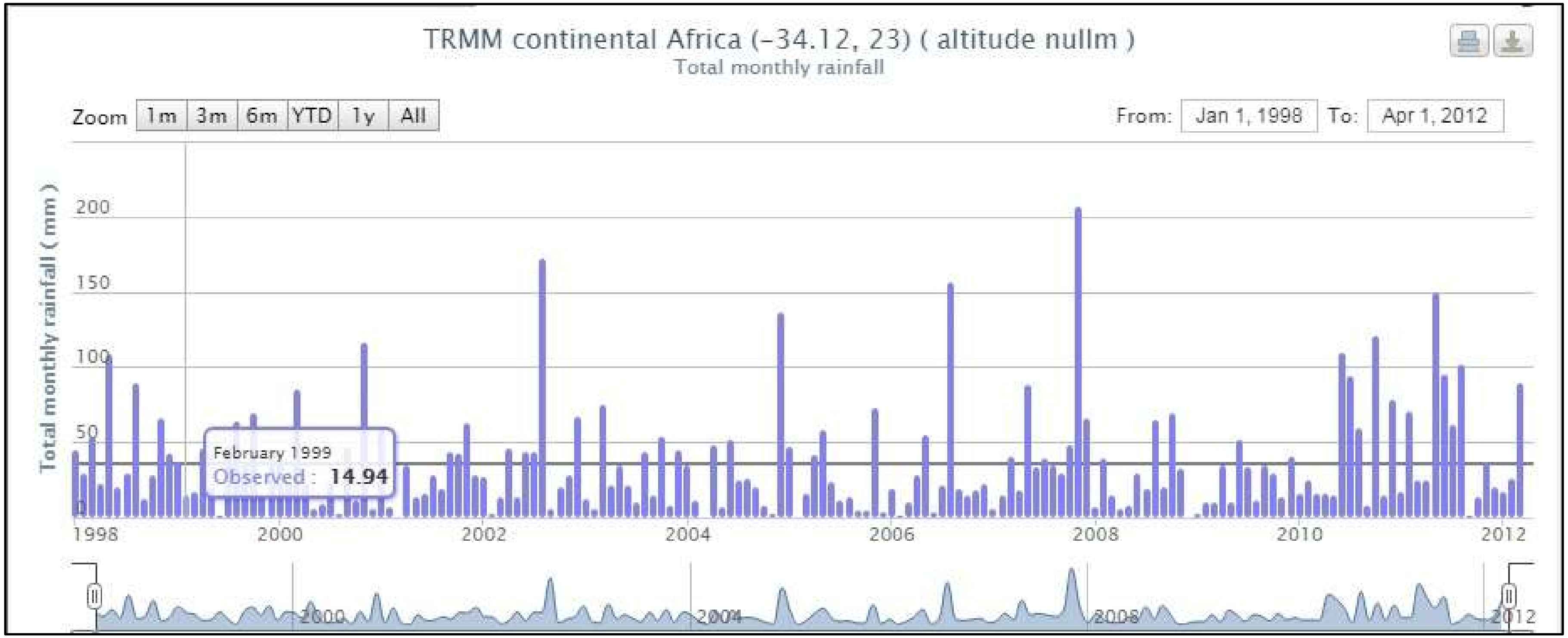

FIG. 2.4 *The rainfall trends of Plettenberg Bay (Source: Climate Information Platform (CIP), Climate Systems Analysis Group (CSAG), University of Cape Town: http://www.csag.uct.ac.za/)*

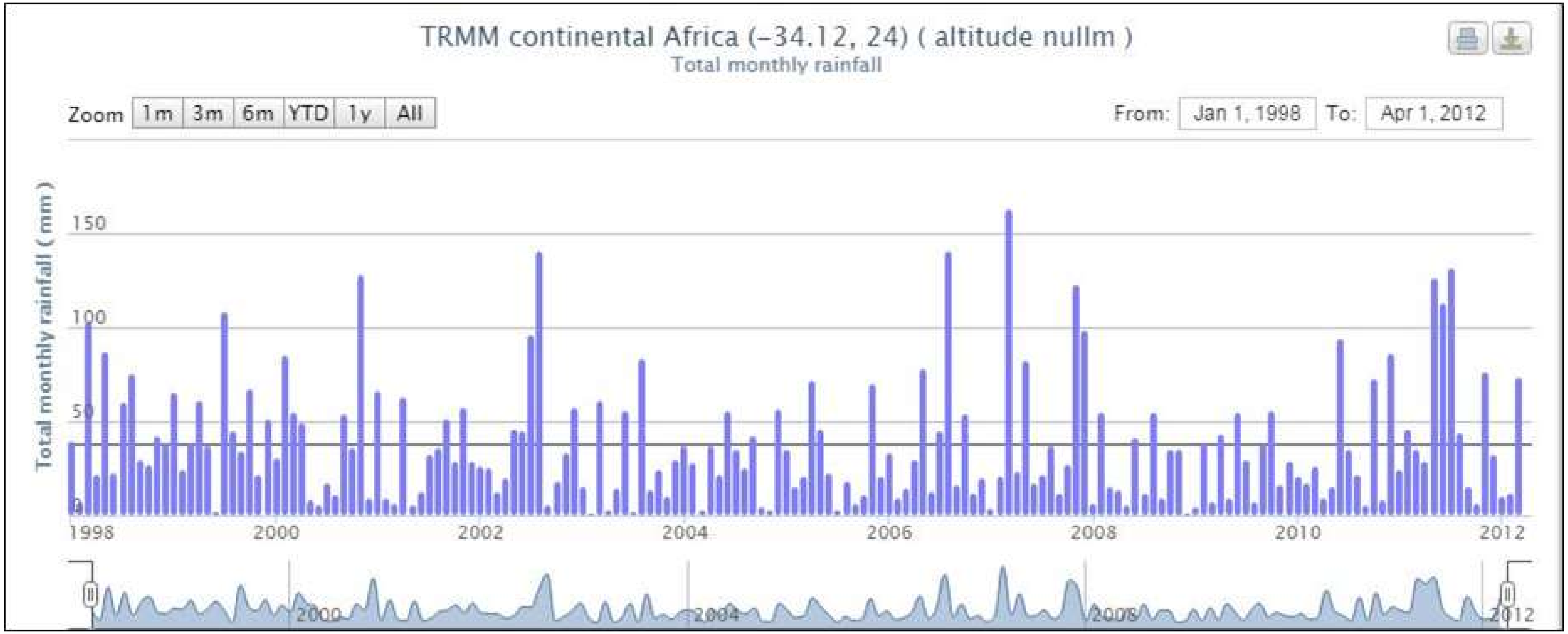

FIG. 2.5 *The rainfall trends of the Tsitsikamma Coast (Source: Climate Information Platform (CIP), Climate Systems Analysis Group (CSAG), University of Cape Town: http://www.csag.uct.ac.za/)*

pressure; these evaporation factors desiccate the landscape (Schultze 1997: 35). The difference between the Mean Annual Precipitation (MAP) and Mean Annual Potential Evaporation (MAPE), determines the moisture reservoir from which plants draw their water supply (Schultze 1997: 30).

Potential high moisture availability over the SRZ is a consequence of high evaporation over the sea surface because of the warm conditions brought by the Agulhas Current from the Indian Ocean (Beal *et al.* 2011). Over the WRZ, strong, dry polar air masses evaporate the landscape (Mucina & Rutherford 2006; Blome *et al.* 2012). Schultze (1997: 37) reports that annual seasonal reference potential evaporation increases along the southeast/ northwest trend line, with low evaporation (i.e. less than 1750 mm/year) over the south and east areas and high evaporation (i.e. more than 3000 mm/ year) on the north and west areas of southern Africa. The MAP on the Tsitsikamma Coast is 845 mm and the MAPE is 1680 mm (Mucina and Rutherford 2006: 95). These are accompanied by mean annual temperatures of 15.5˚C The effective moisture availability, which is the function of (or difference between) precipitation and evaporation, on this coast is, therefore, 835 mm (Mucina & Rutherford 2006).

2.1.5 Vegetation around Klasies River main site

According to Mucina and Rutherford (2006), the area around Klasies River main site is located in the Eastern Fynbos-Renosterveld bioregion (Fig. 2.7). However, in an ongoing study of the vegetation in the vicinity of the Klasies River caves, van Wijk and colleagues (2017: 13, 15) have found relatively few fynbos plants and have identified a complex mosaic of interdigitating Fynbos, Subtropical Thicket, Grassland and Forest Biomes. Appendix 1 presents a list of the shrub and tree species (some also used for reference material in this study) identified by van Wijk and colleagues (from 2013 to 2015) and Zwane (in 2016). These are woody species collected up to 5 km from the Klasies River caves and show the relative abundance of species within the different vegetation biomes. Thicket and forest species are particularly abundant close to the cave sites (van Wijk *et al.* 2017: 27).

The distribution of the vegetation types is governed by aspect, exposure to fire and salt-laden winds, and the underlying geology and associated soils (Van Wijk *et al.* 2017: 16, 28). Woody plants often inform on the conditions of the habitats in which they occur (Thomas *et al.* 2008: 23). The cliffs, ridges and dunes around Klasies River protect certain areas from wind and sea spray and as a result, variation in the growth of the vegetation, such as height, leaf colour and wood texture, can be observed. For example, the height of woody vegetation on south-facing slopes may vary according to exposure to the salty winds from the sea. In the areas where the winds from the ocean blow un-obstructed over this slope, the vegetation tends to grow shorter than in protected areas of the same aspect (van Wijk *et al.* 2017).

Of the 268 species identified around the Klasies River sites, the highest frequency of species was recorded in thicket (33%), followed by coastal vegetation (22%), forest (20%) and then fynbos (15%) (Van Wijk *et al.* 2017: 27). The highest frequency of co-occuring species (29%) co-occur in thicket and forest vegetation and only 7% of the species co-occur in all four vegetation types (van Wijk *et al.* 2017: 27).

The thicket is classified as dune thicket, and is dominated by *Sideroxylon inerme, Pterocelastrus tricuspidatus, Euclea racemosa, Euclea racemosa, Putterlickia pyracantha, Tarchonanthus littoralis and Searsia glauca* (van Wijk *et al.* 2017: 16). The forest in the Klasies River landscape is Southern Coastal Forest (van Wijk *et al.* 2017). This subtropical forest ranges from 3- 6 m in height and is adapted to high rainfall intake. Characteristic shrubs and trees include *Sideroxylon inerme, Ekebergia capensis, Olea capensis* subsp. *capensis, Canthium inerme, Pterocelastrus tricuspidatus, Gymnosporia nemorosa, Cassine perugea, Acokanthera oppositifolia* and *Searsia chirindensis* (Van Wijk *et al.* 2017: 16).

Coastal vegetation owes its origin to the coastal climate created mainly by the ocean surface temperatures (Mucina & Rutherford 2006: 660). Coastal vegetation is salt-tolerant and grows at sea level. This vegetation is generally very diverse in nature, differing according to coastal conditions. At Klasies River, the Coastal vegetation occurs as “low grassy ground cover” with diverse species of herbs, creepers, geophytes and trees, mostly on fossil dunes with much humus from degraded plant matter (van Wijk *et al*. 2017: 16). Some of the Coastal vegetation woody species identified in the Klasies landscape are *Tetragonia fruticosa, Trachyandra divaricata* and *Pelargonium capitatum*.

The Fynbos is a fire-adapted, evergreen shrubland that is specially adapted to cool winter rainfall, poor soils and recurrent fires (Mucina & Rutherford 2006). The definitive marker of this biome is the prevalence of shrubs belonging to Ericaceae, Restionaceae, and Proteaceae families (Cowling *et al.* 1997). In the Klasies landscape the Fynbos taxa grow on the well-drained, inland slopes of the sandstone plateau on the fringes of the immediate area, including on the slope above the river (Klasies River), located to the west of the main site (van Wijk *et al.* 2017). Woody species belonging to the Fynbos around Klasies River include *Erica glandulosa* subsp. *fourcadei, Erica peltata*, *Protea coronata,* and *Restio eleocharis*. In summary, the Klasies River landscape supports vegetation that is described as rich and complex (van Wijk *et al.* 2017: 28) and which occurs as a result of a wide range of microhabitats and microclimates.

2.2 The Holocene sea level fluctuations and associated terrestrial environmental changes along the southern Cape

The Holocene is a climatically variable period during which a series of sea level fluctuations as well as short and long-lived cold and warm episodes are reported (Ramsay & Cooper 2002; Mayewski *et al.* 2004). Along the Tsitsikamma Coast and the broader southern Cape coast, evidence for the climatic or environmental conditions associated with this period is drawn from a number of marine and terrestrial sources.

2.2.1 Early to mid-Holocene sea levels

Singer and Wymer (1982) report that an occupational hiatus exists between the Middle Stone Age (MSA) and LSA deposits at Klasies River cave 1. During this occupational break, an accumulation of flowstone and no intrusive sediments suggest that the cave was blocked or closed-off from the outside soil-formation activity (Butzer 1978). This event is associated with the development of a stalagmite which formed over tens of thousands of years (from the end of Middle Stone Age III, ca. 55 000 years ago) extending well into the early Holocene (Butzer 1978). Lewis (2008: 173) interprets the lack of evidence of occupation at the site around this time as indicative of harsher climatic conditions which prevailed from the terminal Pleistocene. The cave remained closed during the early Holocene at Klasies River and was re-opened during a period of higher sea levels in the mid Holocene (Butzer 1987). The implication is that increased sea levels brought high waves which eroded the aeolian sand blocking the entrance of cave 1 (Butzer 1987).

Off-site early Holocene environmental data from along southern African coast suggest that this period was characterised by rising or turbulent sea levels (Fig. 2.7) (Appendix 2). Ramsay (1995) reports that sea levels rose from the early Holocene (9000 – 8000 BP) and reached the present level around mid-Holocene (6000 BP) following a warming phase that accompanied the early Holocene period. Thereafter, another rise in sea levels from an estimated 1.5 m above the present datum reached 3.5 m above mean sea level (AMSL) by 5080 BP (Ramsay 1995). These high sea levels were maintained during the mid-Holocene (5800- 4650 BP) (Ramsay 1995). Similarly, Compton (2001) relates the high-energy tidal action to the 0-3 m increased sea levels around 6800 BP, which modified the Langebaan Lagoon on the south-west coast of South Africa.

On the east coast, Strachan and colleagues (2014) report that a +3 m AMSL highstand spanning from 7300 to 6000 cal. BP is associated with a post glacial warming episode. Cooler, yet warmer than present, conditions followed this highstand which resulted in a +2 m AMSL sea level rise by mid-Holocene (c. 5000 cal. BP) (Strachan *et al.* 2014). Appendix 2 shows that there were multiple episodes of sea level rise and fall within the Holocene, although the mixture of calibrated and uncalibrated dates complicates interpretation.

2.2.2 Early to mid-Holocene terrestrial environments

The early to mid Holocene period is related to the most recent glacier retreat events (Mayewski *et al.* 2004: 246). This event is associated, by Mayewski and colleagues (2004), with a warming phase over the earth's atmosphere. Across the subcontinent of southern Africa, these warmer, often arid, conditions span c. 8300 to 7700 BP and are based on analyses of pollen recovered from archaeological sites (Chase & Meadows 2007).

Scott (1989) reports that pollen recovered from sites over the southern African interior indicates that generally warm temperatures followed the last glacial maximum. These conditions were rather dry at the beginning of the Holocene c. 10 000 to 8000 years BP, but warm and moist conditions developed thereafter and persisted until c. 5000 years BP (Scott 1989; Scott & Nyakale 2002). Charcoal recovered from Rose Cottage and Tloutle caves, in the Free State province (South Africa) and Lesotho respectively, likewise indicates that warm and dry climatic conditions occurred in the early Holocene and were subsequently replaced by warmer/moister conditions which prevailed over the southern African interior (Esterhuysen & Mitchell 1996).

Similarly, charcoal recovered from the deposits at the southern Cape Boomplaas Cave, c. 250 km west of the Klasies River caves, shows that warmer, xeric conditions were experienced in this area from 7000 to 5000 years BP (Scholtz 1986). In the analysis of charcoal remains from three LSA sites (Colwinton Rock Shelter, Ravenscraig and Bonawe Caves) in the Eastern Cape Province, Tusenius (1986; 1989) interprets the presence of plant taxa such *Leucosidea* and *Euryops* as evidence for a change in climate from moister, cooler to dry, warmer conditions from early to mid-Holocene respectively (Tusenius 1989). These conditions were correlated with wider environmental data from the faunal assemblage of the same region dated to the last 12 000 years (Tusenius 1989). Partridge (1993) and Partridge and colleagues (1999) describe the period from 7000 to 5000 years BP as the Holocene Altithermal in both the SRZ and WRZ in southern Africa, exceeding the Holocene average temperatures by more than 2˚C.

2.2.3 Mid to late Holocene sea levels

As discussed in Chapter 1, the accumulation of sediments with LSA cultural debris is associated with the mid and late Holocene period at Klasies River (Butzer 1978; Singer & Wymer 1982; Binneman 1995). Two occupational sequences, corresponding to two middens (Lower and Upper Midden) were deposited from the mid to late Holocene.

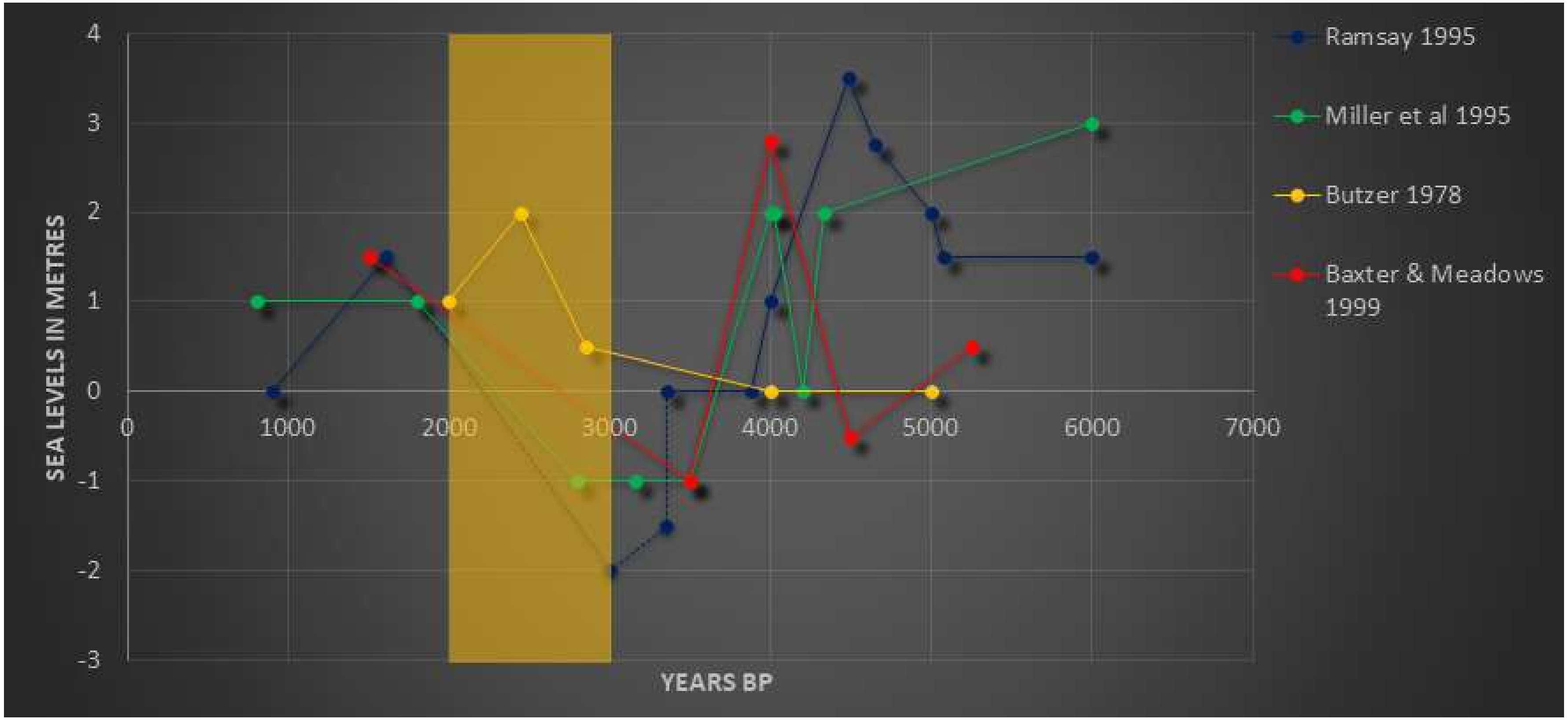

FIG. 2.6 *Southern African sea level fluctuations from the mid to late Holocene period inferred from marine data from Klasies River (Butzer 1978), the south-east coast (Ramsay 1995) and south-west coast (Miller et al. 1995; Baxter & Meadows 1999). Only data with uncalibrated dates is included in this fluctuation curve.*

An occupational break separates these deposits. Butzer (1978: 147) suggests that during the deposition of the Lower Midden (Layers KRM1-4 to KRM1-12) around 4825 – 4000 BP the sea was near present levels (Figure 2.7). After 4650 BP, there was a marked decrease in sea levels over the south-east coast of southern Africa (Ramsay 1995) related to significant cooling in the atmosphere.

Subsequently, a rise in sea levels of between +2 to +1.5 m AMSL occurred on the east coast between 4000 and 2450 BP (Ramsay 1995). Butzer (1978: 146) suggests that this rise in sea levels at Klasies River was between +2 and 4 m AMSL around 2450 BP (Fig. 2.7). The sea level highstand resulted in the erosion of a significant portion of the Lower Midden. The deposition of the Upper Midden layers (Layers KRM1-3 to KRM1-1) is on top of the partly eroded Lower Midden layers (Butzer 1978). The charcoal remains investigated in this study date to this late Holocene period when sea levels off the coast at Klasies River were approaching (dropping to) near present levels (Butzer 1978). The terrestrial environmental setting of the 2300 BP Klasies River landscape is investigated to understand the climatic conditions during this time as well as their relation to the fluctuating sea levels along the Tsitsikamma Coast.

Conclusion

This discussion has shown that the Holocene climate and the environment fluctuated markedly. There is not much proxy evidence for the Late Holocene, but it is possible that the environmental setting related to the charcoal assemblage studied here from the late Holocene period (c. 2300 BP) at Klasies River main site, would have been different from that prevailing today.

CHAPTER 3: METHODS AND MATERIALS

Introduction

The anatomical structure in contemporary woody species reflects, to a large extent, the information about major adaptations to specific environments over many years (Creber & Chaloner 1984; Baas & Wheeler 2011). This information is a result of macro and microevolution of woody plants that make each species better adapted to either aquatic, mesic or xeric environments. By comparing the anatomy of wood assemblages through time, climatic conditions may be inferred. This anthrocology method is applied in this study to infer environmental conditions that dominated the Klasies River landscape around 2300 BP.

3.1 Methods

3.1.1 Wood anatomy and the environment

All trees (single stemmed woody plants) and most shrubs (multi-stemmed woody plants) are C_3 plants in both tropical and temperate climates (van der Merwe 1982). Like other plants, trees and shrubs have functional physiological characteristics that are suited to a specific range of environmental parameters such as moisture, temperature and acidity (Baas & Wheeler 2011). As a result, different woody plant species are adapted to specific aquatic, xeric or mesic environments.

The microstructure of woody plants carries information about the adaptive evolution of species through time (Baas & Wheeler 2011). The functional and adaptive microstructure of the living wood is consistent within each tree and shrub species and is similar across space and through time, with minor anatomical variations that may be related to different ecological settings (Carlquist 1977; Wheeler *et al.* 2007). The functional and adaptive wood anatomical microfeatures allow for the identification of wood families, genera and closely related species (Baas & Wheeler 2011). Because woody plants are adapted to specific environments, identifying any woody plant taxonomically using extant plants can be used to describe ecological settings and trends on past landscapes (Baas & Wheeler 2011). It is this relationship between plant growth and the environment that allows wood anatomists to associate specific woody species with specific environments.

Functional features or characteristics in wood anatomy also provide direct proxies for environmental conditions. For example, there is a relationship between the xylem vessels and climatic parameters such as rainfall abundance, rainfall seasonality and mean annual temperatures (Carlquist 1977; February 1992; 1993; Baas & Wheeler 2011). A xylem vessel is the wood tissue that transports sap from the roots to the leaves (Baas & Wheeler 2011). The physiology of this tissue reflects the conductive capacity of resources such as water by a plant (Creber & Chaloner 1984; Baas & Wheeler 2011). The amount of water available for a plant during its' growth, like other other environmental parameters is impressed on the xylem vessels (Creber & Chaloner 1984). The relationship between this tissue and precipitation is understood as: with increasing water availability, vessel size (diameter of vessel) increases while vessel frequency decreases (Carlquist 1977; Creber & Charloner 1984; February 1992). Water, or more specifically, moisture availability is a function of more than only precipitation and is governed by factors such as the amount and intensity of insolation (aspect and seasonality play a role here), and the frequency and quantity of precipitation (when and how much rains falls) and temperature (Schultze 1997). Cooler conditions with low rainfall may produce similar moisture availability to hot conditions with much more rainfall. The operative determinant is the evaporotranspiration rate, or amount of moisture that is lost by the plant (Schultze 1997).

3.1.2 Anthracology method

The functional or anatomical features of wood are 3 dimensional in nature. However, these can be studied in 2 dimensional sections over three planes, with a good understanding of how all the anatomical features of woody plants function together in the living plant (Wheeler *et al.* 2007). The microscopic anatomical structure of wood is retained after the wood is carbonised or charcoalified. The analysis of charcoal using anthracology protocols allows for the taxonomic identification of charcoal based on wood anatomy (Wheeler *et al.* 2007). By comparing the anatomy of archaeological charcoal remains with the charcoal fragments of known species from contemporary woody vegetation, a taxonomic identification of woody vegetation from the past can be made. Furthermore, this analysis is useful for describing the basic wood anatomical structure (xylem diameter) of any charcoal fragment or species, which can be used to infer moisture availability.

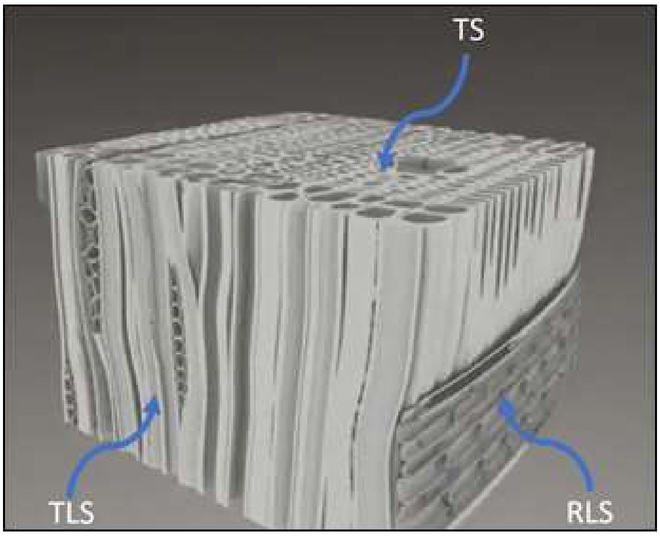

FIG. 3.1 *The 3-dimensional modelling of an angiosperm wood microstructure showing the Transverse Section (TS), Tangential Longitudinal Section (TLS) and Radial Longitudinal Section (RLS) (Source: Ambrozeek: https://www.youtube.com/watch?v=NnXSk5Xz3iM).*

Taxonomic identification method

The method for the taxonomic identification of charcoal in this study is based on the standard wood identification protocols set by the International Association for Wood Anatomists (IAWA) (Wheeler *at al.* 2007). According to research conducted on the wood anatomy of various woody species globally, there are microscopic features that must be identified and studied to taxonomically identify any wood fragment. These are divided into 162 anatomical and 58 miscellaneous features (Wheeler *et al.* 2007). The 162 anatomical IAWA features are derived from the presence or absence, arrangement, quantification and measurement of the main elements of the physiological cellular structure of hardwoods (Wheeler *et al.* 2007). These elements are vascular cell structure, hard tissue cells (fibres), soft tissue cells (parenchyma) as well as wood ray cells. They are studied and described along three 2-dimensional sections: Transverse (TS), Tangential Longitudinal (TLS) and Radial Longitudinal (RLS) sections (Fig. 3.1) for a comprehensive picture of their 3-dimensional nature (Wheeler *at al.* 2007; Baas &

Wheeler 2011). The 58 miscellaneous features are derived from the non-anatomical microstructures that occur in woods. These microfeatures are embedded into the wood structure either as inclusions, i.e. mineral particles get caught in the transport system of the plant, or as secretory elements of the wood, i.e. phloem or radial canals. These miscellaneous features (and/or their types) occur in selected woody species and are therefore, crucial in the identification of woody vegetation to species level (Wheeler *at al.* 2007; Baas & Wheeler 2011).

Method for the analysis of wood anatomical structure

Water, one of the plant growth regulators, is one of the factors controlling tree growth (Creber & Chaloner 1984: 404). "As much as 90% of the annual variation in the xylem increment may be attributable to water deficits in arid regions and up to 80% in wet localities" (Creber & Chaloner 1984: 404). The information about the availability and relative amount of moisture is stored in the wood macroscopic features such as growth rings and microstructures such as vessels and tracheids (Creber & Chaloner 1984; February 1992; Baas & Wheeler 2011).

For this reason, the variation in the microstructure of wood of any species owes its origin, to some degree, to environmental influences such as rainfall amounts or rainfall availability (Creber & Chaloner 1984; February 1992). Such an influence can be identified from analysing the vascular structure of wood. There are three vessel characteristics that are useful for understanding ecological trends such as rainfall (Baas *et al.* 1983; February 1992). These are the vessel frequency, the diameter of vessel lumina as well as the vessel length (Carlquist 1977; Baas *et al.* 1983). For example, wood vessels are the main conductors of water and therefore retain information about the uptake of water by any plant (Carlquist 1977).

Carlquist (1977) proposed that the water conductivity capability of any plant may be understood by studying the 'Vulnerability Index' of any given wood fragment. The "Vulnerability Index" (VI) of wood is a ratio calculated by dividing the diameter of vessel lumina by the vessel frequency (Carlquist 1977). The value of this index is indicative of the rainfall availability of the landscape at any given point in time. This method was used in this study to understand the relative rainfall abundance at 2300BP vs today in the Klasies River landscape.

3.2 Creating a comparative collection

3.2.1 Field sampling and identification

The main comparative collection for the identification of archaeological charcoal in this study was created from the trees and shrubs growing on the contemporary Klasies River landscape. A botanical survey of the area in the immediate vicinity of the caves was conducted by myself, Prof. Wurz and Prof. Bamford. This was done to understand the composition of woody vegetation taxa in the landscape. Klasies River main site is located on a southeast facing cliff of the Tsitsikamma Coastal platform. The Klasies River landscape is presently surrounded by farms that are heavily infested with invasive vegetation. The collection of comparative woody species in this study was, therefore, focused within a 1.5 km radius of Klasies River main site, where there is less invasive vegetation.

The following protocols were followed for creating a comparative wood collection from the Klasies River locality:

- Photograph and collect leaf vouchers of different woody species as well as respective wood samples.
- Identify the collected woody species using the leaf and wood vouchers as well as photographs.
- Carbonise the wood samples of the identified comparative woody species
- Study the microstructure of the carbonised woody species for comparative analysis.
- Create microphotographs of the carbonised woody species for comparative analysis.

The comparative wood samples were collected over different areas to record the present woody species diversity around the caves. Thus, every different woody plant was selected for collection. The context of the wood samples was noted and recorded collectively (or grouped) over smaller sub-areas of approximately 250 m^2. Global

Positioning System (GPS) coordinates were taken for each sub-area. A Nikon digital camera was used to photograph the wood samples during the collection procedure. The leaf and wood vouchers were labelled in numerical order according to the sequence in which they were collected. Each leaf and wood voucher were labelled with masking tape bearing consecutive numbers, while the details of their context were recorded. The following details were recorded for each wood sample collected: the geographic location of the surveyed area, aspect, geology, soil type, as well as the description of the collected woody plant i.e. height of the plant and leaf physiognomy.

The woody species from Klasies River were initially identified by Prof. Bamford. The final identification of these species was confirmed by Dr van Wijk. The leaf vouchers of identified species were then pressed and are housed at the Evolutionary Studies Institute Herbarium, University of the Witwatersrand. The wood samples of each species were taken to the University of the Wiwatersrand to be analysed for comparative analysis in this study.

3.2.2 Laboratory analysis and microphotography

The wood samples collected in the vicinity of the cave were left to dry in the sun for seven days (Fig. 3.2a). They were then cut into smaller pieces of approximately 2-4 cm (Fig. 3.2b) and dried in an oven at 50 ˚C for 24 hours (Fig. 3.2c). The comparative wood samples were wrapped in aluminium foil and placed in a Lenton muffle furnace, with each piece labelled accordingly. They were left to char in the furnace for 2.5 hours at a temperature of 350˚C. Charred comparative fragments were fractured, snapped between fingers or cut using a scalpel blade to foster a natural break along the Transverse Section (TS), Tangential Longitudinal Section (TLS) and Radial Longitudinal Section (RLS) (Wheeler *et al.* 2007).

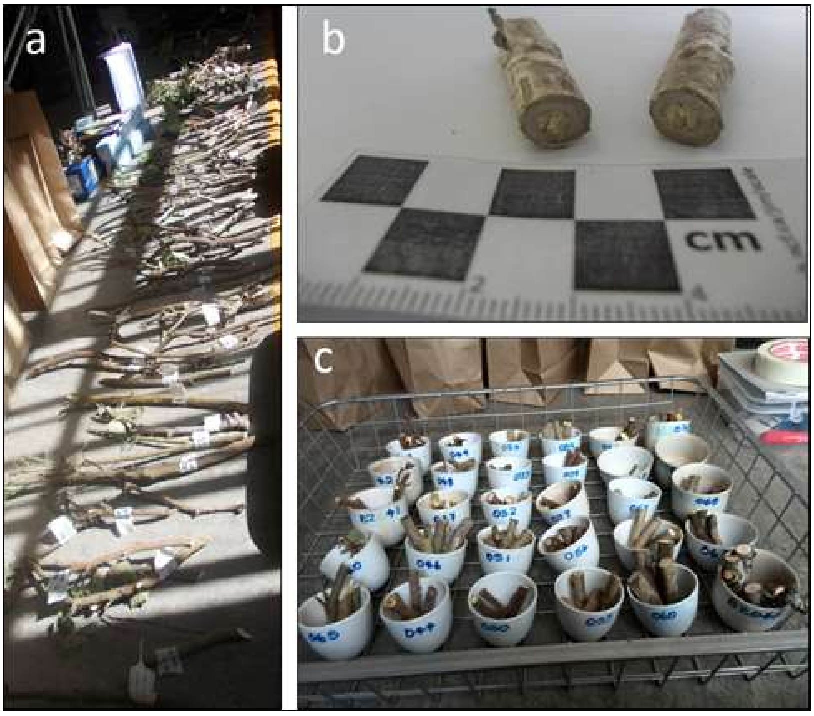

FIG. 3.2 *The laboratory preparation of wood pieces. Wood pieces were (a) sun-dried, then (b) cut into smaller pieces and (c) loaded inside crucibles and desiccated in an oven.*

The fracturing technique was strategically applied on the three sections following the pattern demonstrated on a fresh (uncharred) piece of wood in Figure 3.3. The fractured pieces were then loaded and fixed onto a microscope glass slide, using Prestik as an adhesive (Fig. 3.4a). The charcoal fragments of each species were analysed under reflective light objectives of an Olympus stereomicroscope, which was connected to a computer, at 50X, 100X, 200X and 500X magnification.

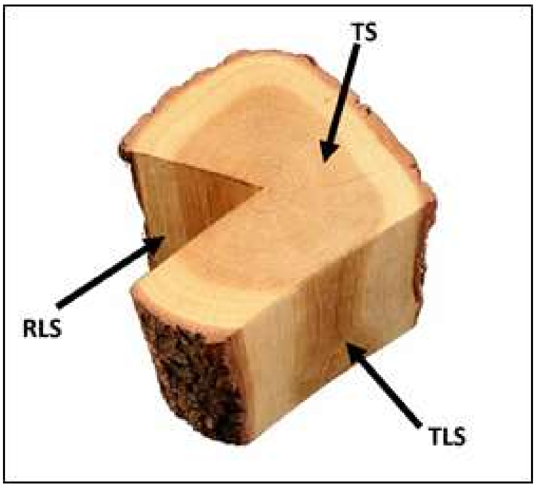

FIG. 3.3 *Uncharred wood piece demonstrating the planes at which charcoal fragments were fractured for a TS, RLS and TLS (Source: Čufar & Zupančič 2009).*

Using Olypus Stream Essentials' Analysis Software, the magnified microscopic structure of each charcoal fragment was studied on a computer monitor (Fig. 3.4b). This software was also used to digitally measure and count the different features of wood or charcoal, i.e. vessel diameter, vessel frequency, vessel length, ray length, ray thickness. Each section of each wood voucher or species was studied under Dark Field and Bright Field of the microscope from a low magnification (i.e. 50X) to a high magnification (i.e. 500X) for an accurate description of the observed microscopic features.

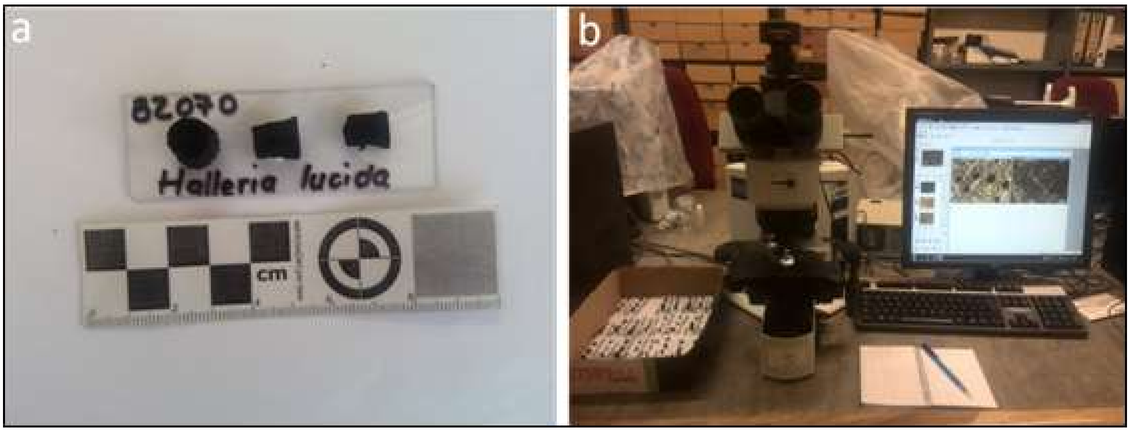

FIG. 3.4 *The charcoal fragments (a) loaded on a microscope slide and (b) analysed under a stereomicroscope.*

The documented descriptions of the comparative species were recorded for vascular cell structure, hard tissue cells (fibres), soft tissue cells (parenchyma), wood ray cells as well as miscellaneous features observed over the three sections (Wheeler *et al.* 2007). The same microscope method was used with Extended Focal Image (EFI) software to create microphotographs of all the important features of each species. The micrographs and descriptions of species from Klasies River locality were used along with other charcoal comparative collections from southern Africa to taxanomically identify archaeological charcoal from cave 1 to species level.

3.2.3 Other comparative collections from southern Africa

Numerous charcoal collections created during charcoal studies in southern Africa were consulted for comparative analysis of archaeological charcoal in this study. These include comparative charcoal collections created during an analysis of archaeological charcoal at Tloutle Rock Shelter and Rose Cottage Cave (Esterhuysen & Mitchell 1996); Sibudu Cave (Allott 2006), Bonawe, Colwinton and Ravenscraig Rock Shelters (Tusenius

1986); Boomplaas Cave (Scholtz 1986); Great Zimbabwe (Chikumbirike 2014) as well as published descriptions of woody species from around Diepkloof Rock Shelter (Cartwright 2013) and Elands' Bay Cave (Cartwright & Parkington 1997; Cartwright *et al.* 2014). A collection of charcoal micrographs created for woody species from all over southern Africa and published by Kromhout (1975) was also referred to for comparative analysis in this study.

In addition to these, an online "InsideWood" database (http://insidewood.lib.ncsu.edu/) with descriptions and micrographs of woody species collected throughout the world was consulted. This database was visited for comparative analysis as well as for the wood anatomy descriptions of species as the database adheres to the standard IAWA terminology for the description of wood anatomical features.

3.3 Recovery of archaeological charcoal

3.3.1 Field sampling

Archaeological charcoal was excavated from the LSA deposit that remained after the excavations by a team led by Wymer between 1967 and 1968 (Singer & Wymer 1982). This deposit was named the Witness Baulk (Singer & Wymer 1982, Wurz 2016). A grid of 50 X 50 cm squares was set over the Witness Baulk following Deacon's 1984 grid system (Wurz per. comm.). The squares excavated for the data in this study are located towards the north end of the Witness Baulk. Three squares were opened in 2016 over the Upper Midden area: A15, B15 and B16 (Fig. 3.5). These squares are all located north, adjacent to the area excavated by Binneman in 1995. There was a lack of clear stratigraphic differences and thus excavation was done in spits. The identification of individual hearths was not possible. The top most layer of the Upper Midden area was characterised by a very loose soil matrix and disturbed context. This layer was removed and was designated 'Surface/ Profile Cleaning'. Spits 1, 2 and 3 were excavated to a total depth of between 5-10 cm while Spit 4 was excavated to more than 10 cm deep. Charcoal and seeds were recovered mostly *in situ* from each layer (spits) over the three

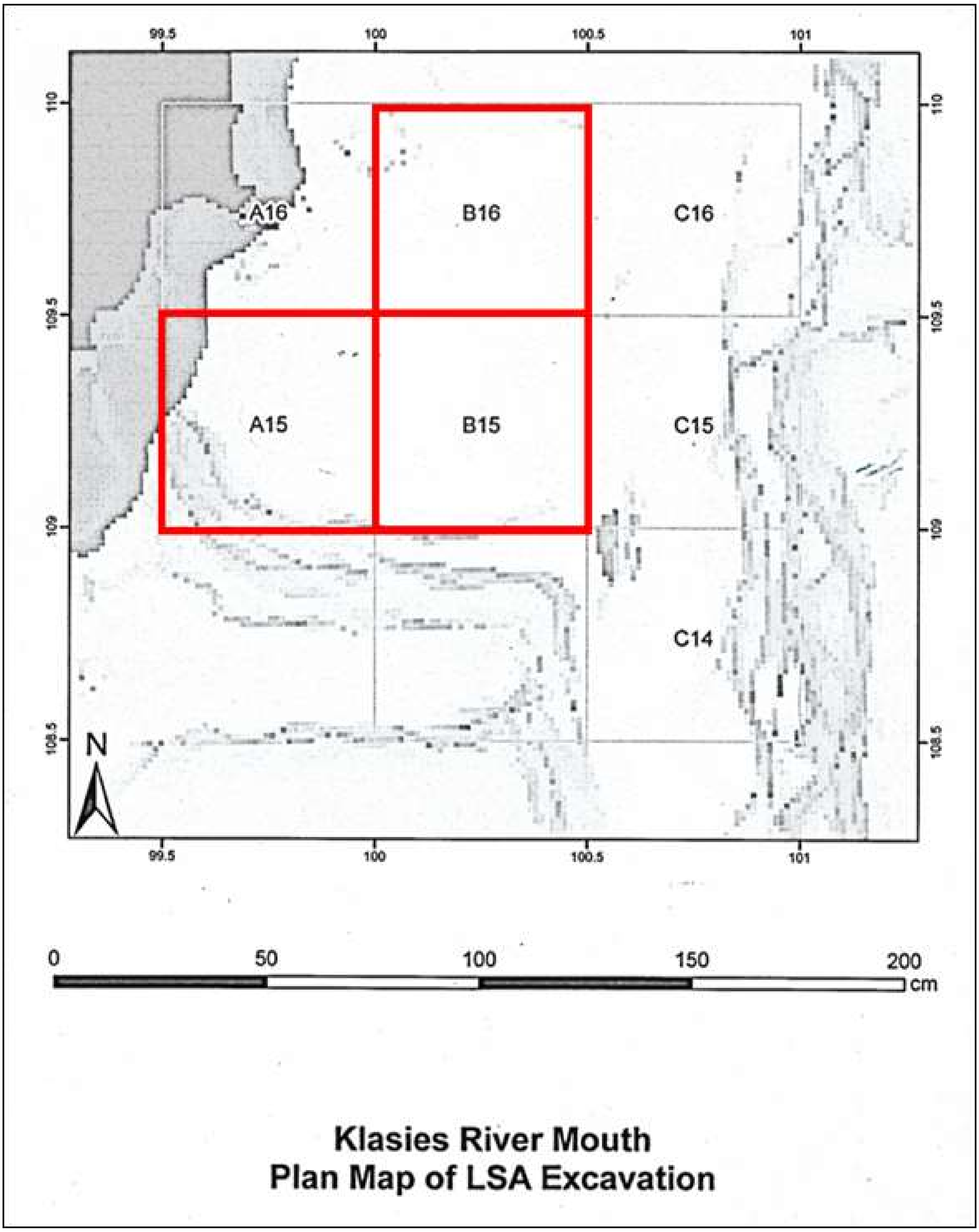

FIG. 3.5 *The excavation plan of the LSA deposit at Klasies River cave 1 showing squares A15, B15 and B16 excavated in 2016. (Image by S. Wurz)*

squares and from the 3 mm and 1 mm mesh used to sieve the excavated deposit. These were stored in protective plastic containers and labelled according to their archaeological context.

3.3.2 Laboratory analysis, microphotography and identification

Laboratory analysis and microphotography

The charcoal remains recovered from Klasies River cave 1 were prepared in the laboratory for analysis. Each fragment was cleaned of all dust particles, using a small paint brush with soft bristles of less than 1 cm to minimise damage during cleaning. The cleaned charcoal fragments were then each fixed onto microscope slides with Prestik and details of their context were written on the slides.

As with the comparative charcoal species, archaeological charcoal was studied along the TS, TLS and RLS. The charcoal fragments were first studied under the microscope, to understand which section was exposed on different sides; this allowed for an informed decision on which angles to fracture each fragment to obtain a good view of other sections. The fracturing method followed that described in section 3.2.2. However, because the archaeological fragments were generally very small and fragile, finger nails, instead of full finger tips, were often used to break the fragments. This ensured better control of the amount of pressure applied and greater precision of the angle of fracture on the fragments.

The wood anatomy of the archaeological charcoal fragments was studied and photographed under the stereomicroscope following the microscope settings and software described in section 3.2.2. The descriptions of the anatomical and miscellaneous features were documented for vascular cell structure, hard tissue cells (fibres), soft tissue cells (parenchyma) as well as wood ray cells as observed over the three sections (Wheeler *at al.* 2007). The descriptions along with the microphotographs of archaeological charcoal were compared against those in the comparative collection from Klasies River locality as well as those from other southern African archaeological sites, for taxonomic identification.

Taxonomic identification

The taxonomic identification procedure of archaeological charcoal followed in this study is presented in Figure 3.6. Different 'Types' of charcoal were first identified by grouping all the fragments with similar wood microstructure from all spits and squares.

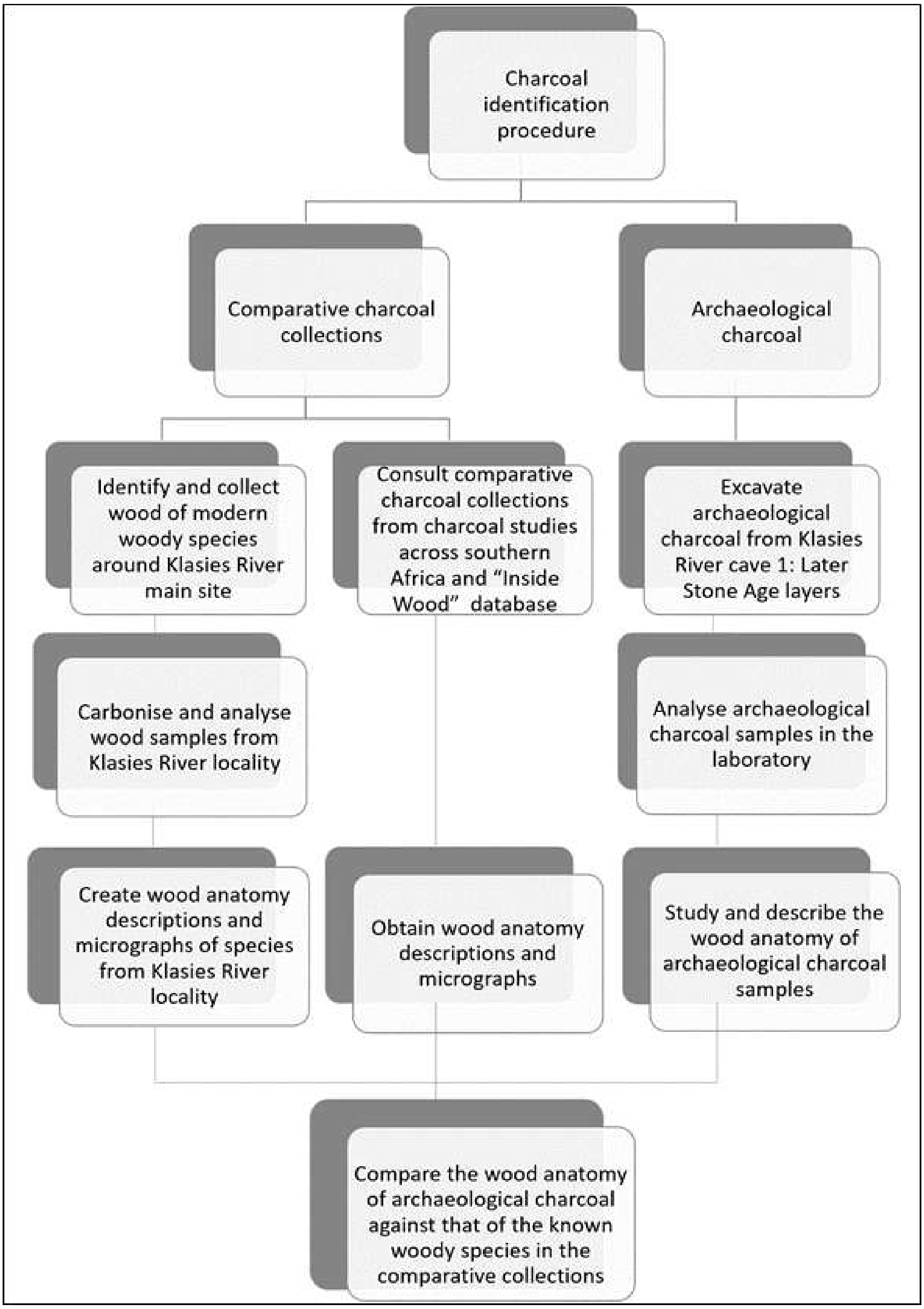

FIG. 3.6 *The identification procedure of archaeological charcoal followed in this study.*

The groups were then assigned 'Type' numbers. Each 'Type' represents a a single woody species. The wood descriptions of each charcoal 'Type' was compiled using the wood descriptions of all fragments within each 'Type' category. It is this 'Type' description that was compared to the descriptions of known species of modern woody vegetation from southern Africa. After comparing the wood descriptions from the two collections a taxonomic identification of the archaeological fragments (or 'Types') was made.

Analysis of the wood anatomical structure

Information about two vessel characteristics, vessel diameter and frequency, were recorded for the archaeological charcoal fragments and comparative species from the Klasies River landscape. Charcoal pieces of each species from the comparative collection were selected for analysis of wood anatomy. Charcoal fragments from each archaeological 'Type', including taxanomically identified and unidentified charcoal 'Types', were selected. Each fragment was studied for vessel frequency on the transverse section following the IAWA method by counting the number of vessels on the TS up to four areas of 1 mm^2 and an average of these was calculated. The diameter of the vessels was measured on the TS in micrometres (µm) from up to 25 vessels, following the IAWA protocols. From these, an average vessel diameter of each fragment was calculated. These vessel characteristics were measured and calculated using Analysis Software that was installed on a computer attached to a stereomicroscope. The microscope allowed for fragments to be analysed at a magnification ranging between 100X and 500 X and microphotographs were taken using Extended Focal Image software. The "Vulnerability" indices were then calculated from these measurements and calculations according to Carlquist's (1977) method. The procedure for understanding the wood anatomical structure of the fragments (archaeological and comparative) in this study is demonstrated in Figure 3.7.

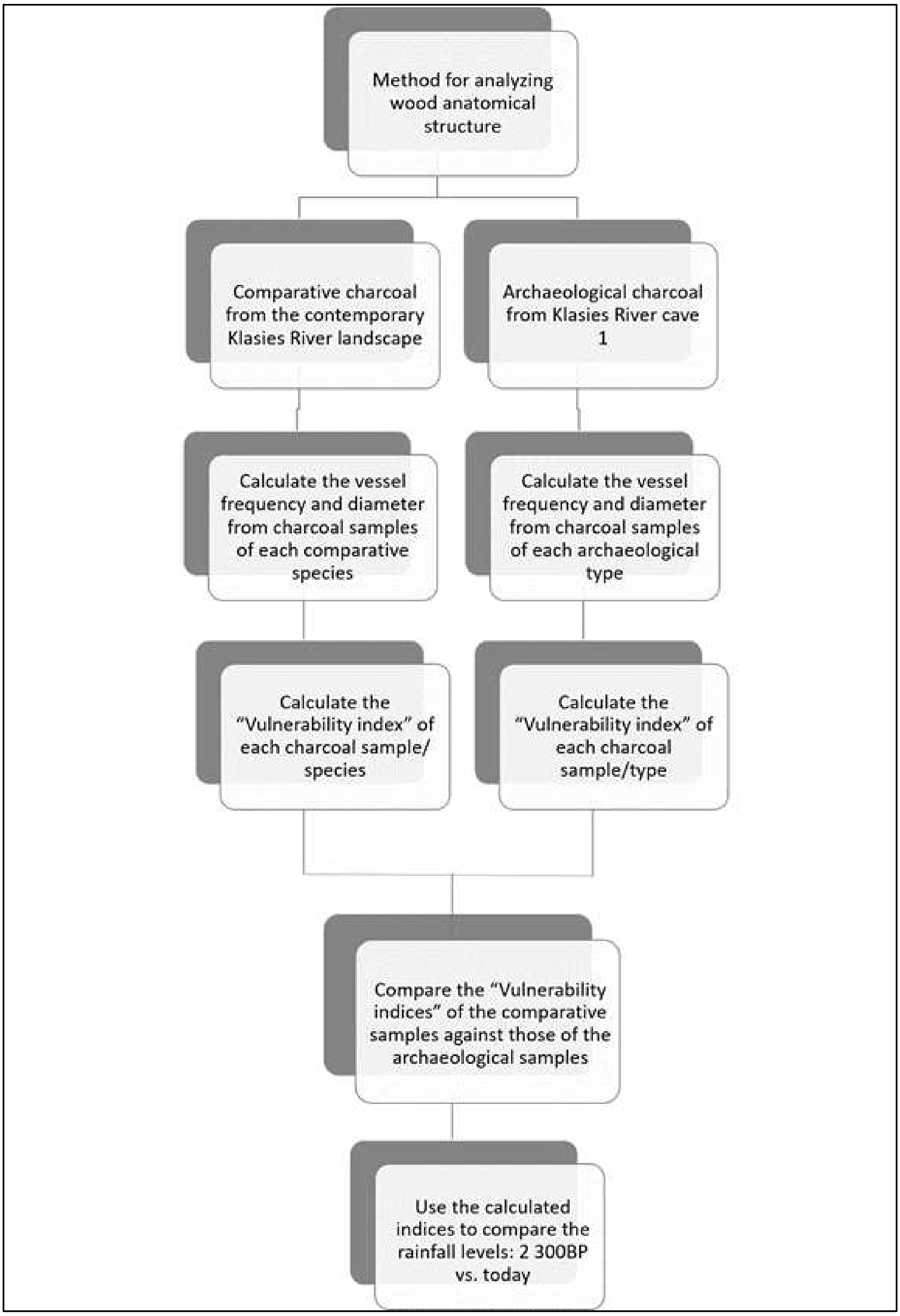

FIG. 3.7 *The method of analysing wood anatomical structure followed in this study.*

3.4 Method for qualitative analysis and interpretation

3.4.1 Taxonomy analysis and environmental interpretation

The Late Holocene environment around the Klasies River landscape was interpreted from the archaeological charcoal assemblage by associating the identified woody taxa with environments using their current distribution. An annotated checklist of all plants in southern Africa compiled by the South African National Biodiversity Institute (Germishuizen & Meyer 2003), as well as books written about trees of southern Africa studied by van Wyk and van Wyk (2013) and by Palgrave (1980) were used extensively to understand the nature and the environmental tolerance of each woody plant. A smaller regional scale distribution of these woody species was identified through studying the distribution patterns recorded by Venter (2012) and Pooley (2006).

A distribution map of each identified taxa was studied to understand the environmental parameters under which each taxon currently grows. Because southern Africa experiences competing climatic systems associated with different conditions, the pattern of distribution of C_3 vegetation over the landscape can be associated with the known distributions and boundaries of environmental conditions, such as temperatures and seasonality of precipitation (Chase & Meadows 2007; Engelbrecht *et al.* 2014). The temperate climate system is associated with winter rainfall while the tropical climate is associated with summer rainfall. Chase and Meadows (2007: 104) estimated the current boundary of the WRZ and thereby estimated the boundary for the YRZ and SRZ over southern Africa. In this study, the boundary estimates of all rainfall zones over southern Africa is derived from Chase and Meadows' (2007) map (Fig. 4.16). These rainfall regions (boundaries) were overlayed over the known distributions of each species to understand the environmental (including climate) setting currently tolerated by each species.

The discussion of the environmental conditions currently tolerated by most woody species identified from archaeological charcoal in this study were extrapolated for the 2300 BP Klasies River landscape. The distribution of the majority of species was used to further argue for the presence and prevalence of specific environmental conditions, although the intensity of the conditions is more difficult to infer. Species richness was recorded per layer but was not considered meaningful to quantify the abundance of each species by the frequency of its' fragments. This is because, as mentioned in section 1.2, environmental interpretations based on archaeological wood or charcoal are subject to wood collection bias as well as preservation bias. The frequency of charcoal fragments reflects neither the abundance of the species around the site nor how much of the species was collected and burnt by people.

Wood properties of different species play a crucial role in the fragmentation and preservation of the charred remnants of every species (Chrzazvez *et al.* 2014). For example, it was noted in this study that there is a stronger correlation between the wood composition of different species and hardness than there is between wood thickness and hardness. This was observed during the analysis of comparative wood, before and after wood pieces were carbonised into charcoal. For example, although having similar wood thickness, species such as *Tarchonanthus littoralis*, *Colpoon compressum* and *Halleria lucida* produced charcoal fragments with significantly different hardness. It was further noted, that when fractured, soft-textured charcoal species tended to fragment into many pieces while the harder species did not.

Thus, there is no direct correlation between the number of charcoal fragments in an archaeological site and the amount of a woody species collected by people (Chrzazvez *et al.* 2014: 36). A quantitative analysis of archaeological charcoal based on fragmented pieces may bias representation of woody species that produce soft-textured charcoal against that of a harder composition. Furthermore, post-depositional processes may discriminate against the preservation of soft-textured wood and favour the representation of hard-textured woody species.

3.4.2 Analysis of wood anatomical structure and interpretation

The late Holocene landscape around Klasies River was also interpreted through the analysis of the anatomical structure of the charcoal. Studies such as those conducted by Scholtz (1986) and February (1992; 1993; 1994; 2000) have suggested that a strong correlation in rainfall and vessel characteristics of southern African woody plants exists. A low vessel count (frequency) generally indicates a plant's adaptation to conducting water efficiently (February 1992). This relationship works inversely with the mean diameter of the vessels (Carlquist 1977; February 1992). Vessels with wider diameter and low frequency signify the availability of water for the woody plant. This means that with increasing rainfall, vessel size (diameter of vessel) increases while vessel frequency decreases (February 1992: 27). The anatomical structure of charcoal fragments from two charcoal assemblages, contemporary vs archaeological wood (c. 2300 BP) were compared using 'Vulnerability Indices' (VI).

Carlquist (1977: 888) determined that woody plants with a VI below 1 are within a 'safety range' and may be considered 'Redundant'; meaning they have greater ability to withstand water scarce conditions, commonly associated with drought (Carlquist 1977). The VI in this study was used to determine if the woody species growing at present around Klasies River main site are more vulnerable to water scarcity than those from the 2300 BP landscape and *vice versa*. This comparison was done to understand the relative abundance of rainfall over the Klasies River landscape 2300 BP vs. the present.

Conclusion

Anthracology, using the methods described in this chapter, provides a reliable way to identify archaeological charcoal to taxon as well as for understanding the anatomical structure of wood remains. Environmental parameters such as climate, determine the presence and distribution of indigenous woody species on any landscape. The interpretation of the environment based on the presence or absence of specific woody species in the Klasies River cave 1 LSA layers will provide an indication of the conditions that prevailed around 2300 BP.

CHAPTER 4: RESULTS

Introduction

Charcoal remains occurred in all the excavations conducted on the LSA deposits by Singer and Wymer (1982: 123), Binneman (1995: 117) and Wurz (2016). These remains are reported as flecked across the different layers and sometimes occurring in lenses within the layers of the deposit (Singer & Wymer 1982; Binneman 1995). The taxa as well as the environmental conditions associated with the taxa of these remains have not been fully investigated. The results of the analysis of contemporary comparative wood or charcoal and archaeological charcoal are presented in this chapter to understand how the conditions of their respective landscapes differ.

4.1 The comparative wood (charcoal) collection from the contemporary Klasies River landscape

4.1.1 Field sampling results

The topography of the area sampled for comparative species around Klasies River main site consists predominantly steep slope dunes and with precipitous gorges. As a result, most areas are inaccessible and are mainly situated to the north-east of the boundary indicated in Figure 4.1. Preliminary observations indicated that the indigenous vegetation in the dune area is dense and evergreen; however, it has characteristics for succulence, i.e. the leaves of the woody plants generally have a fleshy, thick appearance and were often oblanceolate. These characteristics have developed in response to harsh conditions. Although the area is situated within a landscape that receives rainfall reliably throughout the year, the vegetation must withstand strong winds and salt spray from the Indian Ocean. A total of six sub-areas were surveyed. Up to 70 leaf and wood vouchers belonging to 50 different species and 27 families were sampled. Illustrated below, are the areas surveyed as well as significant features of each area that contribute to the microclimate over the landscape. The areas are presented in the order in which they were surveyed.

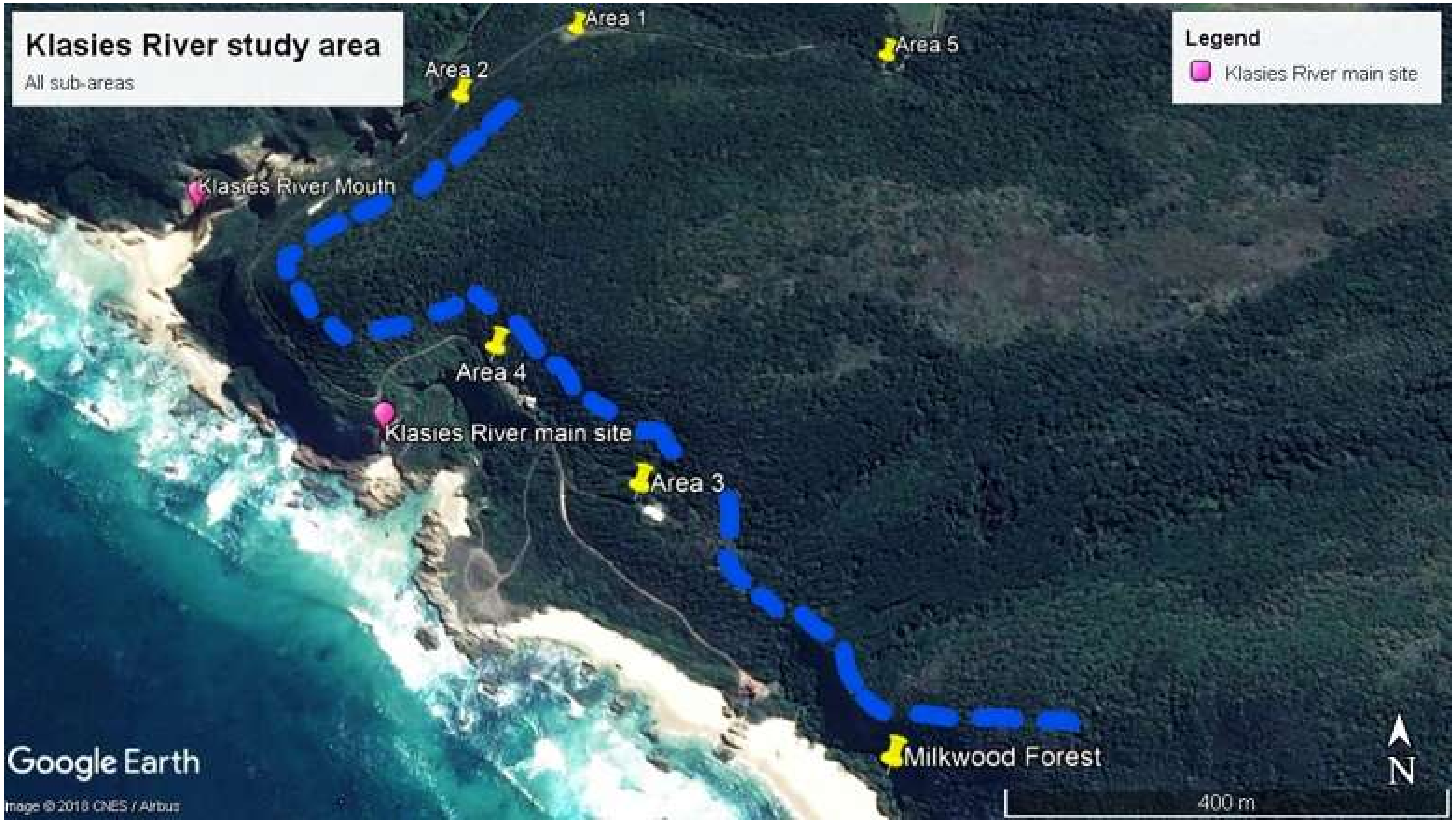

FIG. 4.1 *Map of the areas sampled for comparative woody species around Klasies River cave sequence. The blue dotted line indicates the beginning of most of the inaccessible area around the caves. (Google Earth Map accessed from 18 May 2018)*

Area 1- Figure 4.2

Area 1 is mostly a patchwork of low-lying grass and shrubs/small trees. This area is situated approximately 600 m from Klasies River main site. Thirteen different woody species (Table 4.1) were noted and collected from this area (Fig. 4.2).

FIG. 4.2 *Area 1 of the total area surveyed around Klasies River main site. Red arrow on Google Earth map indicates the main collecting routes from the starting point of Area 1. (Image on the left by S. Wurz)*

This area is gently sloped and located on the north-west parts of the dune. It receives sunlight during daylight hours. Of all the six areas sampled, this area has the highest elevation, namely 72 m above sea level. No harsh microclimatic conditions are present in this area.

Area 2- Figure 4.3

Area 2 stretches along a dirt road with an elevation of between 65 -70 m above sea level, and it is located over the north-west of the dune area (Fig. 3.4). The area stretches entirely along the east bank of the Klasies River, and 25 mostly tall shrub and small tree samples were collected (Table 4.1)

FIG. 4.3 *Area 2 of the total area surveyed around Klasies River main site. Red arrow on Google Earth map indicates the main collecting routes over Area 2. (Image on the left by S. Wurz)*

Area 3- Figure 4.4

Area 3 is located along the south-facing steep slope of the dune. The elevation of this area varies between 39 and 68 m above sea level. Nine different woody species were collected from this area (Fig. 4.4) (Table 4.1). Three of these were duplicates of species already collected from Areas 1 and 2. The woody vegetation in this area experiences very harsh windy conditions accompanied by salty spray from the Indian Ocean.

FIG. 4.4 *Area 3 of the total area surveyed around Klasies River main site. Red arrow on Google Earth map indicates the main collecting routes over Area 3. (Image on the left by M. Bamford)*

Area 4- Figure 4.5

Area 4 starts on the south-east facing slope of the big dune area and extends over the south side before adjoining Area 2 to the west of the dune. The elevation of Area 4 varies between 66 and 68 m above sea level. A total of nine different woody species (Table 4.1) were collected from this area (Fig. 4.5). Similar to Area 3, the woody vegetation in this area is exposed to very harsh windy conditions accompanied by salty spray from the Indian Ocean.

FIG. 4.5 *Area 4 of the total area surveyed around Klasies River main site. Red arrow on Google Earth map indicates the main collecting routes from the starting point of Area 4. (Image on the left by M. Bamford)*

Milkwood forest- Figure 4.6

The Milkwood Forest is located below the south-facing cliff that is carved with Caves 3 and 4 of the Klasies River cave sequence, approximately 600 m from the main site (Fig. 4.6) (Table 4.1). This area was surveyed separately to record if the woody vegetation to the far east of Klasies River main site is any different from that found in the main collecting areas.

FIG. 4.6 *Milkwood Forest area, the red dotted line indicates the area surveyed within the Milkwood Forest. (Image on the left by S. Wurz)*

Area 5- Figure 4.7

This area is the furthest away from the Klasies River main site. Located next to a fresh-water source, Area 5 lies on the north-east of a protective dune and features slightly different microclimatic conditions from all other surveyed areas.

Most parts of this area are along a small stream that joins the Klasies River from the east. The elevation is low, namely 37-50 m above sea level. This area was surveyed from an intersection of the stream and the road and extended in in three different directions: (1) towards Area 1, (2) towards the north and (3) upstream from the intersection (Fig. 4.7).

FIG. 4.7 *Area 5 of the total area surveyed around Klasies River main site. Red arrow on Google Earth map indicates the main collecting routes from the starting point of Area 5. (Image on the left by M. Bamford)*

Table 4.1 below presents the summary of the 70 wood and leaf vouchers collected from the six different areas surveyed along with GPS coordinates of the starting point of each area. There is a similar composition of woody plant species across the six areas surveyed within a 1.5 km radius of Klasies River main site. A slight morphological variation in the appearance of some species in different areas is interpreted as an adaptation of the species to the conditions of their microhabitats. For example, duplicate vouchers of species such as *Colpoon compressum*, *Sideroxylon inerme* and *Ficus burtt-davyi* were collected from three different areas because initially they appeared to be different taxa.

TABLE 4.1 *The list of all areas surveyed as well as the species sampled in each area. Table continues to page 45, 46 and 47.*

Area	GPS Coordinates	Elevation (meters)	Voucher #	Tree/ shrub	Genus+ species
1	34°06'11.8"S 24°23'33.3"E	72	BZ001	Shrub	*Acacia cyclops* (Alien)
1	34°06'11.8"S 24°23'33.3"E	72	BZ002	shrub/tree	*Colpoon compressum*
1	34°06'11.8"S 24°23'33.3"E	72	BZ003	tree/tree	*Diospyros dichrophylla*

Area	GPS Coordinates	Elevation (meters)	Voucher #	Tree/ shrub	Genus+ species
1	34°06'11.8"S 24°23'33.3"E	72	BZ004	shrub	*Searsia glauca*
1	34°06'11.8"S 24°23'33.3"E	72	BZ005	shrub	*Stoebe plumosa*
1	34°06'11.8"S 24°23'33.3"E	72	BZ006	shrub	*Agathosma apiculata*
1	34°06'11.8"S 24°23'33.3"E	72	BZ007	tree	*Pterocelastrus tricuspidatus*
1	34°06'11.8"S 24°23'33.3"E	72	BZ008	tree	*Searsia crenata*
1	34°06'11.8"S 24°23'33.3"E	72	BZ009	shrub	*Passerina rigida*
1	34°06'11.8"S 24°23'33.3"E	72	BZ010	small tree	*Tarchonanthus littoralis*
1	34°06'11.8"S 24°23'33.3"E	72	BZ011	small tree	*Osteospermum moniferum*
1	34°06'11.8"S 24°23'33.3"E	72	BZ012	tree	*Diospyros dichrophylla*
1	34°06'11.8"S 24°23'33.3"E	72	BZ013	shrub	*Searsia* cf. *lucida*
1	34°06'11.8"S 24°23'33.3"E	72	BZ014	tree	*Diospyros dichrophylla*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ015	small tree	*Ficus burtt-davyi*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ016	tree	*Pittosporum viridiflorum*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ017	shrub	*Searsia crenata*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ018	shrub/tree	*Eleodendron croceum*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ019	tree	*Cassine peragua*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ020	shrub	*Rhoicissus dentata*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ021	shrub/tree	*Rhamnus prinoides*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ022	shrub/tree	*Nuxia* sp.
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ023	shrub	*Erica glandulosa*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ024	small tree	*Tarchonanthus littoralis*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ025	tree	*Rapanea melanophloes*

Area	GPS Coordinates	Elevation (meters)	Voucher #	Tree/ shrub	Genus+ species
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ026	shrub/tree	*Euclea racemosa*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ027	shrub	*Coleonema pulchellum*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ028	shrub/tree	Missing
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ029	shrub	*Cassine* sp. (Missing)
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ030	shrub/tree	Missing
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ031	shrub/tree	*Searsia pyroides*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ032	tree	*Mystroxylon aethiopicum*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ033	shrub	*Carissa bispinosa*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ034	tree	*Sideroxylon inerme*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ035	shrub	*Zanthoxylum davyi*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ036	tree	*Cussonia thyrsifolia*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ037	tree	*Cussonia thyrsifolia*
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ038	shrub/tree	Missing
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ039	shrub	*Lycium* sp.
2	34°06'15.2"S 24°23'27.7"E	65-70	BZ040	tree	*Dovyalis caffra*
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ041	tree	*Sideroxylon inerme*
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ042	tree	*Pterocelastrus tricuspidatus*
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ043	shrub	*Ficus burtt-davyi*
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ044	shrub	*Ficus burtt-davyi*
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ045	shrub	*Restio eleocharis*
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ046	shrub	*Metalasia muricata*
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ047	tree	*Dovyalis* sp.

Area	GPS Coordinates	Elevation (meters)	Voucher #	Tree/ shrub	Genus+ species
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ048	shrub	*Salvia africana-lutea*
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ049	shrub	*Clausena anistata*
3	34°06'29.7"S 24°23'33.5"E	39-68	BZ050	shrub	*Ilex mitis*
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ051	tree	*Ilex mitis*
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ052	tree	*Cassine peragua*
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ053	tree	*Grewia occidentalis*
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ054	tree	*Nuxia* sp.
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ055	shrub	*Ficus burtt-davyi*
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ056	shrub	*Morella cordifolia*
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ057	shrub	*Phylica axillaris*
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ058	shrub	*Colpoon compressum*
MF	34°06'41.5"S 24°23'47.4"E	39	BZ059	tree	*Nuxia floribunda*
5	34°06'13.2"S 24°23'48.9"E	37	BZ060	tree	*Gymnosporia nemorosa*
5	34°06'13.2"S 24°23'48.9"E	37	BZ061	tree	*Pavetta revoluta*
5	34°06'13.2"S 24°23'48.9"E	37	BZ062	shrub	*Ficus* sp.
5	34°06'13.2"S 24°23'48.9"E	37	BZ063	shrub	*Passerina* sp.
5	34°06'13.2"S 24°23'48.9"E	37	BZ064	shrub	*Colpoon compressum*
5	34°06'13.2"S 24°23'48.9"E	37	BZ065	tree	*Polygala myrtifolia*
5	34°06'13.2"S 24°23'48.9"E	37	BZ066	tree	cf. *Euclea racemosa*
5	34°06'13.2"S 24°23'48.9"E	37	BZ067	shrub	*Agathosma ovata*
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ068	shrub	*Rapanea* cf. *giliana*
4	34°06'26.8"S 24°23'30.5"E	66-68	BZ069	shrub	*Exomis* sp.

Slope variation and aspect (which influences microclimatic conditions) often determines the vegetation pattern and species distribution (Bennie *et al.* 2008). However, these have a limited effect on the distribution of woody plants at Klasies River. That is, although the woody plants collected from the Klasies River landscape have to adapt to conditions that are localised over smaller areas of the landscape, these conditions determine neither the occurrence nor the distribution of woody species. Instead they affect the physical morphology of these plants. It was noted that there is no apparent difference in the density and species diversity of woody plants on the north-facing (warmer and protected) slopes vs south-facing (cold sea-facing) slopes. However indigenous shrubs and trees, such as *Sideroxylon inerme*, tend to grow taller in Areas 1 and 5 (north-facing slopes) than in other areas.

Among the indigenous woody species there are patches of invasive plant species that were introduced mostly for commercial purposes. These invasive plants include rooikrans (*Acacia cyclops*), gum tree (*Eucalyptus* sp.), pine trees (*Pinus* sp.) and wattle trees (*Acacia pycnantha*). Planted pine forests presently border the surveyed area some 2 km from Klasies River main site. All these alien species compete with the indigenous woods for nutrient sources such as water, i.e. gum trees are known to absorb 80- 200 litres of water per day from the ground (Gaertner *et al.* 2015). The invasive plants together with salty sea moisture and strong southerly winds from the Indian Ocean create asuite of conditions that impact on the indigenous woody species over the Klasies River landscape. The 50 indigenous woody species collected, nevertheless, represent the natural influence of the dominant climatic conditions, resulting from the competing temperate and tropical climate systems along the southern Cape coast. The taxonomic interpretation based on the the presence of specific species in the charcoal assemblage will thus be comparable with environmental data interpreted from other sources across southern Africa.

4.1.2 Laboratory analysis results

Detailed descriptions of the comparative species were documented and are presented in Appendix 3. These features are anatomical features (vessels, parenchyma, rays and fibres) as well as miscellaneous features (inclusions and secretory elements). The key to the descriptions and abbreviations used in Appendix 3 is given in Appendix 4. The measurements of the vessel diameters (Appendix 3a), vessel frequency (Appendix 3b) and measurements of the ray structure (Appendix 3c) are presented with the calculated averages for the different features.

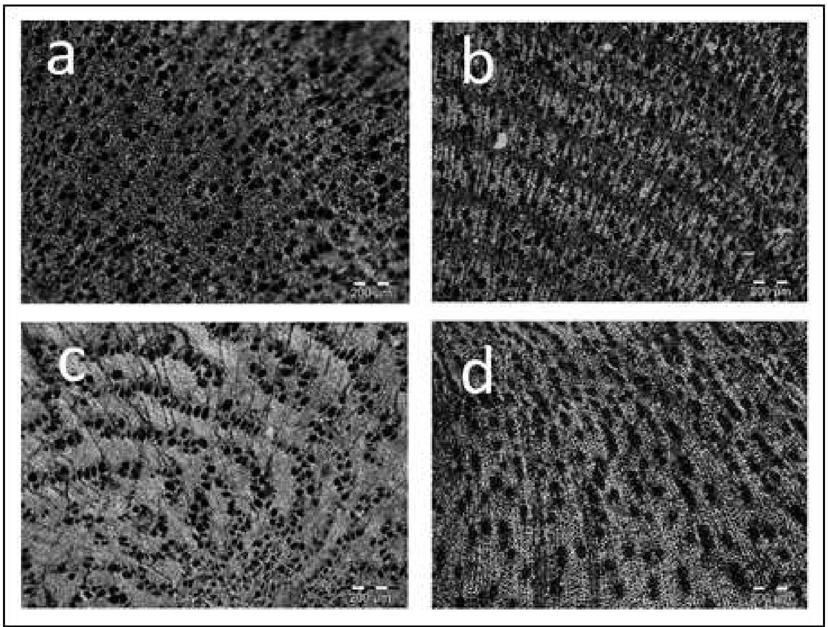

FIG. 4.8 *The TS of four comparative species showing numerous vessels with small diameter of the lumina. The TS sections shown here belong to the species: (a)* Pittosporum viridiflorum*, (b)* Cassine peragua*, (c)* Passerina rigida *and (d)* Rapanea giliana*. The scale bar on all micrographs is 200 µm.*

During microscopic analysis, two features were noted about the microanatomy of the comparative species from the contemporary Klasies River landscape. First, the species generally had numerous vessels (i.e. often more than 100 vessels per mm^2) with a small or narrow diameter of vessel lumina (i.e. often less than 50 micrometres) when viewed in the TS (Fig. 4.8). Secondly, the longitudinal walls of most of the species were dominated by much fibrous material that often impeded the visibility of ray cells. These fibres were generally thick in most species. There appeared to be a correlation between the species with thick fibres and the species that were difficult to fracture during laboratory preparation. Micro-photographs of selected comparative species, for example *Grewia occidentalis* (Fig 4.9), are presented in Appendix 5.

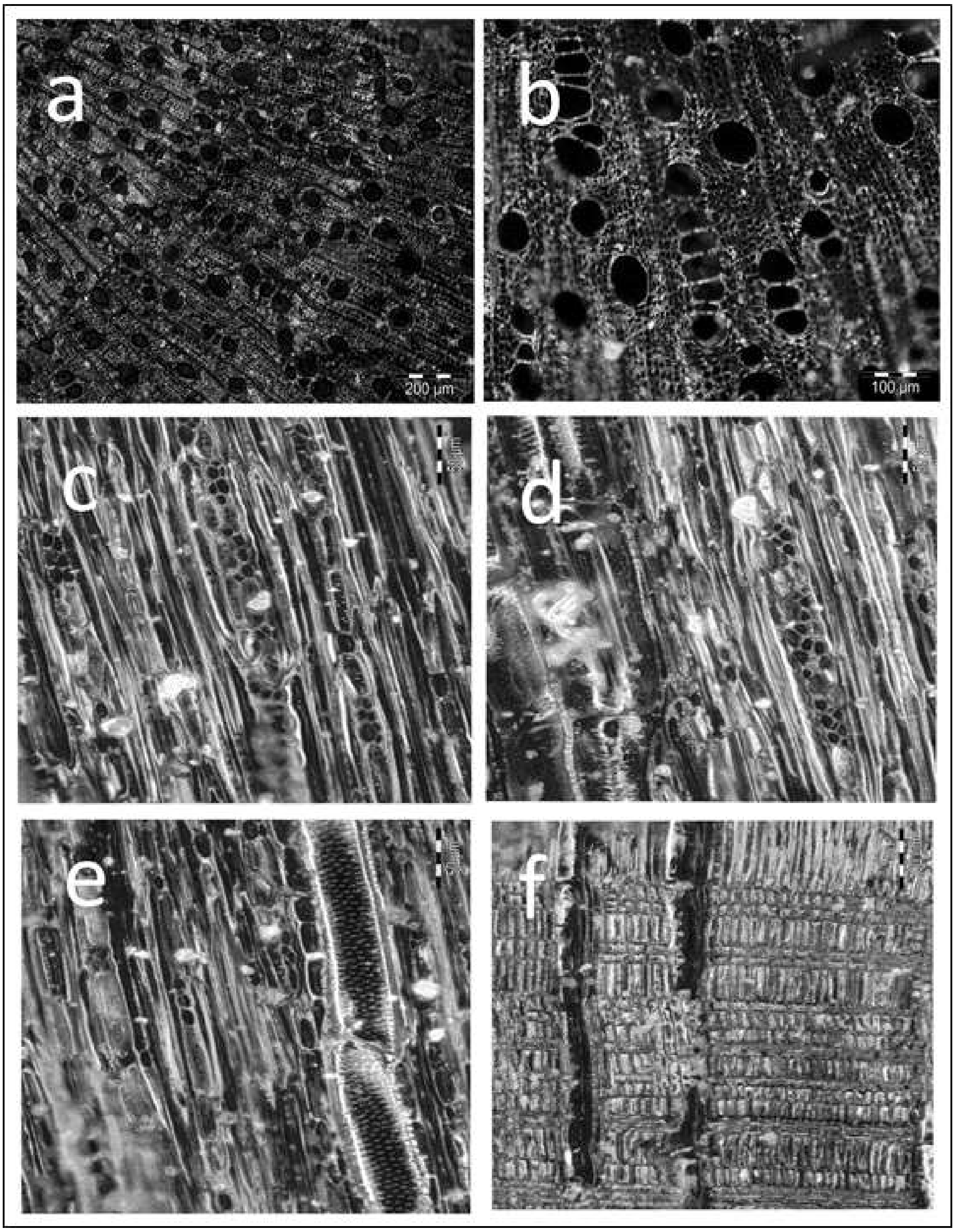

FIG. 4.9 *The microstructure of* G. occidentalis *showing (a) solitary and short radial multiple vessel arrangement; (b) diameter of the vessel lumina (55µm) and thin-thick fibres; (c)&(d) biserriate and triserriate rays along non-septate fibres; (e) parenchyma cells, vessel elements with simple perforation plates and alternating polygonal intervessel pits and (f) procumbent, square and upright ray cells. Scale bar on image (a)= 200µm, (b)& (f)= 100 µm, (c), (d) & (e)= 50 µm.*

4.2 Taxonomy of archaeological charcoal

4.2.1 Identified archaeological charcoal types

Nine hundred and eighty-five charcoal fragments were recovered from the exacvation, but only 911 fragments were big enough and preserved well enough for their microstructure to be studied in detail in the TS, TLS and RLS sections. Approximately 74 fragments (mostly from the Surface/Profile deposit and Spit 4) were too small for analysis. Out of the 911 charcoal fragments analysed, 318 fragments were identifiable. The 318 identifiable fragments were categorised into different charcoal 'Types' according their anatomical features (Appendix 6).

There are 60 'Types' of charcoal fragments identified from the archaeological assemblage of this study. These represent at least 60 different woody species that were collected by the LSA visitors at Klasies River (Appendix 6). As with the comparative collection, measurements of the vessel diameters (Appendix 6a), vessel frequency (Appendix 6b) and the measurements of the ray structure (Appendix 6c) are presented along with calculations of averages for the features.

Seventeen woody species were identified to genus or species level from the charcoal assemblage of this study (Table 4.2). Thirteen of the 17 taxa are described in literature as trees, while four are described as either tall or dwarf shrubs (Table 4.2). Eight out of the 17 species were identified using the comparative woody species collected from the contemporary Klasies River landscape, while nine species were identified using other southern African charcoal reference collections and the "InsideWood" database. The micrograph templates of all the taxonomically identified species in this study are presented in Appendix 7 along with the descriptions of each species according to IAWA terminology. The micrograph template of an archaeological fragment that was identified taxonomically as *Loxostylis alata*, for example, is presented in Figure 4.10. A species not identified in the charcoal assemblage, *Diospyros dichrophylla*, was identified by a seed (endocarp of a drupe) and another seed belonging to one of the species identified in the charcoal assemblage, *Sideroxylon inerme*, was also identified (Table 4.2).

TABLE 4.2 *All identified woody species, cf. marks species or genera that were not identified with certainty.*

Family	**Genus and species**	**Seed/charcoal data**	**Comparative collection used to identify species**
Anacardiaceae	*Loxostylis alata* (tree)	charcoal	Inside Wood
Anacardiaceae	*Protorhus longifolia* (tree)	charcoal	Allott (2006)
Anacardiaceae	*Searsia lancea* (tree)	charcoal	Allott (2006)
Asteraceae	*Metalasia* cf. *muricata* (shrub)	charcoal	Zwane
Asteraceae	*Tarchonanthus* cf. *littoralis* (tree)	charcoal	Zwane
Buddlejaceae	*Nuxia* cf. *floribunda* (tree)	charcoal	Zwane
Celastraceae	*Mystroxylon aethiopicum* (tree)	charcoal	Zwane
Celastraceae	*Pterocelastrus tricuspidatus* (tree)	charcoal	Zwane
Cunoniaceae	*Platylophus trifoliatus* (tree)	charcoal	Inside Wood
Ebenaceae	*Diospyros dichrophylla* (tree)	seed	Zwane
Ebenaceae	*Diospyros whyteana* (shrub)	charcoal	Allott (2006)
Ericaceae	*Erica* cf. *glandulosa* subsp. *fourcadei* (shrub)	charcoal	Zwane
Malvaceae	*Grewia occidentalis* (tree)	charcoal	Zwane
Malvaceae	*Hibiscus* cf. *tiliaceus* (tree)	charcoal	Allott (2006)
Podocarpaceae	*Podocarpus* cf. *latifolius* (tree)	charcoal	Allott (2006)
Rutaceae	*Zanthoxylum davyi* (tree)	charcoal	Zwane
Sapotaceae	*Sideroxylon inerme* (tree)	seed & charcoal	Zwane
Thymelaceae	*Passerina* sp. (shrub)	charcoal	Tusenius (1986: 135)

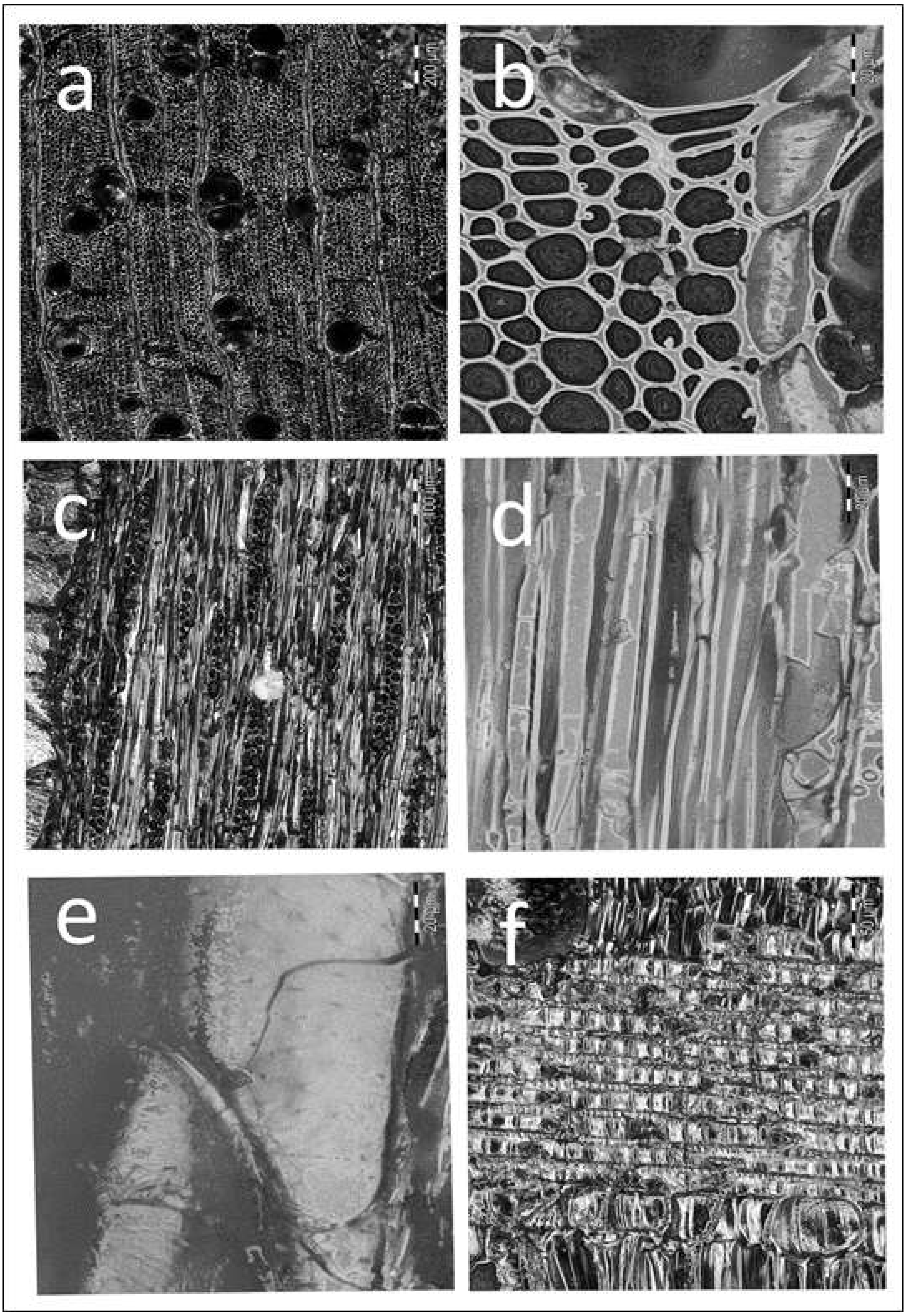

FIG. 4.10 *The microstructure of* L. alata *showing (a) the vessel arrangement; (b) fibre thickness/ fibre lumina; (c) the biserriate rays; (d) the septate and non-septate fibres; (e) the simple perforation plate and alternate intervessel pits and (f) the procumbent and square ray cells with crystals. Scale bar on image (a)= 200 µm, (b), (d) & (e)= 20 µm, (c)= 100 µm and (f)= 50 µm.*

4.2.2 Archaeological context of the identified species

As discussed in Chapter 3, four spits were excavated in each of the three squares, A15, B15 and B16 and small charcoal fragments were recovered from all spits (Fig. 4.11). The charcoal fragments were spread across the spits and squares and not concentrated in any specific areas.

FIG. 4.11 *The surface of Spit 1 in squares A15, B15 and B16after surface cleaning. (Image by S. Wurz)*

Spit 1

Charcoal remains were scattered randomly in the very soft, loose sediments of this spit. Big charcoal fragments (~2 cm), were recovered from among the shell remains (Fig. 4.12). The total frequency of charcoal fragments from all three squares of this spit was 230 (Table 4.3). These fragments belong to 33 different species (Table 4.4) and 13 were identified to genus or species level (Table 4.5).

FIG. 4.12 *Small charcoal fragments inside a marine shell recovered from Spit 1 of square B15. (Image by S. Wurz)*

Spit 2

Spit 2 was characterised by compact brown sediment with less shell debris and fewer artefacts compared to the first spit. Spit 2 layer had a volume of 0. 015 m^3 (Table 4.3). Charcoal fragments (n=173) were scattered through the spit and not localised in any way (Fig. 4.13). Only 44 of the charcoal fragments were identifiable and they were categorised into 28 different charcoal 'Types' representing 28 different species (Table 4.3), eight of which were identified to genus or species level (Table 4.4).

FIG. 4.13 *A charcoal fragment photographed in context in B15 Spit 2. (Image by S. Wurz)*

Spit 3

This spit contained very few organic remains such as bone, charcoal and broken shell remains compared to the first two spits (Fig. 4.14). A clear micro-layer of very compact blackened/burnt sediments was noted in square A15 of this spit; however, this micro-layer was not continuous over the other squares. The sediments in Spit 3 contained the lowest number of charcoal fragments (n=74) (Table 4.3). Thirty-seven of these fragments were preserved well enough to be studied in detail; they were found to belong to 28 different species (Table 4.3), four of which were identified to genus or species level (Table 4.4).

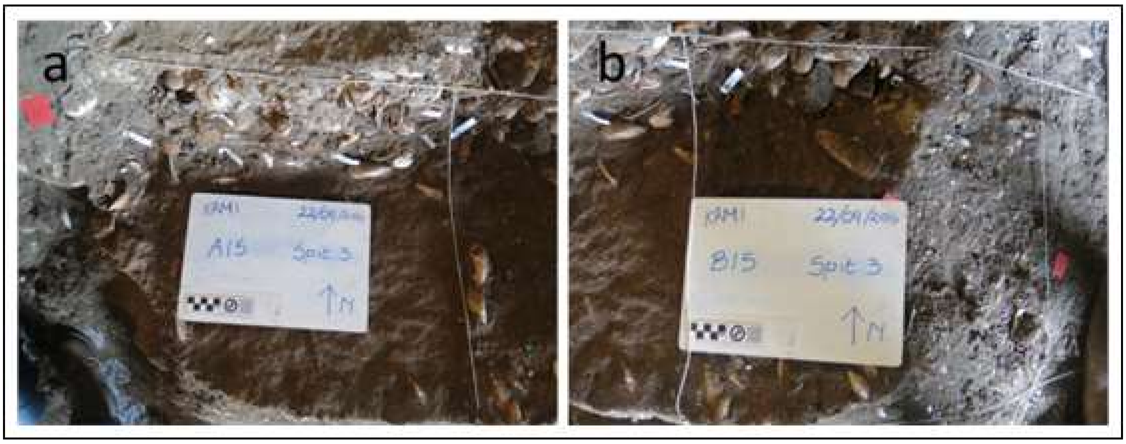

FIG. 4.14 *The top overview of Spit 3 in squares (a) A15 and (b) B15. (Image by S. Wurz)*

Spit 4

Spit 4 was characterised by much cultural material, dominated by many marine shells that were often broken. Charcoal remains from this spit, as well as other fragile organic material (fish and micro-mammal bones) were often found protected by marine shell (Fig. 4.15b). Spit 4 contained the most charcoal fragments (i.e. n= 394). One hundred and twenty-two charcoal fragments from this spit were large enough or well preserved enough to be identified. These were found to belong to 36 different 'Types' or species, of which 10 could be identified to genus or species level.

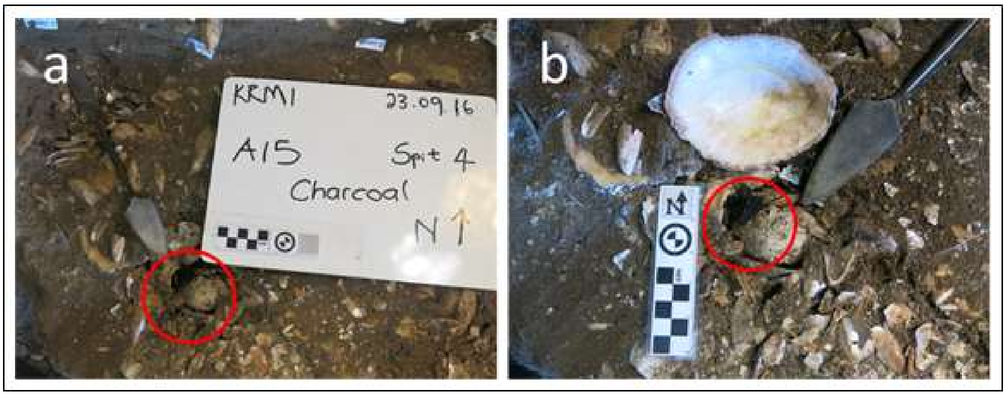

FIG. 4.15 *An overview of Spit 4 in square A15 showing (a) charcoal fragment* in situ *and (b) charcoal fragment that has been protected by shellfish. (Image by S. Wurz)*

TABLE 4.3 *The archaeological context of the fragments and charcoal types analysed. Asterisks * indicate n_i (identifiable fragments) percentage calculated from n.*

Layers (spits)	Volume in m^3	Fragments analysed (n)	Fragments identifiable (n_i) and % of n_i from n	Types (species) identified	Species (type) richness
Surface/ Profile Cleaning	0.023 (13.69%)	40 (4.39%)	7 (17.5%)*	1, 2, 4, 5, 60	5
Spit 1	0.057 (33.93%)	230 (25.25%)	108 (46.95%)*	2, 3, 4, 5, 6, 7, 8, 9, 10, 11,12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 32, 39, 44, 45, 47, 49, 55, 59	33
Spit 2	0.015 (8.93%)	173 (18.99%)	44 (25.43%)*	1, 2, 3, 5, 6, 7, 10, 12, 15, 22, 24, 25, 26, 27, 28, 29, 30, 35, 39, 45, 46, 47, 48, 49, 51, 52, 54, 59	28
Spit 3	0.032 (19.05%)	74 (8.12%)*	37 (50%)*	2, 4, 5, 6, 7, 11, 23, 26, 28, 29, 30, 34, 35, 36, 37, 38, 39, 44, 47, 57	20
Spit 4	0.042 (25.00%)	394 (43.25%)	122 (30.96%)*	2, 3, 4, 5, 7, 11, 12, 15, 19, 20, 21, 24,27, 28, 29, 30, 31, 33, 34, 35, 38, 39, 40, 41, 42, 43, 44, 46, 48, 49, 50, 51, 53, 56, 58, 59	36
Total	**0.168 (100%)**	**911 (100%)**	**318**	**60 (different types)**	

The species richness is highest in Spits 1 and 4. This is probably related to the high frequency of charcoal fragments recovered from Spits 1 (n= 230) and Spit 4 (n= 394). Less than a third (17 of 60) of the recovered charcoal 'Types' were identified.

TABLE 4.4 *The archaeological context of identified species and species richness within the excavated spits.*

Layers (spits)	Species identified taxonomically	Species richness
Surface/profile cleaning	*Nuxia* cf. *floribunda*	1
Spit 1	*N.* cf. *floribunda, Platylophus trifoliatus, Searsia lancea, Metalasia* cf. *muricata, Hibiscus* cf. *tiliaceus, Sideroxylon inerme, Passerina* sp.*, Grewia occidentalis, Protorhus longifolia, Zanthoxylum davyi, Podocarpus* cf. *latifolius, Pterocelastrus tricuspidatus, Mystroxylon aethiopicum*	13
Spit 2	*Platylophus trifoliatus, Metalasia* cf. *muricata, Zanthoxylum davyi, Pterocelastrus tricuspidatus, Mystroxylon aethiopicum, Loxostylis alata, Diospyros whyteana, Erica* cf. *glandulosa* subsp. *fourcadei*	8
Spit 3	*Platylophus trifoliatus, Podocarpus* cf. *latifolius, Loxostylis alata, Diospyros whyteana*	4
Spit 4	*Nuxia* cf. *floribunda, Platylophus trifoliatus, Metalasia* cf. *muricata, Grewia occidentalis, Protorhus longifolia, Pterocelastrus tricuspidatus, Loxostylis alata, Diospyros dichrophylla, Tarchonanthus* cf. *littoralis, Erica* cf. *glandulosa* subsp. *fourcadei*	10

4.2.3 The description, habitat preference and current distribution of the identified woody species

The woody species (identified in the charcoal and seed assemblage) are described in the literature as forest taxa although they also occur in a range of other habitats (Palgrave 1980; Germishuizen & Meyer 2003; Pooley 2006; Venter 2012; van Wyk & van Wyk 2013).

Anacardiaceae - *Searsia lancea* (willow-crowberry)

This small to medium sized, evergreen tree, occurs in a variety of habitats; it is often found in woodlands, along river and stream banks and on termite mounds (Palgrave 1980: 481). *Searsia lancea* is widely distributed over the interior parts of southern Africa over a variety of altitudes often on calcareous substrates (Palgrave 1980; Germishuizen & Meyer 2003; van Wyk & van Wyk 2013). It tolerates a wide range of environments including both tropical and temperate climatic settings over southern Africa. Hence it occurs over the SRZ, YRZ and WRZ (Fig. 4.16). This tree is drought and frost resistant (van Wyk & van Wyk 2013). According to van Wyk and van Wyk (2013), *S. lancea* is presently distributed on the Klasies River landscape, Tsitsikamma Coast.

Malvaceae - *Grewia occidentalis* (crossberry)

Grewia occidentalis is a scrambling shrub or small tree (Fig. 4.16) (van Wyk & van Wyk 2013). The shrub or tree tolerates the climatic conditions of both tropical and temperate climates (van Wyk & van Wyk 2013). However, this species appears to be distributed over areas that receive high amounts of rainfall along the coastal and high-altitude areas (Cape Fold Mountains, uKhahlamba-Drakensberg Mountains, Lebombo and Bvumba Mountains) of southern Africa (Fig. 4.16b). While it is limited to the low-lying areas over the south-western and southern Cape coast (or YRZ and WRZ) this shrub or tree is distributed on both high and low altitudes over the east and interior areas (or SRZ). The distribution of this species is far more extensive over the SRZ than the WRZ. It was identified at Klasies River by van Wijk and colleagues (2017) between 2013 and 2015 as well as during the collection of comparative wood used in this study. *Grewia occidentalis* was identified in sub-area Area 4 of the area surveyed in this study (Table 4.1).

Ebenaceae - *Diospyros whyteana* (bladdernut)

This evergreen shrub or small tree (Fig. 4.16c) (Pooley 2006; van Wyk & van Wyk 2013). It occurs in scrub and forest, often in rocky places as well as on mountain slopes (Palgrave 1980; van Wyk & van Wyk 2013). The bladdernut is distributed over the SRZ, YRZ as well as the WRZ (Fig. 4.16c) (van Wyk & van Wyk 2013).

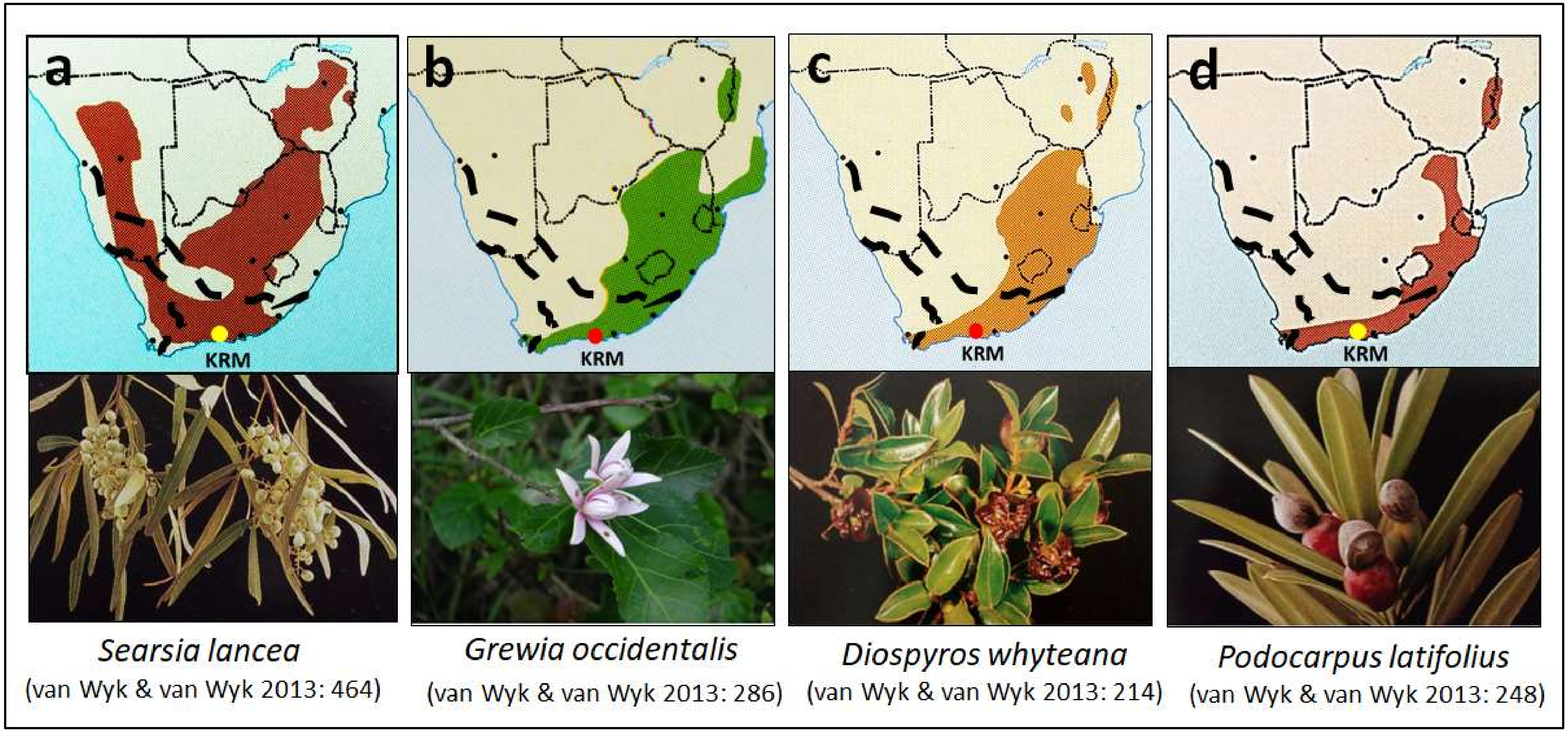

FIG. 4.16 *The current distribution of* Searsia lancea, Grewia occidentalis, Diospyros whyteana *and* Podocarpus latifolius *over southern Africa according to van Wyk and van Wyk (2013). The green shaded distributions indicate that the species is endemic to southern Africa. The location of the Klasies River caves on the maps is indicated by KRM. (Image of leaf and flowers of* G. occidentalis *courtesy of M. Bamford)*

Over the south-west coast and the southern Cape, *D. whyteana* occurs at low altitudes including along the Tsitsikamma Coast (Palgrave 1980; van Wyk & van Wyk 2013). In the eastern interior and east coastal areas, this species is distributed over high and low altitude areas, below and above the escarpment as well as along mountain ranges, i.e. uKhahlamba-Drakensberg Mountains, Lebombo and Bvumba Mountains (Palgrave 1980; van Wyk & van Wyk 2013). This species was not identified by the botanists at Klasies River between 2013 and 2015 (van Wijk *et al.* 2017) nor in 2016 during the botanical survey for this study.

Podocarpaceae - *Podocarpus latifolius* (real yellowwood)

This is a medium to large evergreen tree which can grow up to 30 m in height (Fig. 4.16d) (Palgrave 1980). It occurs in Afromontane and coastal forests (Palgrave 1980). Real yellowwood is distributed across tropical and temperate climates in southern Africa over an altitude range of 10 – 2200 m AMSL (Germishuizen & Meyer 2003). It can withstand some frost and thrives in a cool climate with high rainfall (Pooley 2006). The tree is adapted to the parts of the subcontinent that receive high amounts of precipitation (and orographic precipitation) through the SRZ, YRZ and WRZ (Fig. 4.17d) (van Wyk & van Wyk 2013). These areas include the Cape Fold Belt in the southern Cape and the uKhahlamba-Drakensberg Mountains, Lebombo Mountains and the Bvumba Mountains on the east escarpment (Palgrave 1980; van Wyk & van Wyk 2013). Real yellowwood was not identified by the botanists at Klasies River between 2013 and 2015 (van Wijk *et al.* 2017) nor in 2016 during the botanical survey for this study.

Sapotaceae - *Sideroxylon inerme* (white milkwood)

This is an evergreen shrub or small tree that grows up to 10 m (Fig. 4.17a) (Palgrave 1980). *Sideroxylon inerme* occurs in coastal dune thicket and forest, also on bushveld, often in termitaria (Palgrave 1980; van Wyk & van Wyk 2013). The white milkwood is distributed mostly along the low-lying coastal areas in the SRZ, YRZ and WRZ (Fig. 4.17a) (van Wyk & van Wyk 2013). In the SRZ and along the border of South Africa, Swaziland and Mozambique, this tree occurs at low and high altitudes (i.e. 2- 1092 m AMSL) (Germishuizen & Meyer 2003; van Wyk & van Wyk 2013). The species tolerates both the tropical and temperate climates. At Klasies River, white milkwood grows in a number of areas including Areas 2, 3 and 4 of this study (Table 4.1).

Asteraceae - *Metalasia muricata* (white flowerbush)

Metalasia muricata is a much-branched rounded shrub or small tree, with erect branches (van Wyk & van Wyk 2013). It occurs on coastal dune sand and in mountainous areas, often along streams or between rocks. *Metalasia muricata* thrives under the conditions of both tropical and temperate climates, thus it is distributed over all three rainfall regions of southern Africa: SRZ, YRZ and WRZ (Fig. 4.18b) (van Wyk & van Wyk 2013). It is found along the coastal regions of the east coast, southern Cape and the west coast commonly within an altitude of 5 – 300 m AMSL (Germishuizen & Meyer 2003). According to van Wyk and van Wyk (2013) this species is not found along the Tsitsikamma Coast; however, van Wijk and colleagues (2017: 20) identified it within a 5 km radius of the Klasies River cave sequence. It was also identified in Area 3 of this study (Table 4.1).

Celastraceae - *Pterocelastrus tricuspidatus* (candlewood)

Pterocelastrus tricuspidatus is a small or medium-sized evergreen tree (Fig. 4.17c) (van Wyk & van Wyk 2013). This species occurs along forest margins, in dune scrub and in dry forest (Venter 2012). Distributed almost entirely within the YRZ, the candlewood is adapted to and endemic to the combined influence of both tropical and temperate climates (Fig. 4.17c). This species is found within the altitude range of 5 – 1615 m AMSL (Germishuizen & Meyer 2003). This tree is also distributed to a small degree in the SRZ and WRZ. It was identified at Klasies River during the botanical survey of this study as well as by van Wijk and colleagues between 2013 and 2015 (2017).

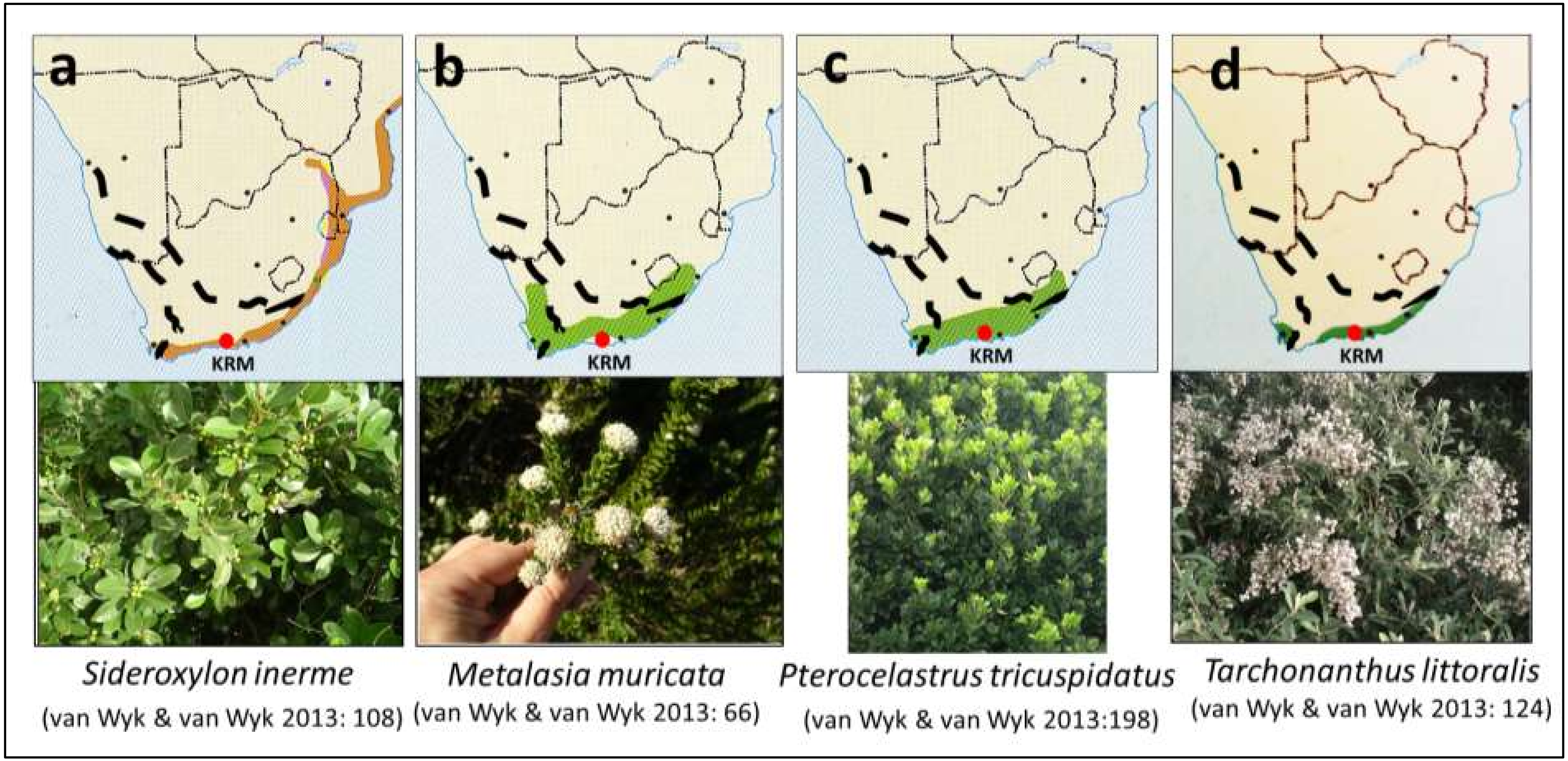

FIG. 4.17 *The current distribution of* Sideroxylon inerme, Metalasia muricata, Pterocelastrus tricuspidatus *and* Tarchonanthus littoralis *over southern Africa according to van Wyk and van Wyk (2013). The green shaded distributions indicate that the species is endemic to southern Africa.The location of the Klasies River caves on the maps is indicated by KRM. (Images of leaves and flowers were all taken from Klasies River landscape and courtesy of M. Bamford and S. Wurz)*

Asteraceae - *Tarchonanthus littoralis* (coastal camphorbush)

Tarchonanthus littoralis is a small to medium sized evergreen tree with separate sexes on different plants (van Wyk & van Wyk 2013). This tree occurs in forest and thicket and usually in coastal areas (van Wyk & van Wyk 2013). It can withstand coastal winds and severe frost and drought (Venter 2012). Occurring between the altitudes of 300 and 700 m AMSL, this species tolerates the combination of both tropical and temperate climates (Germishuizen & Meyer 2003). This is evidenced by a distribution pattern that is mostly over the YRZ and, to a small degree, in the SRZ and WRZ (Fig. 4.17d) (van Wyk & van Wyk 2013). It was identified within a 5 km radius of Klasies River main site (van Wijk *et al.* 2017) as well as in Area 2 of this study.

Celastraceae - My*stroxylon aethiopicum* (Cape kooboo-berry)

This is a very variable evergreen shrub or small to medium sized tree (Fig. 4.18a) (van Wyk & van Wyk 2013). *Mystroxylon aethiopicum* occurs in bushveld, evergreen forests and coastal scrub and is endemic to the southern parts of the Western and Eastern Cape (Venter 2012; van Wyk & van Wyk 2013). The growth of *M. aethiopicum* along the southern Cape and south-eastern coast seems to be favoured by the presence of both tropical and temperate climatic conditions within the YRZ (Fig. 4.18a) (van Wyk & van Wyk 2013). However, the distribution of this species extends into the SRZ (van Wyk & van Wyk 2013). Currently, *M. aethiopicum* occurs strictly along the coastal areas (including at the Tsitsikamma Coast) between the altitudes of 10 and 1000 m AMSL (Germishuizen & Meyer 2003). It was identified by van Wijk and colleagues (2017) as well as in Area 2 of this study.

Anacardiaceae - *Loxostylis alata* (tarwood)

Loxostylis alata is a small to medium sized evergreen tree with separate sexes on different plants (van Wyk & van Wyk 2013). It occurs along forest margins and on the outcrops of sandstone and quartzite (van Wyk & van Wyk 2013). It is endemic to southern Africa and grows along river banks and fringing forests (Palgrave 1980).

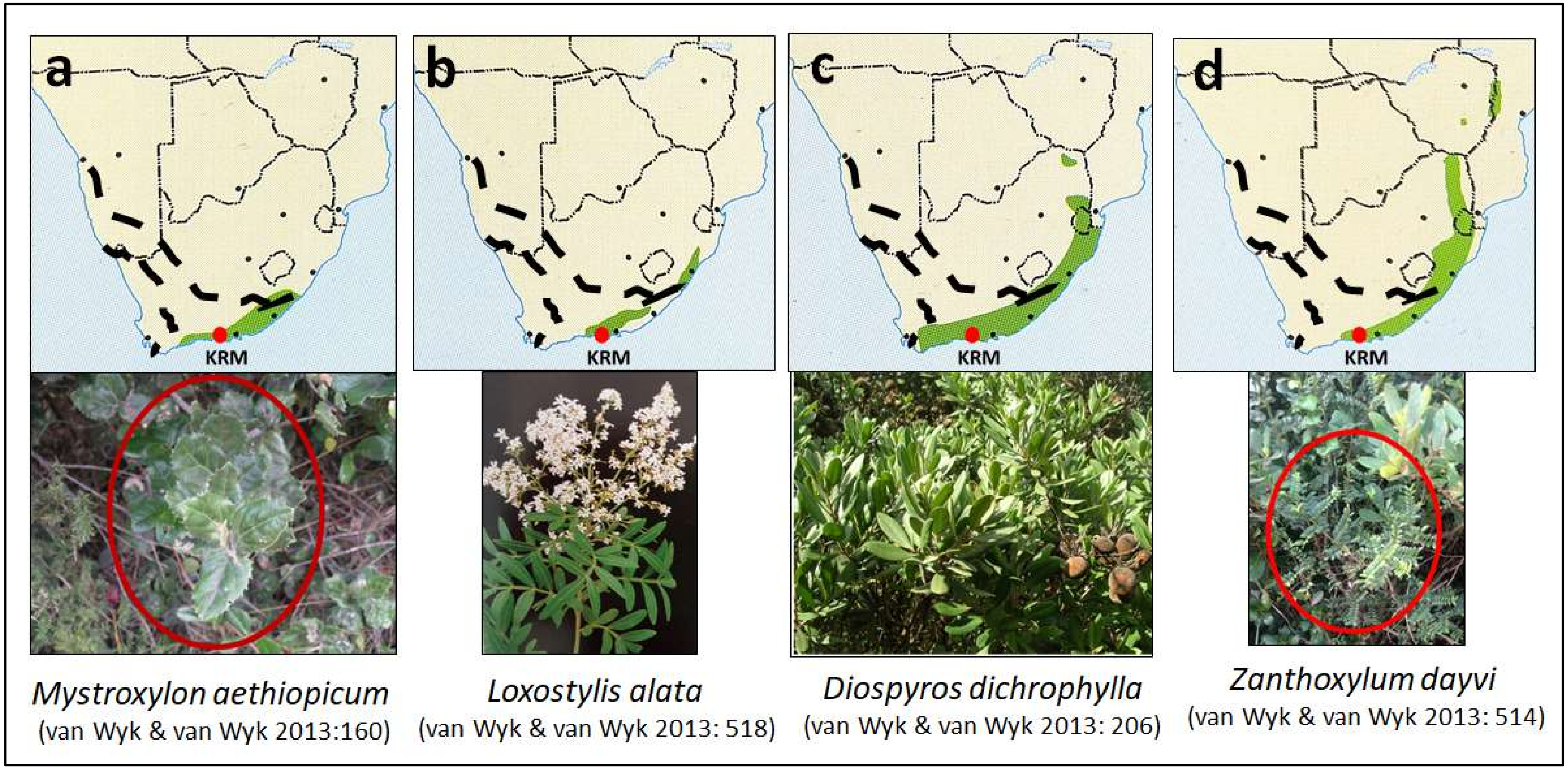

FIG. 4.18 *The current distribution of* Mystroxylon aethiopicum, Loxostylis alata, Diospyros dichrophylla *and* Zanthoxyllum davyi*. The green shaded distributions indicate that the species is endemic to southern Africa. The location of the Klasies River caves on the maps is indicated by KRM. (Images of* M. aethiopicum*,* D. dichrophylla *and* Z. davyi *were taken from Klasies River landscape by M. Bamford and S. Wurz)*

Tarwood is adapted mostly to the mixed climatic conditions offered by the YRZ on the southern Cape coast, including in the Tsitsikamma Coast (Fig. 4.19b) (van Wyk & van Wyk 2013). This species' occurrence over the SRZ indicates that it can also tolerate an exclusively tropical climatic setting (van Wyk & van Wyk 2013). *Loxostylis alata* was not identified at Klasies River, neither in the survey for this study nor during the general botanical study River between 2013 and 2015 (van Wijk *et al.* 2017).

Ebenaceae - *Diospyros dichrophylla* (star-apple)

Diospyros dichrophylla is a shrub or small to medium-sized tree that grows up to 3 m (Fig. 4.18c) (Palgrave 1980). It occurs in coastal scrub, open grassland, wooded ravines and forest habitats (Palgrave 1980; van Wyk & van Wyk 2013). The distribution of *D. dichrophylla* along the southern Cape coast (YRZ) and the east coast (SRZ) suggests that this species prefers the influence of a tropical and mixed tropical and temperate climates (Fig. 4.18c) (van Wyk & van Wyk 2013). The species occurs at altitudes ranging between 10 and 1500 m AMSL (Germishuizen & Meyer 2003). At Klasies River it was identified adjacent to Cave 4 by van Wijk and colleagues (2017) and collected from Area 1 of this study (Table 4.1).

Rutaceae - *Zanthoxylum davyi* (forest knobwood)

This medium to large tree (Fig. 4.18d) (van Wyk & van Wyk 2013) occurrs in coastal and mistbelt forests from Knysna to Zimbabwe. *Z. davyi* is often found as part of the main elements of montane forests (Palgrave 1980; van Wyk & van Wyk 2013). *Zanthoxylum davyi* is distributed and endemic over the SRZ and YRZ, suggesting that this species has a strong preference for a tropical climate (Fig. 4.18d) (van Wyk & van Wyk 2013). In the YRZ this species thrives along the coastal (including along the Tsitsikamma Coast) areas while in the SRZ it occurs from the coastal areas to the high altitude or escarpment areas. At Klasies River, this species was identified during the botanical survey of this study and collected from Area 2 (Table 4.1).

Buddlejaceae - *Nuxia floribunda* (forest elder)

Nuxia floribunda is a small to medium-sized evergreen tree with a densely leafy, somewhat rounded crown (Fig. 4.19a) (Pooley 2006). *Nuxia floribunda* occurs in and around forests and tolerates mild frost (Pooley 2006; van Wyk & van Wyk 2013). The forest elder tolerates a tropical climatic setting over the southern African landscape. The distribution of this species extends from the southern Cape (YRZ), where it is limited to the coastal regions (Fig. 4.19a) (van Wyk & van Wyk 2013) to the SRZ. In the SRZ, this species is found both on the coast and at high altitudes, i.e. 30 -1980 m AMSL (Germishuizen & Meyer 2003). The high-altitude areas include the mountain ranges further north: uKhahlamba-Drakensberg Mountains and the Lebombo and Bvumba Mountains along the east escarpment. At Klasies River this species was collected in the Milkwood Forest during the survey for this study (Table 4.1).

Anacardiaceae - *Protorhus longifolia* (red-beech)

This is a medium to large evergreen tree (van Wyk & van Wyk 2013). *Protorhus longifolia* occurs in coastal and montane forests (van Wyk & van Wyk 2013) as well as in open woodlands and along river banks (Palgrave 1980) and it tolerates mild frost (Pooley 2006). The current distribution of *P. longifolia* indicates that this species thrives under tropical climate conditions. Although the species' distribution extendsfrom the YRZ in the south-east coast, the growth of the species within this region tends towards the SRZ, suggesting that it prefers a warmer, tropical climate. (Fig. 4.19b) (van Wyk & van Wyk 2013). This perennial tree occurs in low (coastal) and high-altitude areas within a range of 12 – 1980 m AMSL (Germishuizen & Meyer 2003) and it is not found on the Tsitsikamma Coast today.

Malvaceae - *Hibiscus tiliaceus* (lagoon hibiscus)

Hibiscus tiliaceus is a shrub or small tree (Fig. 4.20c) (van Wyk & van Wyk 2013). The distribution of *H. tiliaceus* over southern Africa is limited along the coastal lowland areas. These areas include the entire east coast, which is located within the SRZ and

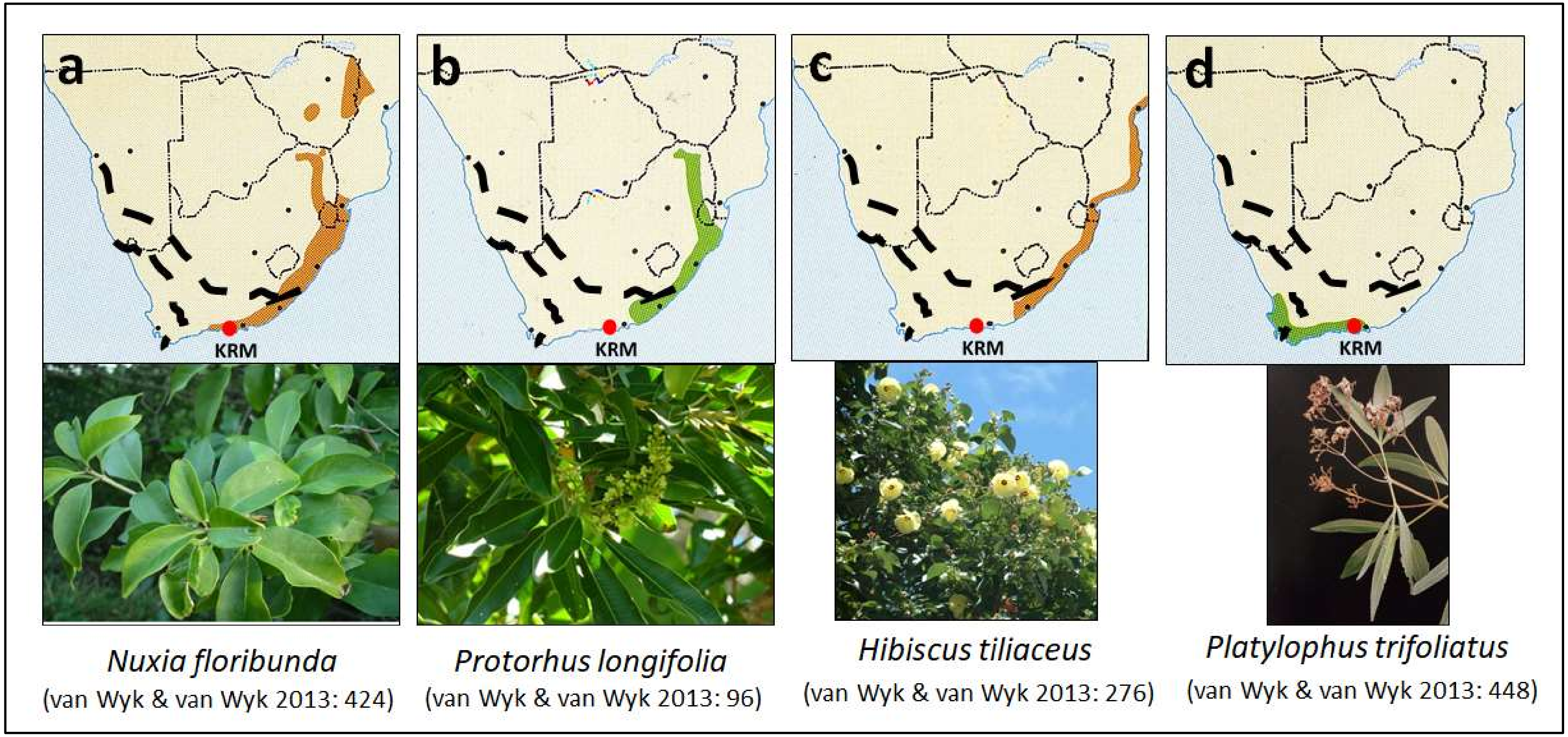

FIG. 4.19 *The current distribution of* Nuxia floribunda, Protorhus longifolia, Hibiscus tiliaceus *and* Platylophus trifoliatus*. The green shaded distributions indicate that the species is endemic to southern Africa. The location of the Klasies River caves on the maps is indicated by KRM. (Image of* N. floribunda *leaves were taken from Klasies River landscape by M. Bamford)*

slightly in the south-east coast, which is situated within the YRZ (Fig. 4.19c) (van Wyk & van Wyk 2013). This species is currently not distributed on the Tsitsikamma Coast and was neither identified by the botanists at Klasies River between 2013 and 2015 nor during field survey for this study in 2016.

Cunoniaceae - *Platylophus trifoliatus* (white alder)

This is a small to large evergreen tree with pale yellowish-white to dark brown wood. *Platylophus trifoliatus* occurs in forest, often along stream banks (Palgrave 1980). The geographical limit for the distribution of white alder is towards the west coast and southern Cape, including the Tsitsikamma Coast (Fig. 4.19d) (van Wyk & van Wyk 2013). The occurrence of this species in the YRZ indicates that *P. trifoliatus* tolerates the combined influence of both tropical and temperate climates; however, it has a strong preference for temperate climatic conditions as suggested by its distribution that is localised more towards the west part of the YRZ (van Wyk & van Wyk 2013). *P. trifoliatus* is also distributed over the WRZ where, like in the YRZ, it grows along the coastal regions within the altitude range of 45 – 765 m AMSL (Germishuizen & Meyer 2003).

Ericaceae - *Erica glandulosa* subsp. *fourcadei* (Fourcade's heath)

Erica glandulosa subsp. *fourcadei* is a coastal, single to multi-stemmed shrub growing up to 1.2 m tall (Fig. 4.20) (pza.sanbi.org). Van Wijk and colleagues (2017) identified *Erica glandulosa* subsp. *fourcadei* within a 5 km radius of the Klasies River cave sequence. The shrub is tolerant of acidic and neutral soils and can withstand salt-laden winds and dry conditions (pza.sanbi.org). This shrub is widespread and commonly found in nature reserves and conserved areas along the mountains and coastal plains of the southern and western parts of the Eastern Cape Province and into the Western Cape Province. According to SANBI's (PlantZAfrica) online database of southern Africa's plants, Fourcade's heath occurs in a narrow band along southern Cape coast from George to Cape St Francis (Fig. 4.20) (pza.sanbi.org). This species was identified at Klasies River on the lower eastern edge of Cave 1c (van Wijk *et al.* 2017: 22). It was also identified on a north-west-facing steep slope that is referred to as Area 2 in section

4.1.1 of this study. Van Wijk and colleagues (2017: 16) described this area as containing thicket and fynbos vegetation elements.

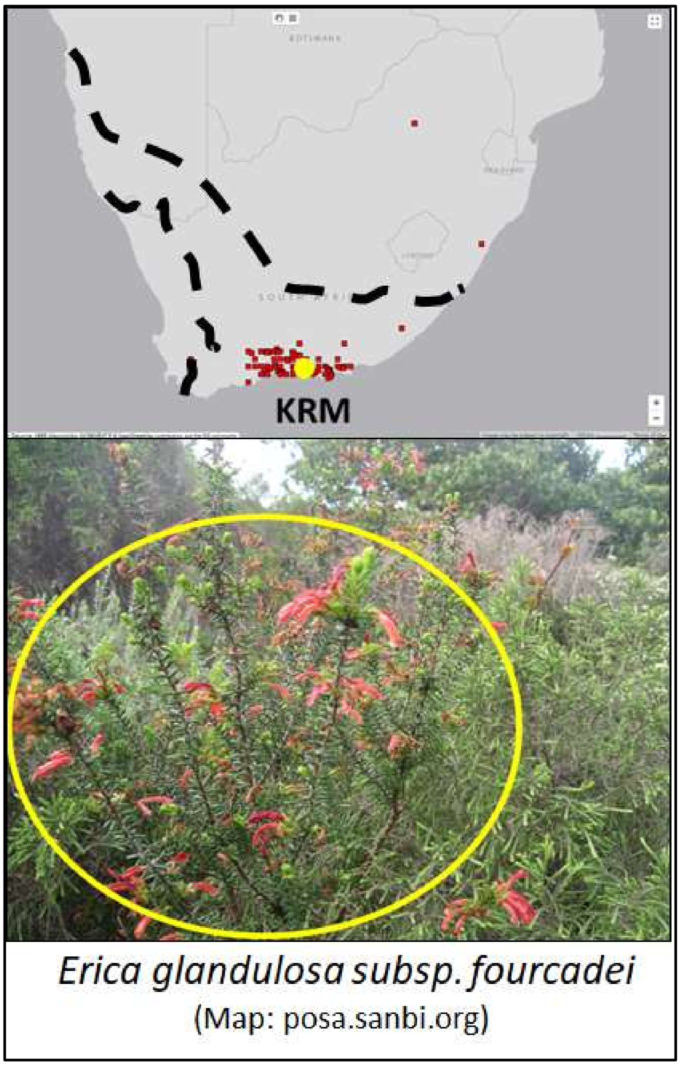

FIG 4.20 *The distribution of* E. glandulosa *subsp.* fourcadei *between George and Cape St Francis is indicated by a green streak. The location of the Klasies River main site is indicated by KRM. (Image of* E. glandulosa *subsp.* fourcadei *was taken from Klasies River landscape by M. Bamford) (Map source: dmaps.com).*

Thymelaceae- *Passerina* sp.

The archaeological sample was identified to genus level and matches *Passerina* sp. identified near Colwinton Rock Shelter (Tusenius 1986). Tusenius (1986: 80) described *Passerina* species generally as "heathland elements" of the southern Cape and Drakensberg regions. The habitat of the *Passerina* sp. identified at Klasies River is unknown, hence its distribution and environmental tolerances are unknown.

In summary, fifteen of the eighteen species identified archaeologically occur along the Tsitsikamma Coast (or at Klasies River) today. These are: *Loxostylis alata*, *Searsia lancea*, *Metalasia* cf. *muricata*, *Tarchonanthus* cf. *littoralis*, *Nuxia* cf. *floribunda*, *Mystroxylon aethiopicum, Pterocelastrus tricuspidatus*, *Platylophus trifoliatus, Diospyros dichrophylla*, *Diospyros whyteana*, *Erica* cf. *glandulosa* subsp. *fourcadei, Grewia occidentalis*, *Podocarpus* cf. *latifolius*, *Zanthoxylum davyi* and *Sideroxylon inerme* (Table 4.5). Ten of these species were identified in the contemporary Klasies River landscape by van Wijk and colleagues (2017).

Species such as *Searsia lancea*, *Diospyros whyteana*, *Grewia occidentalis*, *Podocarpus* cf. *latifolius* and *Sideroxylon inerme* currently occur in both tropical and temperate climates and their distribution indicates tolerance of more than one climatic regime. However, while tolerant of more than one climate, *Diospyros whyteana*, *Grewia occidentalis*, *Podocarpus* cf. *latifolius* and *Sideroxylon inerme* grow mostly in areas that receive high precipitation (Figs. 4.16 and 4.17). This is true especially, for *Diospyros whyteana*, *Grewia occidentalis* and *Podocarpus latifolius* whose current distribution ranges from low lying coastal (southern and eastern) regions to high altitude areas of southern Africa (Fig. 4.18).

Six species, *Metalasia muricata, Pterocelastrus tricuspidatus*, *Tarchonanthus* cf. *littoralis, Loxostylis alata*, *Mystroxylon aethiopicum* and *Erica* cf. *glandulosa* subsp. *fourcadei* tolerate mild climate conditions. This is evidenced by their distributions which occur mostly in the southern Cape, although these species occur in the WRZ and SRZ (Figs. 4.17, 4.18 and 4.20). Five species were found to be widely distributed over the SRZ of southern Africa, excluding the dry inland areas. These are *Diospyros dichrophylla*, *Zanthoxylum davyi*, *Nuxia* cf. *floribunda*, *Protorhus longifolia* and *Hibiscus* cf. *tiliaceus*. The distribution of these species begins from the low-lying southern Cape coast up the east coast and into the high-altitude parts of the east coast (Figs. 4.20 and 4.21). However, *Protorhus longifolia* and *Hibiscus* cf. *tiliaceus* do not occur on the Tsitsikamma coast where Klasies River main site is located.

TABLE 4.5 *The distribution and habitat of all the species identified from the archaeological assemblage. Species are listed in the alphabetical order of their family names.The table continues to page 73.*

Species	**Biome** (Mucina & Rutherford 2006)	**Vegetation type** (Germishuizen & Meyer 2003)	**Topography, terrain, lithology** (van Wyk & van Wyk 2013) (pza.sanbi.org)	**Habitat** (van Wyk & van Wyk 2013) (pza.sanbi.org) (Palgrave 1980)	**Rainfall zone** (Chase & Meadows 2007) (van Wyk & van Wyk 2013)	**Frost tolerence** (pza.sanbi.org)	**Drought tolerance** (pza.sanbi.org)
Loxostylis alata	Thicket, Fynbos	Shrub/tree	Outcrops of sandstone and quartzite	Forest margins, beside rivers	YRZ, SRZ	Tolerates light frost	Drought resistant
Protorhus longifolia	Afrotemperate Forest	Tree	Rocky outcrops	Coastal and montane forest, along river banks	YRZ, SRZ	Tolerates mild frost	Drought resistant
Searsia lancea	Thicket, Afrotemperate Forest	Tree	Calcareous soil substrates	Wide range of habitats	YRZ, SRZ, WRZ	Can tolerate some frost	
Metalasia cf. *muricata*	Thicket, Coastal vegetation, Fynbos	Shrub	Coastal dunes, mountainous areas	Along streams or between rocks	YRZ, SRZ, WRZ	Frost tolerant	Drought resistant
Tarchonanthus cf. *littoralis*	Thicket, Coastal vegetation, Afromontane Forest, Fynbos	Tree/shrub	Hillsides and coastal dunes	Dunes and riverbanks	YRZ, SRZ, WRZ	Can tolerate some frost	Drought resistant
Nuxia cf. *floribunda*	Afrotemperate Forest	Tree	Mountainous areas	In and around forest, frequently along watercourses	YRZ, SRZ	Relatively sensitive to frost	Relatively sensitive to drought
Mystroxylon aethiopicum	Thicket, Afrotemperate Forest, Coastal vegetation	Tree	Rocky ridges and termitaria	Fringes rivers	YRZ, SRZ	Can tolerate some frost	
Pterocelastrus tricuspidatus	Thicket, Coastal vegetation, Afromontane Forest, Fynbos	Shrub/tree	Rocky outcrops, dunes	Forest margins, in drier forest, dune scrub	YRZ, SRZ, WRZ	Frost tolerant	

Species	**Biome** (Mucina & Rutherford 2006)	**Vegetation type** (Germishuizen & Meyer 2003)	**Topography, terrain, lithology** (van Wyk & van Wyk 2013) (pza.sanbi.org)	**Habitat** (van Wyk & van Wyk 2013) (pza.sanbi.org) (Palgrave 1980)	**Rainfall zone** (Chase & Meadows 2007) (van Wyk & van Wyk 2013)	**Frost tolerence** (pza.sanbi.org)	**Drought tolerance** (pza.sanbi.org)
Platylophus trifoliatus	Afromontane Forest	Tree	Protected, forested kloofs	Moist to wet habitat, mostly along stream banks	YRZ, WRZ	Sensitive to frost	
Diospyros dichrophylla	Thicket, Coastal vegetation, Afromontane Forest, Fynbos	Shrub	Sandy coastal flats, rocky hillsides	Coastal scrubland, open grassland, wooded ravines, along forest margins	YRZ, SRZ	Can tolerate some frost	Drought tolerant
Diospyros whyteana	Thicket, Afrotemperate Forest	Tree	Mountain slopes and rocky places	Scrubland and forest, often along rocky places	YRZ, SRZ, WRZ	Can tolerate some frost	
Erica cf. *glandulosa* subsp. *fourcadei*	Fynbos	Shrub	Mountain slopes and lowlands			Sensitive to frost	
Grewia occidentalis	Thicket, Afrotemperate Forest, Coastal vegetation	Tree/shrub	Coastal dunes, mountainous areas	Forest margins in bushveld, wooded grassland	YRZ, SRZ, WRZ	Tolerates light frost	Drought resistant
Hibiscus cf. *tiliaceus*	Afrotemperate Forest	Tree		Along the coast, fringing lagoons and rivers	YRZ, SRZ	Sensitive to frost	
Podocarpus cf. *latifolius*	Afrotemperate Forest	Tree	Mountaneous areas	Afromontane and coastal forest	YRZ, SRZ, WRZ	Tolerates light frost	
Zanthoxylum davyi	Afrotemperate Forest	Tree		Montane forest occurs as a canopy constituent	YRZ, SRZ		
Sideroxylon inerme	Thicket, Coastal vegetation, Afromontane Forest, Fynbos	Tree	Coastal dunes	Coastal dune forest and thicket, almost always in coastal woodlands and also in littoral forests	YRZ, SRZ, WRZ	Sensitive to frost	

The distribution of *Passerina* sp. is unknown. The distribution of *Platylophus trifoliatus* extends from the Tsitsikamma Coast to the coastal areas of the west coast. The western part of southern Africa experiences a temperate climate associated with winter rainfall and therefore the presence of *P. trifoliatus* indicatesthese environmental conditions.

Despite the observed preferences for specific climatic settings, the distribution of each of the species, whether predominantly in the SRZ, WRZ or YRZ, overlaps with other rainfall zones. Table 4.8 presents the summary of the distribution of all (n=18) the species identified from the archaeological assemblage across the rainfall regions. The majority (n=17) of the species occur, in varying degrees, over the YRZ (n=17) while the minority of the species (n=9) tolerates environmental conditions associtated with the WRZ. A total of 16 species have their distribution over the SRZ. Figure 4.21 illustrates the three rainfall regions as well as the species that occur in each region. *Erica* cf. *glandulosa* subsp. *fourcadei* occurs exclusively in the YRZ. This illustration excludes *Passerina* sp. because the distribution of this species is unknown (Fig. 4.21). Eight species have a distribution over all three rainfall zones, seven species are distributed over SRZ and YRZ, while only one species is distributed exclusively in the YRZ and the WRZ (Fig. 4.21).

Van Wijk and colleages (2017) identified thicket, afrotemperate forest, coastal and fynbos vegetation around Klasies. Of the 18 species identified, seven species are Fynbos species, seven are coastal vegetation, 10 species are thicket vegetation and 14 species are classified as afrotemperate forest species (Table 4.8).

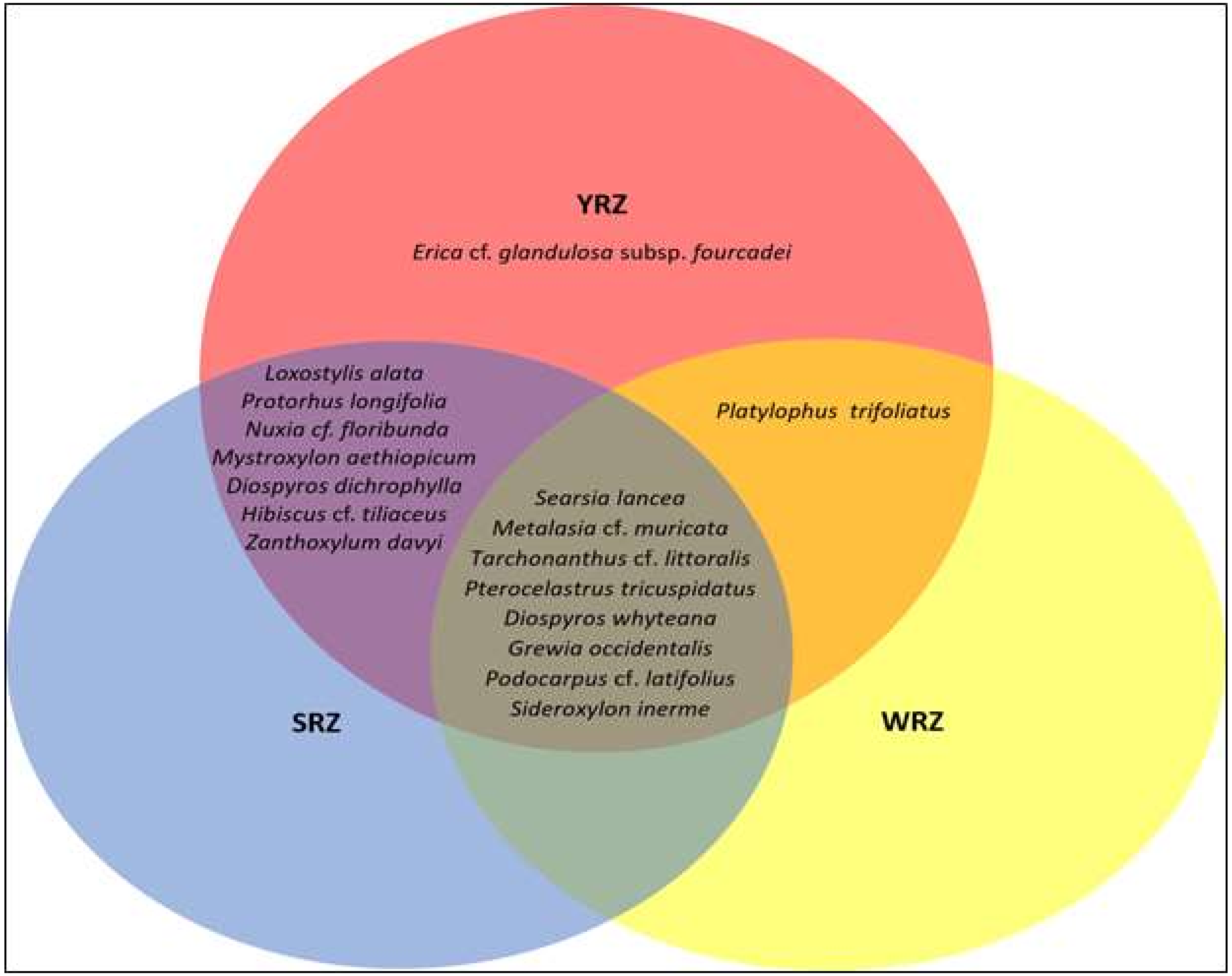

FIG. 4.21 *A Venn diagram of the distribution of all species across rainfall zones SRZ, YRZ and WRZ. Species are listed in the alphabetical order of their family names.*

4.3 Results of the analysis of the wood anatomical structure

The anatomical microstructure, i.e. vessel structure of the comparative vs. archaeological species was used to understand the difference in the water uptake of the species within the two assemblages. This in turn was used to estimate the relative abundance of water or rainfall during the growth of the two woody vegetation sets around Klasies River.

4.3.1 The wood anatomical structure of contemporary comparative species

The anatomical structure of all the comparative species was analysed and the results are presented in Table 4.6 below. All 50 species were considered for the calculation of the 'Vulnerability Indices'(VI). However, because of the difficulty in viewing some of the anatomical features in some species 48 comparative species were included in the analysis of the microstructure. The diameter of the vessel lumina of the comparative species was measured from all 48 species. They ranged between 17.12 µm (*Stoebe plumosa*) and 72 µm (*Rhoicissus tridentata*). The average (or mean value) of all the vessel diameter measurements is 36.52 µm.

TABLE 4.6 *The anatomical structure of comparative woody species from the Klasies River landscape. V.diam= Diameter of the vessel lumina in µm, V.freq=vessel frequency per mm^2, VI.= 'Vulnerability Indices'. Species are listed according to the alphabetical order of the families.* *The table continues to page 77.*

Genus & species	Voucher #	V.diam (µm)	V.freq (per mm^2)	VI (V.diam/freq)
Exomis sp.	BZ069	55,96	83	0,67
Searsia crenata	BZ017	35,72	105	0,34
Searsia glauca	BZ004	41,56	65	0,64
Searsia lucida	BZ013	43,72	155	0,28
Searsia pyroides	BZ031	30,04	133	0,23
Carissa bispinosa	BZ033	26,76	121	0,22
Ilex mitis	BZ051	20,16	154	0,13
Cussonia thyrsiflora	BZ037	50,68	69	0,73
Osteospermum moniliferum	BZ011	36,00	72	0,50
Metalasia muricata	BZ046	34,16	91	0,38
Stoebe plumosa	BZ005	17,12	84	0,20
Tarchonanthus littoralis	BZ010	33,48	158	0,21
Cassine peragua	BZ019	22,62	225	0,10

Genus & species	**Voucher #**	**V.diam (µm)**	**V.freq (per mm^2)**	**VI (V.diam/freq)**
Eleodendron croceum	BZ018	27,00	219	0,12
Gymnosporia nemorosa	BZ060	31,84	199	0,16
Mystroxylon aethiopicum	BZ032	18,46	204	0,09
Pterocelastrus tricuspidatus	BZ007	27,40	102	0,27
Diospyros dichrophylla	BZ012	53,08	107	0,50
Euclea racemosa	BZ066	38,00	254	0,15
Erica glandulosa	BZ023	33,04	197	0,17
Salvia africana-lutea	BZ048	19,00	143	0,13
Grewia occidentalis	BZ053	54,62	72	0,76
Ficus burtt-davyi	BZ043	39,62	32	1,24
Ficus sp.	BZ062	34,27	122	0,28
Morella cordifolia	BZ056	43,50	116	0,38
Rapanea giliana	BZ068	33,73	148	0,23
Rapanea melanophloes	BZ025	25,19	124	0,20
Pittosporum viridiflorum	BZ016	36,50	286	0,13
Polygala myrtifolia	BZ065	35,31	119	0,30
Phylica axillaris	BZ057	36,27	161	0,23
Rhamnus prinoides	BZ021	35,85	242	0,15
Pavetta revoluta	BZ061	42,23	140	0,30
Agathosma apiculata	BZ006	34,36	111	0,31
Agathosma ovata	BZ067	21,50	153	0,14
Clausena anistata	BZ049	31,80	125	0,25
Coleonema pulchellum	BZ027	38,73	160	0,24
Zanthoxylum davyi	BZ035	49,62	76	0,65
Dovyalis caffra	BZ040	29,46	146	0,20
Dovyalis sp.	BZ047	26,73	154	0,17
Colpoon compressum	BZ002	51,35	82	0,63
Sideroxylon inerme	BZ034	32,92	82	0,40
Lycium sp.	BZ039	35,15	78	0,45
Halleria lucida	BZ070	44,92	221	0,20
Nuxia sp.	BZ054	47,50	151	0,31
Nuxia sp.	BZ022	34,42	97	0,35
Nuxia floribunda	BZ059	54,23	46	1,18
Passerina rigida	BZ009	30,77	249	0,12
Rhoicissus tridentata	BZ020	72,00	106	0,68
AVERAGE		**36,42**	**136,23**	**0,35**

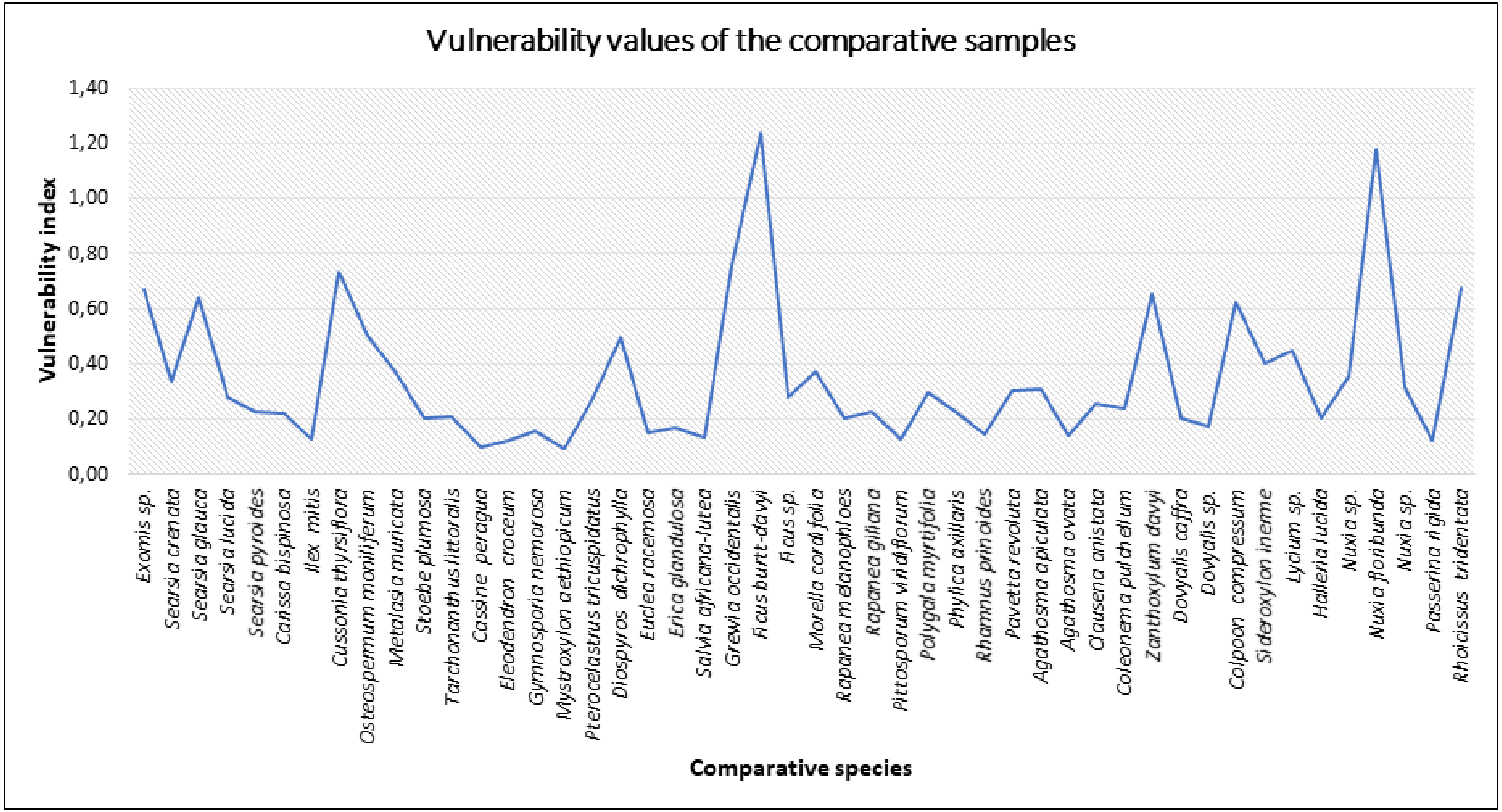

FIG. 4.22 *The 'Vulnerability indices' of fragments from the collection of comparative species. Species are listed according to the alphabetical order of the family names.*

The vessel frequency (number of vessels per square mm) was counted from all 48 species as well. These had an average of 136.47 vessels per mm^2 (Table 4.6). The vessel frequency of comparative species ranged between 32 (*Ficus burtt-davyi*) and 286 (*Pittosporum viridiflorum*). The mean of the VI of the whole comparative collection (n=48) is 0.35. These indices ranged between 0.09 and 1.24 (Table 4.6). When plotted on a line graph, the VI of the comparative species showed that most of the woody species growing on the contemporary Klasies River landscape tend to have VI that are below 0.8 (Fig. 4.22). Only two species; *Ficus burtt-davyi* and *Nuxia floribunda* have VI above 1, i.e. *F. burtt-davyi* scored 1.24 while *N. floribunda* scored 1.18. *Mystroxylon aethiopicum* had the lowest VI of 0.09.

4.3.2 The anatomical structure of archaeological charcoal species

Most of the archaeological species (or 'Types) analysed in this study were not identified (n=60-17) taxonomically. However, the vessel measurements of specimens were recorded (n=60). Similar to the comparative species, the archaeological charcoal fragments were analysed for VI. However, 'Type' 23 and 'Type' 58 were excluded from this analysis as these are softwood (gymnosperms) species and have tracheids instead of vessels.

TABLE 4.7 *The anatomical structure of the archaeological fragments (for each archaeological type) from the Klasies River cave 1 deposit. V.diam= Diameter of the vessel lumina, V.freq= vessel frequency per mm^2, VI= 'Vulnerability Indices'. Species are listed according to the numerical order of their 'Type' numbers. Key to layers: letter + first two digits= square number; last digit= spit number; A15PC= fragment from 'Profile Cleaning' sediments of square A15; WBLSA(SC)= fragment from 'Surface Cleaning' over the LSA deposit. Grey shaded 'types' were identified taxonomically. Table continues to page 80 & 81.*

Type	Layer	Fragment #	V.diam (µm)	V.freq (per mm^2)	VI (V.diam/freq)
1	A152	38	46,42	40	1,16
2	A154	166	49,20	68	0,72
3	B164	5	52,20	68	0,77
4	A154	71	37,40	84	0,45
5	A154	11	69,60	56	1,24
6	B162	12	39,40	87	0,45
7	B153	13	44,20	119	0,37

Type	Layer	Fragment #	V.diam (µm)	V.freq (per mm²)	VI (V.diam/freq)
8	B151	11	126,59	16	7,91
9	B151	42	44,80	110	0,41
10	B151	21	38,60	136	0,28
11	B164	2	54,80	146	0,38
12	A154	31	33,20	130	0,26
13	B151	82	52,60	79	0,67
14	B151	116	40,00	32	1,25
15	B152	1	27,40	279	0,10
16	B161	16	63,60	42	1,51
17	B161	20	50,40	53	0,95
18	B161	29	11,00	349	0,03
19	B161	35	27,60	88	0,31
20	B154	30	62,80	51	1,23
21	B154	9	56,40	49	1,15
22	B151	69	27,80	72	0,39
24	B151	97	32,00	110	0,29
25	B151	75	42,00	75	0,56
26	A153	1	37,20	50	0,74
27	A154	5	40,40	113	0,36
28	A154	38	88,40	31	2,85
29	A154	17	36,80	268	0,14
30	A154	127	70,00	9	7,78
31	B154	4	67,60	28	2,41
32	B151	45	53,60	42	1,28
33	A154	140	51,00	88	0,58
34	A153	5	44,40	123	0,36
35	A153	10	39,00	41	0,95
36	A153	12	28,60	163	0,18
37	B153	8	63,80	41	1,56
38	B153	9	29,40	84	0,35
39	A154	139	42,20	173	0,24
40	A154	77	40,40	78	0,52
41	A154	83	31,30	38	0,82
42	A154	206	27,40	318	0,09
43	B154	23	94,00	13	7,23
44	B151	86	58,20	62	0,94
45	A152	31	47,80	122	0,39
46	A15PC	2	48,00	79	0,61
47	B153	6	45,40	46	0,99
48	A154	228	33,82	197	0,17
49	A154	178	44,60	46	0,97
50	A154	175	27,80	217	0,13

Type	Layer	Fragment #	V.diam (µm)	V.freq (per mm²)	VI (V.diam/freq)
51	A154	24	64,40	79	0,82
52	B162	6	57,80	31	1,86
53	B154	26	60,20	88	0,68
54	A152	17	56,00	62	0,90
55	A151	13	42,52	28	1,52
56	A154	9	92,00	17	5,41
57	A153	31	70,60	42	1,68
59	A154	2	50,80	82	0,62
60	WBLSA(SC)	3	54.60	30	1.82
AVERAGE			**49,39**	**91,89**	**1,22**

The anatomical microstructure of archaeological species is presented in Table 4.7. The diameter of vessel lumina, like other characteristics, was measured from one fragment belonging to each of the 58 types. The measurements for this characteristic ranged between 11 µm (B161-29) and 126 µm (B151-11) (Table 4.10). The mean of the diameter of the vessel lumina is 49.39 µm and mean vessel frequency was 91.89 vessels per mm^2.

The mean VI of the archaeological species is 1.21 (Table 4.10). These values ranged between 0.03 (Type 18) and 7.23 (Type 43). The wide range of VI scores within this assemblage is demonstrated in Figure 4.25. Sixty-nine percent (n= 40) of the species had VI below 1; while 22% of species (n=13) had their VI scores between 1 and 2.5. Five species had VI indices between 2.5 and 8; these are namely: Types 8 (7.91), Type 28 (2.85), Type 30 (7.78), Type 43 (7.23) and Type 56 (5.41) (Fig. 4.23). These five species make up 8.6% of the archaeological charcoal 'Types' analysed for vessel characteristics.

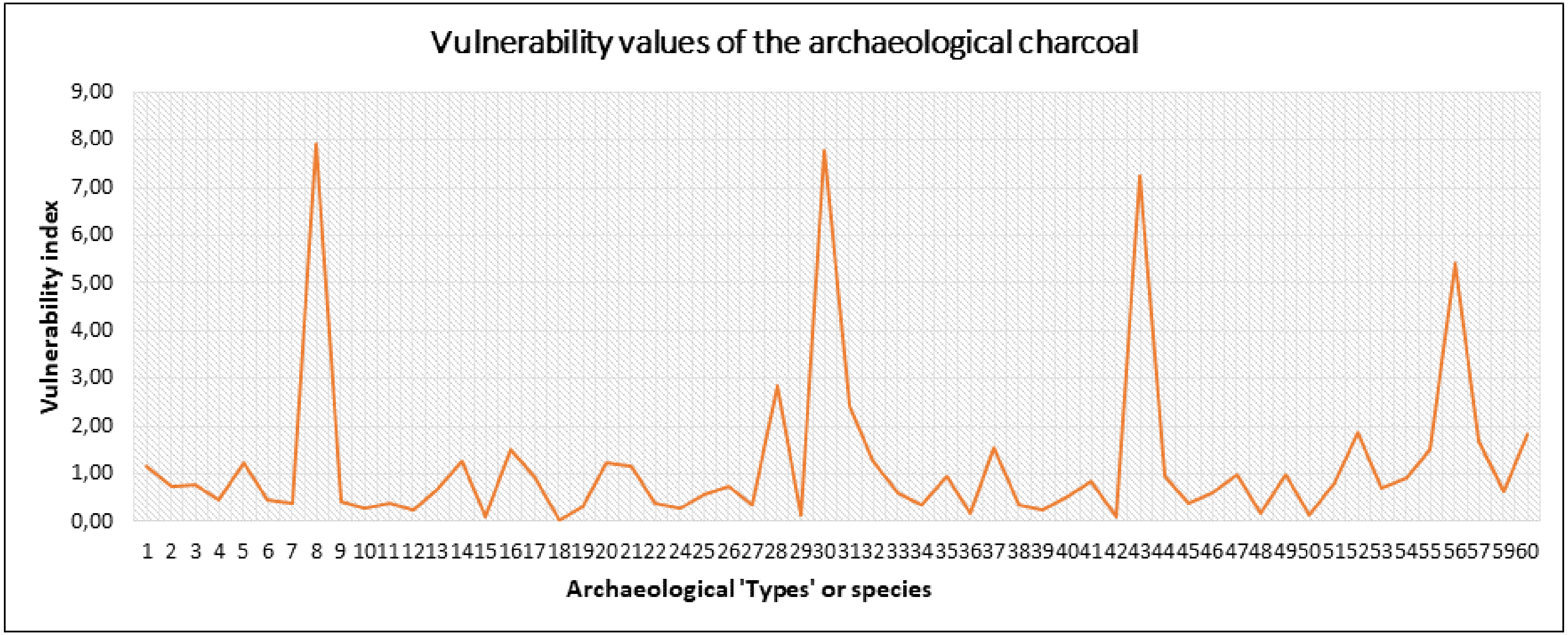

FIG. 4.23 *The 'Vulnerability indices' of charcoal fragments from the archaeological charcoal assemblage. Species are listed according to the numerical order of their 'Type' numbers.*

4.3.3 The vessel characteristics of contemporary woody species and those of their counterparts from the 2300 BP landscape

Nine species identified from the archaeological charcoal assemblage occur on the contemporary Klasies River landscape (Table 4.2). The vessel characteristics of these species from the two landscapes were compared. Table 4.8 below lists the species along their respective vessel characteristics including their VI indices.

TABLE 4.8 *The vessel characteristics of the contemporary comparative species and their archaeological counterparts from the Klasies River landscape. Comp.= Modern comparative fragments, Arch.= Archaeological fragments, V.diam= Diameter of the vessel lumina in µm, V.freq= Vessel frequency per mm^2 and VI= Vulnerability index. Species are listed in the alphabetical order of their families.*

Species	**Arch. Type #**	**Comp. V.diam**	**Comp. V.freq**	**Comp. VI**	**Arch. V.diam**	**Arch. V.freq**	**Arch. VI**
Metalasia muricata	12	34,16	91	0,38	33,20	130	0,26
Tarchonanthus littoralis	33	33,48	158	0,21	51,00	88	0,58
Nuxia floribunda	4	54,23	46	1,18	37,40	84	0,45
Mystroxylon aethiopicum	25	18,46	204	0,09	42,00	75	0,56
Pterocelastrus tricuspidatus	24	27,40	102	0,27	32,00	110	0,29
Erica glandulosa subsp. *fourcadei*	46	33,04	197	0,17	48,00	79	0,61
Grewia occidentalis	20	54,62	72	0,76	62,80	51	1,23
Zanthoxylum davyi	22	49,62	76	0,65	27,80	72	0,39
Sideroxylon inerme	17	32,92	82	0,40	50,40	53	0,95
Average		37,55	114	0,46	42,73	82	0,59

The VI of the comparative wood or charcoal were generally lower than those of the archaeological charcoal fragments (Table 4.8). For example, the mean VI of comparative species was 0.46 and that of archaeological species 0.59. However, the VI of three species (*M. muricata*, *N. floribunda* and *Z. dayvi)* had archaeological VI lower than that of contemporary wood/charcoal. Six archaeological species have higher VI than their contemporary counterparts. These are *T. littoralis*, *M. aethiopicum*, *P. tricuspidatus*, *E. glandulosa* subsp. *fourcadei*, *G. occidentalis* and *S. inerme* (Table 4.11).

Conclusion

The microstructure of the wood fragments in the archaeological assemblage was used to (1) identify the taxa of woody plants collected by the visitors at Klasies River main site and (2) to analyse the vascular structure of woody plants that grew around the site 2300 BP. The taxonomic composition as well as the vessel characteristics of the archaeological and contemporary charcoal assemblage will be used to interpret the past climate in the next chapter.

CHAPTER 5: DISCUSSION AND CONCLUSION

Introduction

In this study, a number of woody taxa were identified in order to provide some information on the vegetation and palaeoenvironment of the late Holocene assemblage from Klasies River cave 1. In the discussion below, the taxonomic results and the vessel characteristics are intepreted.

5.1 Discussion of results

5.1.1 Interpretation of taxonomy results of archaeological charcoal

The taxa identified in this study can be used to understand the environment of the 2300 BP Klasies River landscape. The presence of *Protorhus longifolia* and *Hibiscus* cf. *tiliaceus* in the archaeological assemblage suggests that the late Holocene landscape was favourable for these species to grow in the near vicinity of the cave. These species do not occur on the Klasies River landscape today (Figs. 5.2 and 5.3). This could be due to, for example, anthropogenic activity and/or environmental change along the southern Cape coast since 2300 BP. Recent large-scale farming in the area may be responsible for the significant change in the landscape since 2300BP.

Extreme conditions such as wild fires and droughts are currently experienced along the the southern Cape (Fitchett *et al*. 2016) and may limit the distribution of *Protorhus longifolia* and *Hibiscus* cf. *tiliaceus* on the Tsitsikamma Coast because these species cannot tolerate extremely dry conditions (pza.sanbi.org). Also, frost and drought are often related and *P. longifolia* can tolerate only mild frost (Pooley 2006). *Hibiscus tiliaceus* cannot grow at all under frost conditions. Both species grow in areas with plenty of water (pza.sanbi.org). The current distribution of the two species along the east coast areas of southern Africa suggests that, they are adapted to the high rainfall associated with the SRZ (van Wyk & van Wyk 2013). Conditions associated with summer rainfall seasonality, thus, may have occurred around 2300 BP at Klasies River. The quantitative results of this study also suggest that the Klasies River landscape although located entirely within the YRZ, supported woody vegetation species well adapted to summer rainfall seasonality (Fig. 5.1).

The woody species identified here predominantly occur in the YRZ (n=17) followed by SRZ (n=16). Only 9 species occur in the WRZ (Figure 5.1) and as discussed in Chapter 4, only one of these, *Platylophus trifoliatus*, is strictly adapted to temperate climate conditions associated with the WRZ. More than 80% of the archaeological species identified currently occur in the SRZ, fewer than 60% are distributed in the WRZ and 94% occur in the YRZ (Fig. 5.1). It can thus be inferred that environmental conditions associated with year-round rainfall dominated the landscape c. 2300 BP. It is possible that this region experienced more pronounced summer rainfall seasonality conditions than it did winter rainfall conditions during this period.

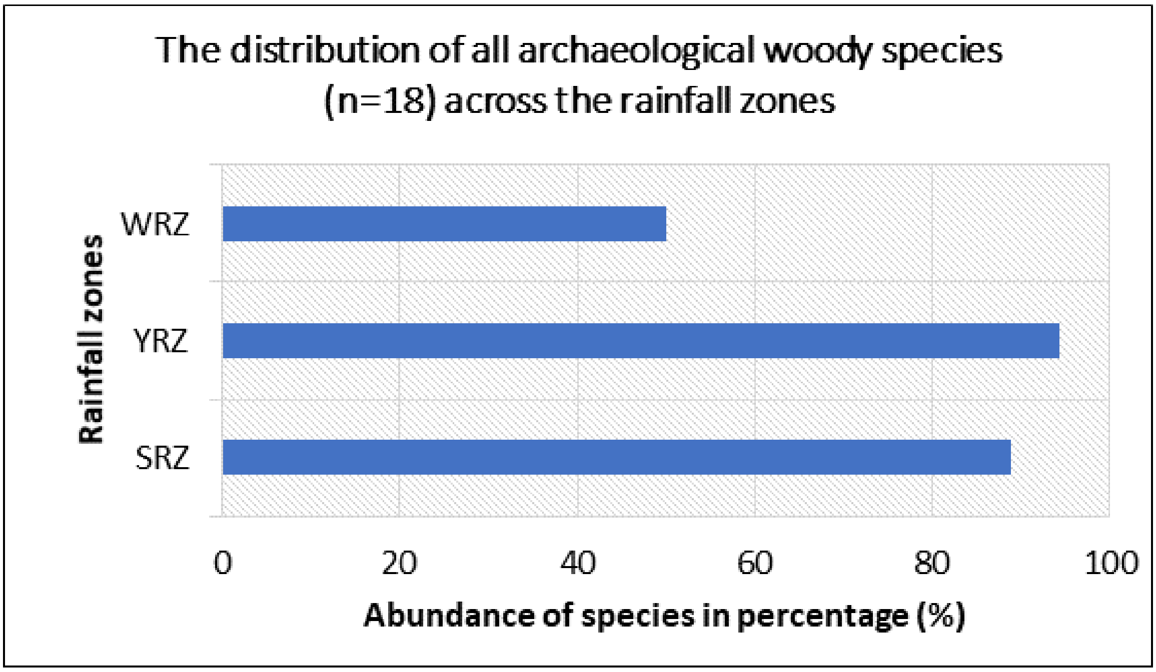

FIG. 5.1 *The distribution of all the archaeological species against the rainfall zones of southern Africa. WRZ= Winter Rainfall Zone , YRZ= Year-round Rainfall Zone and SRZ= Summer Rainfall Zone.*

Van Wijk and colleagues (2017) identified 122 different woody species over the contemporary Klasies River landscape. Appendix 6 contains the list of all woody species identified by van Wijk and colleagues (2017) as well as their distribution according to Germishuizen and Meyer (2003). Their current distribution in southern Africa was plotted across the different rainfall zones (Fig. 5.2).

The contemporary Klasies River landscape is currently characterised by a larger proportion of species that prefer a temperate environment. Figure 5.2 shows that of the 122 woody species identified by van Wijk *et al.* (2017, see Appendix 6) WRZ species are represented to a much larger extent. This is related to current incidence of predominantly winter rainfall as recorded at two locations, St Francis Bay and Cape St Francis, located ~50 km east of Klasies River (Fitchett *et al.* 2016: 2).

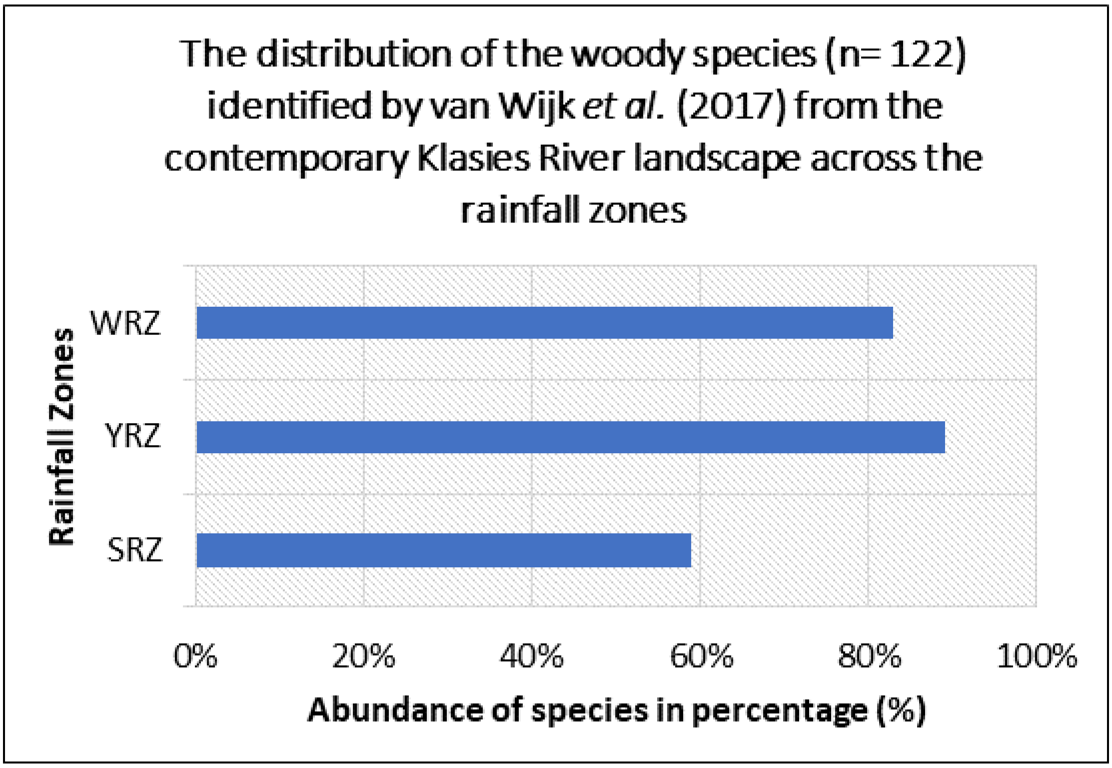

FIG. 5.2 *The distribution trend of the woody vegetation species identified over the contemporary Klasies River landscape by van Wijk and colleagues (2017) across southern Africa. WRZ= Winter Rainfall Zone, YRZ= Year-round Rainfall Zone and SRZ= Summer Rainfall Zone.*

The interpretation that the Klasies River landscape c. 2300 BP experienced increased summer rainfall and less winter rainfall is admittedly based on a very small charcoal sample size. The woody species in the present landscape are 122 and those from the 2300 BP landscape are 18. Therefore, while the data in this study suggest that woody vegetation around Klasies River has changed, this change cannot be argued with certainty due to the small sample size. Bias is involved in the interpretation of the archaeological sample because the presence of the different species depends on the selection of wood by people in the past. The limited comparative wood or charcoal collection available for taxonomic identification in this study could also bias the interpretation. Taphonomic factors, too, also influence the preservation of charcoal. Nevertheless, the interpretation of the late Holocene environment may be relevant if one considers that past groups would have collected wood in the immediate vicinity of the cave, following the 'Least Effort Principle' (Shackleton & Prins 1992). The data presented in this dissertation may indicate that the environment around Klasies River 2300 BP was warmer, with moister conditions than at present.

5.1.2 Interpretation of the wood anatomical structure

In Chapter 4 it was discussed that wood anatomical structure provides an indication of past moisture availability. Investigating this aspect is also important to understand the environment and the climate of Klasies River landscape c. 2300 BP. In this study, it was found that a considerable difference in water conduction of the woody taxa from the two vegetation sets occur. This was inferred from vessel frequency, vessel diameter and the 'Vulnerability Indices' (VI) of the two vegetation sets.

The woody vegetation from the 2300 BP landscape (mean frequency= 91.89) (Table 4.6) could conduct water more efficiently than contemporary woody vegetation (mean frequency= 136.47). The diameter of vessel lumina of the archaeological charcoal assemblage had a mean of 49.39 µm and that of contemporary charcoal was 36.52 µm. The wider vessel lumina of the archaeological fragments generally indicate that woody vegetation c. 2300 BP at Klasies was adapted to conduct larger amounts of water than woody vegetation from the present landscape. This is, however, sugested with caution because of the difference in the number of species used for comparison, i.e. 48 contemporary vs. 60 archaeological species.

According to Carlquist (1977: 891), VI below 1 indicates "Redundancy" in a plant and signifies the woody plant's ability to withstand conditions of water stress. This means that species with VI below 1 have better chances of surviving harsh climatic conditions such as drought and freezing (Carlquist 1977). The VI of the contemporary comparative species in this study ranged between 0.09 and 1.24 and had an average of 0.35. These values suggested that the majority of contemporary wood around Klasies River is (or would be) less vulnerable to stressful environmental conditions. Only two species, *N. floribunda* and *F. burtt-davyi,* with VI values 1.24 and 1.18 respectively, have VI outside the safety range. The wood anatomy of woody vegetation species growing at Klasies River landscape today is, therefore, generally adapted to withstand water stressful environmental conditions.

VI between 1 and 2.5, on the other hand, indicate Mesomorphy in a woody species (Carlquist 1977). Mesomorphic plants are adapted to conditions of abundant water and relatively humid conditions (Carlquist 1977). These high VI indicate a woody plant's inability to withstand harsh or water stressful conditions (Carlquist 1977). Thirty percent of the archaeological charcoal fragments in this study would not have been able to withstand water scarce conditions.

The archaeological charcoal collection had a VI with an average of 1.21. These values ranged between 0.03 and 7.23. Although the VI of the archaeological species had an average score that is outside the VI safety range (i.e. 1.21 is above 1), approximately 69% (n= 40) of the fragments have values within the VI safety range (Fig. 5.2). Thirteen species had a VI between 1 and 2.5, whereas 5 species had values beyond the 'Mesomorphy' range, i.e. above 2.5 (Fig. 5.2). This implies that 31% of the woody species that grew around Klasies River around 2300 BP were not adapted to withstand water stressful conditions and would be 'Vulnerable' under environmental conditions such as drought and freezing conditions.

Figure 5.3 shows the comparison of the VI of woody species of the contemporary vs. archaeological assemblage. Approximately 96% (n= 46) of the contemporary comparative species analysed in this study are suited to grow under water scarce conditions, while only 4% (n=2) have signs of being mesomorphic woody plants (Fig. 5.3). Likewise, the VI of the majority or 69% of archaeological species (n=40) was 'Redundant' as these species appear to be adapted to conditions of water stress. However, the VI of 18 (13+ 5) archaeological species analysed here indicate that the 2300 BP landscape around Klasies River featured a higher proportion of mesomorphic woody plants than the present landscape.

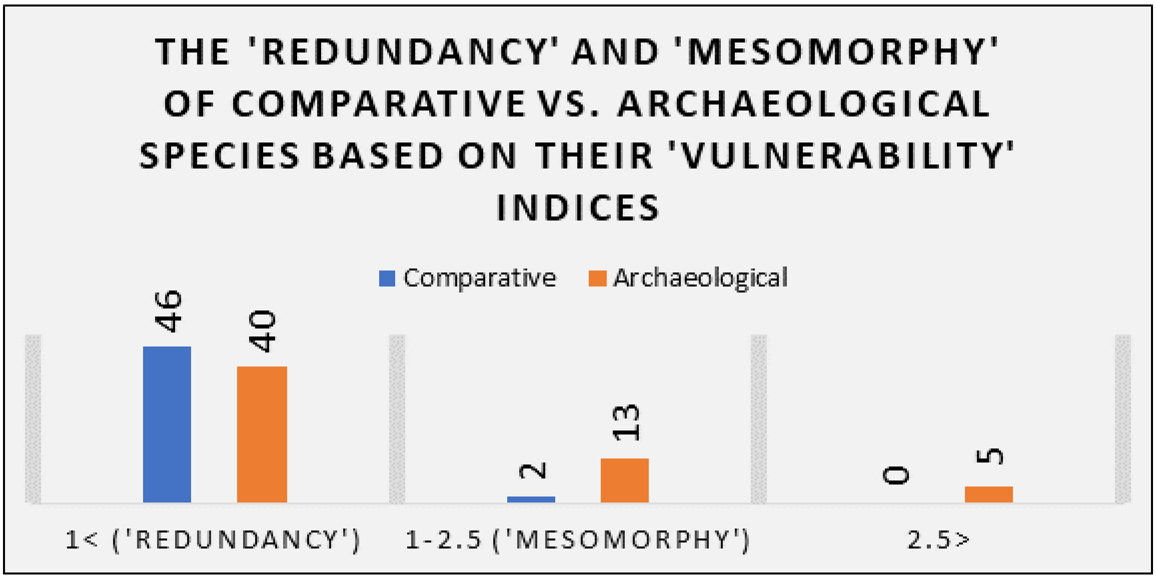

FIG. 5.3 *The summary of 'Vulnerability Indices' of species in the comparative vs. archaeological species showing the 'Redundancy' and 'Mesomorphy' of each assemblage.*

The archaeological species appear to be more 'Vulnerable' against harsh (water-scarce) conditions compared to the woody species from the contemporary Klasies River landscape. This implies that the archaeological taxa could not (or did not) tolerate dry, drought-like environmental conditions. It can be argued that the 2300 BP landscape had more moisture than the present Klasies River landscape. These conditions are associated with the 2300 BP landscape although it is possible that some of the wood collected and burnt by the people in the cave may be slightly older than this. For example, it takes time time for woody vegetation (especially tree species) to grow, and even possibly die, before it can be collected by people as fuel source (Scholtz 1986). The variability in the VI values may, perhaps, reflect the varied environments under which the wood grew during the late Holocene, prior to 2300 BP.

The variability in the VI values of archaeological charcoal can also be due to many unknown attributes of the the Later Stone Age sample. Wood maturity (trunk vs. branch) may play a role in the VI variability, i.e. the more mature the the wood the higher the VI (Wolfe & Upchurch 1987: 64). The size of the woody plants also plays an important role in the variability of the vessel frequency and diameter (Wolfe &

Upchurch). The variability in these characteristics is such that large trees typically have higher VI than smaller trees or shrubs (Wolfe & Upchurch 1987: 38).

The majority of the archaeological charcoal types were not identified to species level in this study, it is therefore not possible to assess if the VI variation in the archaeological charcoal could be related to a better representation of the shrubs and small trees vs large trees, *vice versa*. It can also not be determined if the variation is a result of the maturity of the wood burnt by the visitors at Klasies River.

5.1.3 Interpretation of the vessel characteristics of contemporary woody species against those of their counterparts from the 2300 BP landscape.

The vessel characteristics of the same contemporary and archaeological species were compared. Six species, *T. litoralis*, *M. aethiopicum*, *P. tricuspidatus*, *E. glandulosa* subsp. *fourcadei*, *G. occidentalis* and *S. inerme*, from the contemporary landscape had a narrower vessel diameter than their archaeological counterparts. Three species *M. muricata*, *N. floribunda* and *Z. dayvi* did not follow this pattern (Fig. 5.3). This indicates harsher climatic conditions at present (February 1992; 1993).

Similarly, a generally drier environment is suggested for the present when comparing the frequency of vessels in this sample. The vessel frequency of the contemporary comparative woods, *T. littoralis, M. aethiopicum, E. glandulosa* subsp. *fourcadei, G. occidentalis, Z. davyi and S. inerme* is higher compared to their archaeological counterparts from 2300 BP (Fig. 5.4). The vessel frequency of three contemporary species *M. muricata, N. floribunda* and *P. tricuspidatus,* on the other hand, is lower than that of the archaeological fragments (Fig. 5.4). This suggests that the species growing on the contemporary Klasies River landscape are more adapted to water scarcity than the archaeological species.

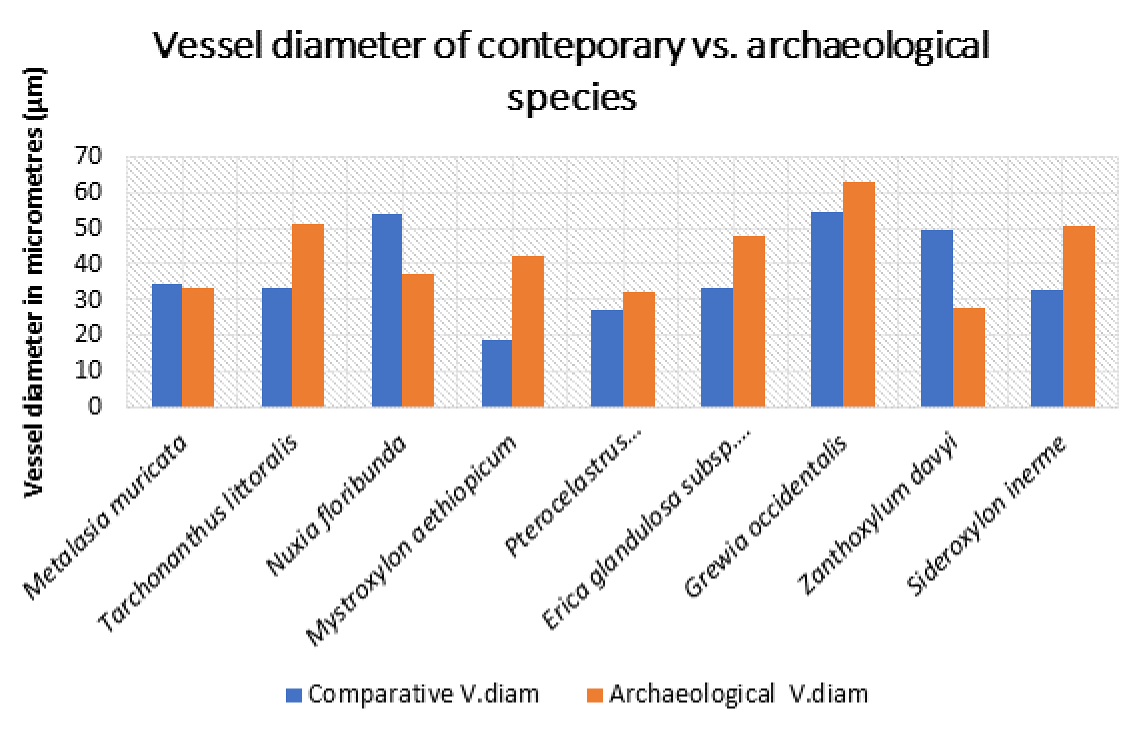

FIG. 5.4 *A bar graph comparing the vessel diameters of contemporary comparative fragments against the archaeological fragments of the same species.*

Most of the nine species from the present and archaeological landscape have their VI within the safety range i.e. have a VI below 1 (Fig. 5.6). Two species, however, have scores outside this safety range, contemporary *N. floribunda* (1.18) and the archaeological *G. occidentalis* (1.2) (Fig. 5.5). This result is not sufficiently meaningful for futher interpretation of the environment.

Generally**,** the VI of six contemporary species, *T. littoralis*, *M. aethiopicum*, *P. tricuspidatus*, *E. glandulosa* subsp. *fourcadei*, *G. occidentalis* and *S. inerme* are lower than those of the archaeological fragments of the same species (Fig. 5.4). This confirms, as mentioned above, a lesser 'Vulnerability' of the contemporary species and that they are thus more adapted to drier conditions. However, the VI values of three contemporary species (*M. muricata*, *N. floribunda* and *Z. dayvi*) are notably higher than those of the archaeological charcoal fragments. It might be that these three species appear to be less 'Vulnerable' to harsh environmental conditions today than they were 2300 BP years ago. These results need to be further intepreted as not all woody species are useful environmental indicators. There are many ecological factors such as water availability, temperature, climate regime, latitude and altitude, amongst others that contribute to the growth of woody plants (Carlquist 1977; Creber & Chaloner 1984; February 1993; Baas & Wheeler 2011). These affect the occurrence and variation of vessel characteristics and their effect may differ across species (Carlquist 1977; February 1993).

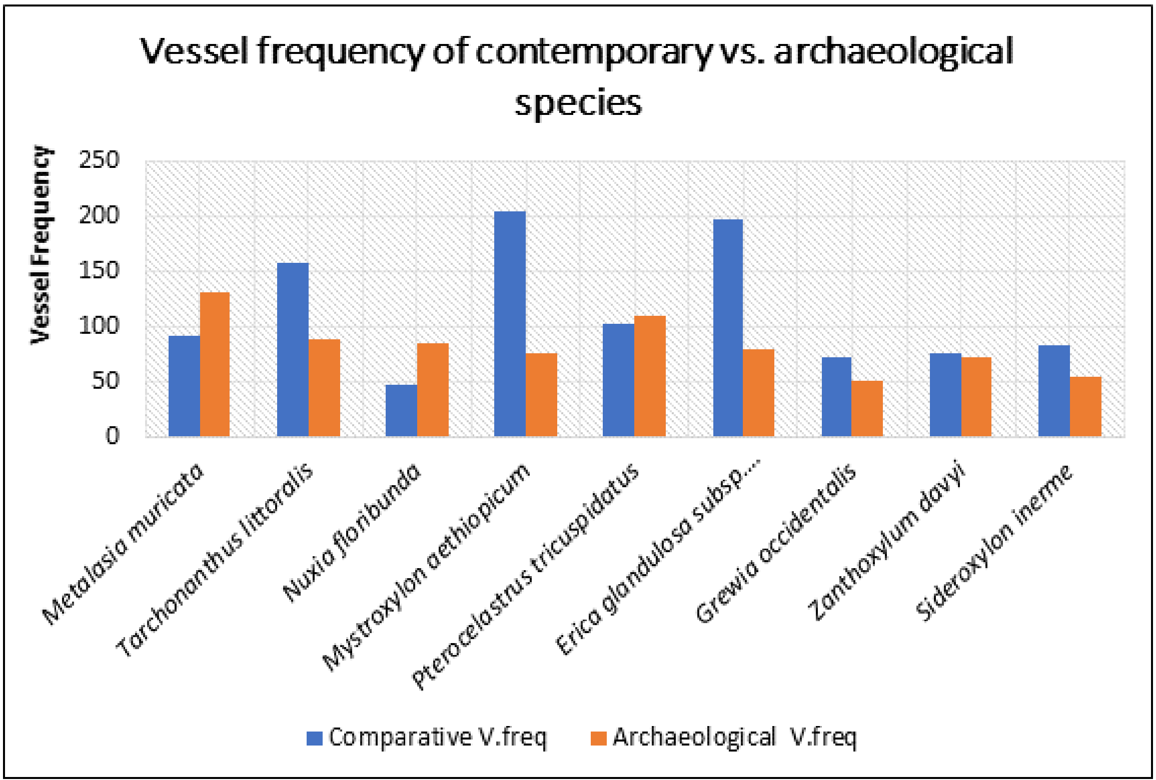

FIG. 5.5 *A bar graph comparing the vessel frequency of contemporary comparative fragments against that of archaeological fragments belonging to the same species.*

For example, February (1992:15) determined that in southern Africa, woody species with a restricted spatial distribution range or a distribution range in close proximity to water sources are not suited for determining changes in vessel characteristics through time. Instead, species that grow over a wide range of ecoclimatic regimes are good for determining changes in vessel characteristics along the rainfall gradient (February 1992; 1993). The results of this study generally indicate that *T. littoralis*, *M. aethiopicum*, *P. tricuspidatus*, *E. glandulosa* subsp. *fourcadei*, *G. occidentalis* and *S. inerme* seem to be slightly more 'Vulnerable' to water scarcity at present than they were c. 2300 BP at Klasies River.

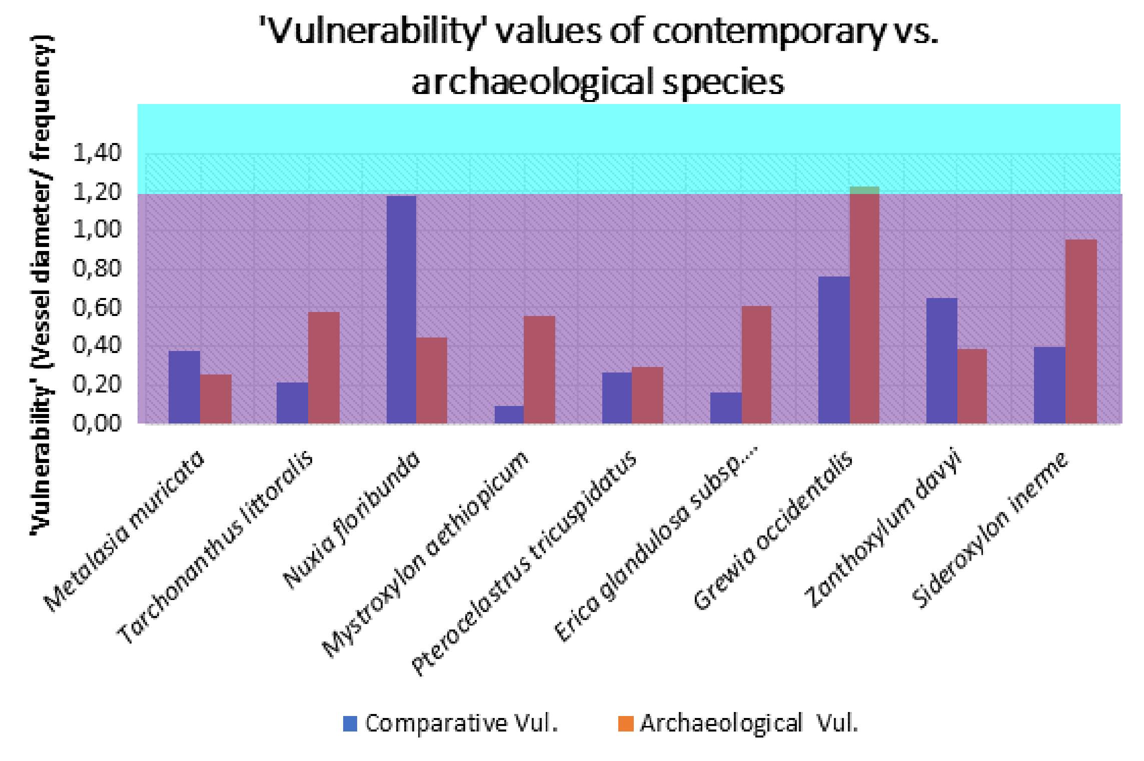

FIG. 5.6 *A bar graph comparing the 'Vulnerability values' of contemporary comparative species against their archaeological counterparts. Blue shaded area highlights 'Vulnerability' values indicative of 'Mesomorphy' and purple shaded area highlights species within the 'Redundancy' (safety) range.*

5.2 The late Holocene environment at Klasies River and the southern Cape coast

The environmental conditions accompanying the deposition of the LSA cultural material at Klasies River cave 1 were previously interpreted from soil sediments and shellfish remains from the cave (Butzer 1978; Binneman 1995; Mosweu 2016). The analysis of soil sediments from Klasies River cave 1 indicated that there were storm surges dated around 2500 BP which brought about a sudden rise in sea levels just off the Tsitsikamma Coast (Butzer 1978). These surges and the accompanying raised sea levels resulted in the erosion of Klasies River cave 1's Lower Midden (Butzer 1978: 147).

Binneman (1995) and Mosweu (2016) indicate that throughout the LSA, visitors at Klasies River cave 1 collected more warm-water adapted shellfish species than cold water species. *Perna perna* and *Scutellastra tabularis,* shellfish species that are indicative of relatively warmer ocean waters, occur in the Upper Midden of the LSA deposit in cave 1, with *P. perna* occurring most abundantly (Binneman 1995: 120;

Mosweu 2016: 41). This suggests that marine conditions during the Late Holocene period investigated in this study, i.e. 2300 BP, compared favourably with those of the present warm Indian Ocean sea-surface temperatures.

The Late Holocene environmental conditions of the southern Cape may have been unlike those of the present time in terms of fluctuating sea levels and temperature (Chase and Meadows 2007; Stager *et al.* 2013; Quick *et al.* 2015; Wundsch *et al.* 2016). As discussed in Chapter 2, sea level fluctuations documented from the east, west and southern Cape coast indicate that generally increasing sea levels between 3000 BP and 2000 BP were followed by minor fluctuations before the present mean sea level was established (Fig. 2.7) (Miller *et al.* 1995; Ramsay 1995; Baxter & Meadows 1999; Strachan *et al.* 2014). This is the period during which the Upper Midden or Singer and Wymers' (1982) LSA II occupation at Klasies River cave 1 was deposited. During this time, i.e. post 2500 BP, Butzer (1978: 147) suggests that cave 1 was dry and the sea was near present level off the Tsitsikamma Coast. Thereafter, the development of present sea levels took place, although this is reported at different times over the three coastal areas of southern Africa, (Miller *et al.* 1995; Ramsay 1995; Baxter & Meadows 1999; Compton 2001; Strachan *et al.* 2014).

Kirsten (2014: 190) reports that the late Holocene period in the Wilderness Embayment area is generally characterised by "extended wet and dry spells." Du Plessis (2015) suggests that a dry phase occurred in the Wilderness Embayment from 3800 to 3600 cal years BP. This was followed by a wet break, associated with winter rainfall, which prevailed until 3200 cal years BP (du Plessis 2015). Thereafter a period from 3200 to

FIG.5.7 *The location of the sites mentioned in this dissertation: Bonawe Rock Shelter (BRS), Boomplaas Cave (BPC), Colwinton Rock Shelter (RCS), Diepkloof Rock Shelter (DRS), Eilandvlei Lake (EL), Elands Bay Cave (EBC), , Groenvlei Lake (GL), Kariega Estuary (KE), Klasies River main site (KRM), , Norga Peat (NP), Ravenscraig Rock Shelter (RRS), Rose Cottage Cave (RCC), Sibudu Cave (SC), Tloutle Rock Shelter (TRS) and Wonderwerk Cave (WWC). (Google Earth map accessed: 18 May 2018)*

2500 cal years BP is correlated with summer rainfall seasonality (du Plessis 2015). These late Holocene conditions are interpreted from pollen and diatom data from Eilandvlei Lake in the Wilderness Embayment (du Plessis 2015). At Norga Peat site, George (c.200 km west of Klasies River caves), pollen assemblages indicate that from 4000 to 2600 years BP, the climatic conditions supported the spread of forest vegetation in the area. During this time, warmer, moister conditions prevailed. Drier (and perhaps colder) conditions are suggested by the contraction of the forest between 2600 and 1400 BP (Scholtz 1986).

An analysis of soil sediments from the Groenvlei Lake, located c. 150 km west of Klasies River, indicated that the surrounding environment of the lake underwent rapid changes caused by sea fluctuation in the late Holocene (Wundsch *et al.* 2016). A dry phase (associated with winter rainfall seasonality) is reported in the period between 4200 and 2700 cal BP; during which two short-lived episodes of heavy rainfall occurred between c.3760- 3690 cal. BP and 2910- 2820 cal. BP (Wundsch *et al.* 2016). It was only after the transition into the wet phase from 2710 cal BP onwards that the Groenvlei Lake, presently located in a YRZ, was influenced by summer rainfall seasonality. This was marked by the transition of the lake from a marine-influenced to a freshwater system (Wundsch *et al.* 2016). The charcoal data from Klasies River in this study may be reflecting these warmer, less arid, summer rainfall conditions albeit around 2300 BP on the Tsitsikamma Coast.

5.3 Shortcomings and future recommendations on this topic

Time restriction for the completion of the degree meant that only a fraction archaeological charcoal species could be recovered and analysed or identified in this project. Also, it may be that a larger wood or charcoal collection of southern African woody species was needed to identify all 60 charcoal types to species level. The high frequency of unidentified (n=43) woody species is also most likely due to the limited reference material from the study area available for this study. Preservation too played a role in the number of recovered as well as identifiable charcoal species.

Further challenges were identified when sourcing the records of the current distribution of the identified woody species. The SANBI point locality distributions for individual woody species reflect few species records for the Tsitsikamma Coast, eg. *Sideroxylon inerme*, *Zanthoxylon dayvi*, *Nuxia floribunda*, *Mystroxylon aethiopicum, Diospyros whyteana, D. dichrophylla* and *Searsia lancea*. This illustrates the relatively limited amount of botanical studies in the area. Although recent studies have been undertaken (e.g. van Wijk *et al.* 2017) they are of restricted extent, for example, van Wijk and colleages (2017) collected only within a 5 km radius of the caves. Finally, the extensive alteration of the natural landscape in the Tsitsikamma coast area affects the growth of indigenous vegetation around the site. It is, thus, unknown to what extent the current distribution of woody species identified in this study reflects what would have occurred naturally in the area, in the absence of these anthropogenic influences. Future studies should focus on sampling a larger area and from a range of depths in the archaeological deposit; this would allow one to investigate changes over time.

Conclusions

The use of anthracology in this study has shown that woody vegetation around Klasies River main site can be used to understand prevailing environmental conditions in the past. An analysis of the wood assemblage from the LSA layers of Klasies River cave 1 indicated that the contemporary woody vegetation during the Late Holocene c. 2300BP grew under somewhat different environmental setting than today. An analysis of the microscopic vascular structure of charcoal assemblage 2300 BP vs. today also confirmed that a slightly different landscape during the late Holocene was present compared to the landscape of today.

The late Holocene c. 2300BP landscape supported woody vegetation species that are more adapted to summer rainfall seasonality, whereas contemporary woody vegetation includes more species that prefer winter rainfall conditions. This suggests that the Klasies River landscape c. 2300 BP experienced warmer, moister environmental or climatic conditions (relative to the present) that made it possible for these species to thrive around the site. Species such as *Protorhus longifolia* and *Hibiscus* cf. *tiliaceus,* whose distribution is currently limited to the east coast of southern Africa, arguably suggest that the relatively warmer conditions of the east coast were present in the Klasies River cave landscape c. 2300 BP.

The comparison of the vascular structure of contemporary charcoal species against that of archaeological charcoal fragments has two environmental implications. The contemporary woody species around Klasies River main site grow under water stressful conditions, i.e. drought-like conditions, as their internal structure is adapted to (or is less vulnerable under) harsh or water scarce conditions. In contrast, the vascular structure of archaeological wood species suggests that some of the species from 2300 BP would have been highly vulnerable to water scarcity. This indicates that the wood assemblage from 2300 years ago generally grew under conditions with relatively high rainfall levels and was not adapted to withstand drought-like environmental conditions.

The prevailing environment at approximately 2300 BP around Klasies River main site can be described as generally warm with high precipitation levels relative to the present. This observation correlates well with other environmental data that is dated between 2710 cal BP to 2500 cal BP from other sites along the southern Cape coast. The charcoal data on which the interpretations are based is small and taxonomic identification of more of the charcoal types in the 2300 BP assemblage would add to the strength of this interpretation. At Klasies River, like at other sites along the southern Cape coast, more environmental proxy data are needed to better understand climatic conditions in the late Holocene.

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APPENDIX 1 The shrub and tree species and their respective vegetation biomes identified around Klasies River caves.

Family	Genus and species, authorship	Vegetation types according to Mucina and Rutherford (2006)				Identified by:
		Thicket	Afrotemperate Forest	Fynbos	Coastal vegetation	
Acanthaceae	*Hypoestes aristata* (Vahl) Sol. ex Roem. & Schult.	x		x	x	van Wijk *et al.* (2017)
Acanthaceae	*Justicia leptantha* (Nees) T. Anderson	-	-	-	-	van Wijk *et al.* (2017)
Acanthaceae	*Isoglossa ciliata* Lindau	x	x			van Wijk *et al.* (2017)
Aizoaceae	*Carpobrotus deliciosus* (L. Bolus) L. Bolus	x		x	x	van Wijk *et al.* (2017)
Aizoaceae	*Ruschia lineolata* Schwantes	-	-	-	-	van Wijk *et al.* (2017)
Aizoaceae	*Tetragonia fruticosa* L.	x			x	van Wijk *et al.* (2017)
Amaranthaceae	*Exomis microphylla* (Thunb.) Aellen	x			x	van Wijk *et al.* (2017), Zwane
Amaranthaceae	*Sarcocornia littorea* (Moss) A.J. Scott	x			x	van Wijk *et al.* (2017)
Anacardiaceae	*Searsia (Rhus) chirindensis* (Baker f.) Moffett		x			van Wijk *et al.* (2017)
Anacardiaceae	*Searsia (Rhus) crenata* (Thunb.) Moffett	x	x	x	x	van Wijk *et al.* (2017), Zwane
Anacardiaceae	*Searsia (Rhus) glauca* (Thunb.) Moffett	x	x	x	x	van Wijk *et al.* (2017), Zwane
Anacardiaceae	*Searsia (Rhus) lucida* L.	-	-	-	-	van Wijk *et al.* (2017), Zwane
Anacardiaceae	*Searsia (Rhus) nebulosa* (Schönland) Moffett	x				van Wijk *et al.* (2017)
Anacardiaceae	*Searsia (Rhus) pyroides* (Burch.) Moffett	x				van Wijk *et al.* (2017), Zwane
Apiaceae	*Notobubon ferulaceum* (Thunb.)	x				van Wijk *et al.* (2017)
Apocynaceae	*Acokanthera oppositifolia* (Lam.) Codd	x	x			van Wijk *et al.* (2017)
Apocynaceae	*Carissa bispinosa (L.)* Desf. ex Brenan	x	x			van Wijk *et al.* (2017), Zwane
Aquifoliaceae	*Ilex mitis* (L.) Radlk		x			van Wijk *et al.* (2017), Zwane
Araliaceae	*Cussonia thyrsiflora* Thunb.	x			x	van Wijk *et al.* (2017), Zwane
Asparagaceae	*Asparagus densiflorus* (Kunth) Jessop	x				van Wijk *et al.* (2017)
Asphodelaceae	*Trachyandra divaricata* Kunth		x		x	van Wijk *et al.* (2017)
Asteraceae	*Artemisia afra* Jacq. ex Willd.	x				van Wijk *et al.* (2017)
Asteraceae	*Felicia echinata* (Thunb.) Nees	x		x	x	van Wijk *et al.* (2017)

Family	Genus and species, authorship	Vegetation types according to Mucina and Rutherford (2006)				Identified by:
		Thicket	Afrotemperate Forest	Fynbos	Coastal vegetation	
Asteraceae	*Helichrysum anomalum* Less.			x	x	van Wijk *et al.* (2017)
Asteraceae	*Helichrysum cymosum* (L.) D. Don	x	x	x	x	van Wijk *et al.* (2017)
Asteraceae	*Helichrysum rosum* (P.J. Bergius) Less	-	-	-	-	van Wijk *et al.* (2017)
Asteraceae	*Helichrysum teretifolium* (L.) D. Don	x		x	x	van Wijk *et al.* (2017)
Asteraceae	*Metalasia muricata* (L.) D. Don	x		x	x	van Wijk *et al.* (2017), Zwane
Asteraceae	*Osteospermum moniliferum* L.	-	-	-	-	van Wijk *et al.* (2017), Zwane
Asteraceae	*Plecostachys serpyllifolia* (P.J. Bergius) Hilliard & B.L. Burtt	x				van Wyk *et al.* (2017)
Asteraceae	*Stoebe plumosa (L.) Thunb.*			x	x	van Wijk *et al.* (2017), Zwane
Asteraceae	*Syncarpha striata* (Thunb.) B. Nord.	-	-	-	-	van Wijk *et al.* (2017)
Asteraceae	*Tarchonanthus littoralis* P.P.J. Herman	x	x	x	x	van Wijk *et al.* (2017), Zwane
Boraginaceae	*Cordia caffra* Sond.	x	x			van Wijk *et al.* (2017)
Celastraceae	*Cassine peragua* L.	x	x	x	x	van Wijk *et al.* (2017), Zwane
Celastraceae	*Elaeodendron croceum* (Thunb.) DC.	x	x			van Wijk *et al.* (2017), Zwane
Celastraceae	*Gymnosporia nemorosa* (Eckl. & Zeyh.) Szyszył.	x	x			van Wijk *et al.* (2017), Zwane
Celastraceae	*Lauridia tetragona* (L.f.) R.H. Archer	x	x	x	x	van Wijk *et al.* (2017)
Celastraceae	*Maytenus procumbens* (L.f.) Loes.	x		x	x	van Wijk *et al.* (2017)
Celastraceae	*Mystroxylon aethiopicum* (Thunb.) Loes.	x	x		x	van Wijk *et al.* (2017), Zwane
Celastraceae	*Putterlickia pyracantha* (L.) Endl.	x	x		x	van Wijk *et al.* (2017)
Celastraceae	*Pterocelastrus tricuspidatus* Walp.	x	x	x	x	van Wijk *et al.* (2017), Zwane
Celastraceae	*Robsonodendron maritimum* (Bolus) R.H. Archer	x	x		x	van Wijk *et al.* (2017)
Crassulaceae	*Cotyledon orbiculata* L.	x	x		x	van Wijk *et al.* (2017)
Crassulaceae	*Crassula atropurpurea* (Haw.) D.Dietr.	x				van Wijk *et al.* (2017)
Crassulaceae	*Crassula cultratea* L.	x				van Wijk *et al.* (2017)
Crassulaceae	*Crassula tetragona* L.	x				van Wijk *et al.* (2017)
Ebenaceae	*Diospyros dichrophylla* (Gand.) De Winter	x	x	x	x	van Wijk *et al.* (2017), Zwane
Ebenaceae	*Euclea racemosa* L.	x	x	x	x	van Wijk *et al.* (2017), Zwane

Family	Genus and species, authorship	Vegetation types according to Mucina and Rutherford (2006)				Identified by:
		Thicket	Afrotemperate Forest	Fynbos	Coastal vegetation	
Ericaceae	*Erica glandulosa* subsp. *foucardei* (L. Bolus) E.G.H. Oliv. & I.M. Oliv.			x		van Wijk *et al.* (2017), Zwane
Ericaceae	*Erica pectinifolia* Salisb.			x		van Wijk *et al.* (2017)
Ericaceae	*Erica peltata* Andrews	-	-	-	-	van Wijk *et al.* (2017)
Euphorbiaceae	*Euphorbia erythrina* Link	x				van Wijk *et al.* (2017)
Fabaceae	*Erythrina caffra* Thunb.	x	x			van Wijk *et al.* (2017)
Fabaceae	*Tephrosia capensis* (Jacq.) Pers.	x		x		van Wijk et al. (2017)
Fabaceae	*Tephrosia grandiflora* (Aiton) Pers.	x				van Wijk *et al.* (2017)
Geraniaceae	*Pelargonium capitatum* (L.) L'Hér.	x			x	van Wijk *et al.* (2017)
Geraniaceae	*Pelargonium odoratissimum* (L.) L'Hér.	-	-	-	-	van Wijk *et al.* (2017)
Lamiaceae	*Clerodendrum glabrum* E. Mey.	x	x			van Wijk *et al.* (2017)
Lamiaceae	*Leonotis leonurus* (L.) R.Br.	x	x			van Wijk *et al.* (2017)
Lamiaceae	*Salvia africana-lutea* L.	x		x	x	van Wijk *et al.* (2017), Zwane
Malvaceae	*Grewia occidentalis* L.	x	x		x	van Wijk *et al.* (2017), Zwane
Meliaceae	*Ekebergia capensis* Sparrm.	x				van Wijk *et al.* (2017)
Moraceae	*Ficus burtt-davyi* Hutch.	x	x		x	van Wijk *et al.* (2017), Zwane
Myricaceae	*Morella cordifolia* (L.) Killick	x	x	x	x	van Wijk *et al.* (2017), Zwane
Myricaceae	*Morella serrata* (Lam.) Killick		x	x		van Wijk *et al.* (2017)
Myrsinaceae	*Rapanea gilliana* (Sond.) Mez	x		x	x	van Wijk *et al.* (2017), Zwane
Myrsinaceae	*Rapanea melanophloeos* (L.) Mez		x		x	van Wyk *et al.* (2017), Zwane
Oleaceae	*Chionanthus foveolatus* (E. Mey.) Stearn	x	x		x	van Wijk *et al.* (2017)
Oleaceae	*Jasminum angulare* Vahl	x	x			van Wijk *et al.* (2017)
Oleaceae	*Olea capensis* L.		x		x	van Wijk *et al.* (2017)
Penaeaceae	*Penaea cneorum* Meerb.		x	x		van Wijk *et al.* (2017)
Pittosporaceae	*Pittosporum viridiflorum* Sims		x		x	van Wijk *et al.* (2017), Zwane
Plumbaginaceae	*Limonium scabrum* Kuntze	x		x	x	van Wijk *et al.* (2017)

Family	Genus and species, authorship	Vegetation types according to Mucina and Rutherford (2006)				Identified by:
		Thicket	Afrotemperate Forest	Fynbos	Coastal vegetation	
Polygalaceae	*Polygala myrtifolia* L.	-	-	-	-	van Wijk *et al.* (2017), Zwane
Polygalaceae	*Muraltia squarrosa* (L.f.) DC.	x		x		van Wijk *et al.* (2017)
Proteaceae	*Leucadendron salignum* R.Br.			x	x	van Wijk *et al.* (2017)
Proteaceae	*Leucadendron spissifolium* I.J. Williams	-	-	-	-	van Wijk *et al.* (2017)
Proteacea	*Leucospermum cuneiforme* (Burm.f.) Rourke			x		Zwane
Proteaceae	*Protea coronata* Lam.	-	-	-	-	van Wijk *et al.* (2017)
Proteaceae	*Protea cynaroides* (L.) L.			x		van Wijk *et al.* (2017)
Proteaceae	*Protea neriifolia* R.Br.			x		van Wijk *et al.* (2017)
Proteaceae	*Protea tenax* R.Br.			x		van Wijk *et al.* (2017)
Restionaceae	*Restio eleocharis*	-	-	-	-	Zwane
Restionaceae	*Restio triticeus* Rottb.	x		x	x	van Wijk *et al.* (2017)
Restionaceae	*Thamnochortus fruticosus* P.J. Bergius	x	x	x	x	van Wijk *et al.* (2017)
Rhamnaceae	*Phylica axillaris* Lam.	-	-	-	-	Zwane
Rhamnaceae	*Phylica litoralis* (Eckl. & Zeyh.) D.Dietr.	x		x	x	van Wijk *et al.* (2017)
Rhamnaceae	*Phylica purpurea* Sond.		x	x		van Wijk *et al.* (2017)
Rhamnaceae	*Rhombus prinoides* L'Hér.	x	x			van Wijk *et al.* (2017), Zwane
Rhamnaceae	*Scutia myrtina* (Burm.f.) Kurz	x	x		x	van Wijk *et al.* (2017)
Rosaceae	*Cliffortia ilicifolia* L.			x		van Wijk *et al.* (2017)
Rosaceae	*Cliffortia linearifolia Eckl. & Zeyh.*	x		x		van Wijk *et al.* (2017)
Rubiaceae	*Burchellia bubalina* (L.f.) Sims	x	x		x	van Wijk *et al.* (2017)
Rubiaceae	*Canthium inerme* (L.f.) Kuntze	x	x		x	van Wijk *et al.* (2017)
Rubiaceae	*Canthium spinosum* (Klotzsch ex Eckl. & Zeyh.) Kuntze	x	x		x	van Wijk *et al.* (2017)
Rubiaceae	*Pavetta revoluta* Hochst.	-	-	-	-	Zwane
Rutaceae	*Agathosma apiculata* E. Mey. ex Bartl. & H.L. Wendl.			x	x	van Wijk *et al.* (2017), Zwane
Rutaceae	*Clausena anisata* (Willd.) Hook.f. ex Benth.	-	-	-	-	van Wijk *et al.* (2017), Zwane
Rutaceae	*Coleonema pulchellum* I. Williams	x				van Wijk *et al.* (2017), Zwane

Family	Genus and species, authorship	Vegetation types according to Mucina and Rutherford (2006)				Identified by:
		Thicket	Afrotemperate Forest	Fynbos	Coastal vegetation	
Rutaceae	*Zanthoxylum capense* (Thunb.) Harv.	x	x		x	van Wijk *et al.* (2017)
Rutaceae	*Zanthoxylum davyi* (I. Verd.) P.G. Waterman	-	-	-	-	Zwane
Salicaceae	*Dovyalis caffra* (Hook.f. & Harv.) Hook.f.	-	-	-	-	van Wijk *et al.* (2017), Zwane
Salicaceae	*Scolopia zeyheri* (Nees) Szyszył.	x	x			van Wijk *et al.* (2017)
Santalaceae	*Colpoon (Osyris) compressum* P.J. Bergius	x	x		x	van Wijk *et al.* (2017), Zwane
Santalaceae	*Thesidium fragile* (Thunb.) Sond.	x		x	x	van Wijk *et al.* (2017)
Sapindaceae	*Allophylus decipiens* (E. Mey.) Radlk.	x	x		x	van Wijk *et al.* (2017)
Sapotaceae	*Sideroxylon inerme* L.	x	x	x	x	van Wijk *et al.* (2017), Zwane
Scrophulariaceae	*Jamesbrittenia microphylla* (L.f.) Hilliard	x		x		van Wijk *et al.* (2017)
Scrophulariaceae	*Selago corymbosa* L.	x				van Wijk *et al.* (2017)
Scrophulariaceae	*Selago myrtifolia* Rchb.	x				van Wijk *et al.* (2017)
Solanaceae	*Lycium ferocissimum* Miers	x				van Wyk *et al.* (2017), Zwane
Solanaceae	*Solunum africanum* Mill.	x			x	van Wijk *et al.* (2017)
Solanaceae	*Solunum linnaeanum* Hepper & P.-M.L. Jaeger	x				van Wijk *et al.* (2017)
Solanaceae	*Withania somnifera* (L.) Dunal	x				van Wijk *et al.* (2017)
Stilbaceae	*Halleria lucida* L.	-	-	-	-	van Wijk *et al.* (2017), Zwane
Stilbaceae	*Nuxia floribunda* Benth.		x			van Wijk *et al.* (2017), Zwane
Thymelaeaceae	*Passerina corymbosa* Eckl. ex C.H. Wright			x	x	van Wijk *et al.* (2017)
Thymelaeaceae	*Passerina ericoides* L.	-	-	-	-	van Wijk *et al.* (2017)
Thymelaeaceae	*Passerina rigida* Wikstr.	x	x		x	van Wijk *et al.* (2017), Zwane
Thymelaeaceae	*Struthiola hirsuta* Wikstr.			x		van Wijk *et al.* (2017)
Vitaceae	*Rhoicissus digitata* (L.f.) Gilg & M. Brandt	x	x		x	van Wijk *et al.* (2017), Zwane

APPENDIX 2 Sea level fluctuations along the east, south and west coast of southern Africa during the Holocene period. AMSL= Above Mean Seal Level (used here for sea elevations originally recorded as 'above mean sea level or a. m. s. l' (Baxter & Meadows 1999), 'above/ below present level' (Butzer 1978 and Butzer in Singer & Wymer 1982) 'above present-day levels or present-day MSL' (Compton 2001), 'above sea level or a. s. l.' (Miller et al. 1995), 'above present datum' (Ramsay 1995), 'above MSL' (Strachan *et al*. 2014) and 'above present sea level' (Wundsch *et al.* 2016).

Author(s)	**Uncalibrated date BP**	**Calibrated date BP**	**Coast, area**	**Seal levels (metres)**	**Klasies cave 1 deposit**
Ramsay 1995	9000		South-east Coast, coastal region	<-5 m below MSL	Cave 1 closed, no occupation
Baxter & Meadows 1999	8500		West Coast, Verlorenvlei Lake	-2 m below MSL	Cave 1 closed, no occupation
Ramsay 1995	8000		South-east Coast, coastal region	-1 m below MSL (Sea rose at 8 mm/year)	Cave 1 closed, no occupation
Baxter & Meadows 1999	8000		West Coast, Verlorenvlei Lake	-2 m below MSL	Cave 1 closed, no occupation
Baxter & Meadows 1999	8000		West Coast, Verlorenvlei Lake	+1 or 2 m AMSL	Cave 1 closed, no occupation
Wundsch *et al.* 2016		8000	Southern Cape, Groenvlei Lake	? m (high stand from ~8000 to 4300)	Cave 1 closed, no occupation
Miller *et al.* 1995	7000		South-western Cape, Lagoons and caves	2-3 m AMSL	Cave 1 closed, no occupation
Baxter & Meadows 1999	6870		West Coast, Verlorenvlei Lake	-3 m below MSL	Cave 1 closed, no occupation
Compton 2001	6800		South-west Coast, Langebaan Lagoon	0-3 m AMSL	Cave 1 closed, no occupation
Strachan *et al.* 2014		6500	East Coast, Kariega Estuary	~ +3 m AMSL	Cave 1 closed, no occupation
Baxter & Meadows 1999	6500		West Coast, Verlorenvlei Lake	3-4 m AMSL	Cave 1 closed, no occupation
Ramsay 1995	6500		South-east, coastal region	0 m AMSL (sea levels reached present levels)	Cave 1 closed, no occupation
Ramsay 1995	6000		South-east, coastal region	+1,5 m AMSL	Cave 1 closed, no occupation
Strachan *et al.* 2014		6000	East Coast, Kariega Estuary	? m (Sea level high stand)	Cave 1 closed, no occupation

Miller *et al.* 1995	6000		South-western Cape, Lagoons and caves	2-3 m AMSL	Cave 1 closed, no occupation
Ramsay 1995	5080		South-east, coastal region	+1.5 m AMSL	Cave 1 closed, no occupation
Ramsay 1995	5000		South-east, coastal region	+2.75 m AMSL	Cave 1 re-opens
Compton 2001	4900		South-west Coast, Langebaan Lagoon	0 m AMSL (sea near present)	Detrital deposit accumulates in cave 1
Butzer 1978	4850-4000		Southern Cape, Klasies River	0 m (sea level at present levels)	LSA I occupation (layers 10 - 12)
Compton 2001	4800		South-west Coast, Langebaan Lagoon	+1 m AMSL	LSA I occupation (layers 10 - 12)
Butzer (in Singer and Wymer 1982)	4745		Southern Cape, Klasies River	? m (Sea probably near present)	LSA I occupation (layers 10 - 12)
Ramsay 1995	4650		South-east, coastal region	+2,75 m AMSL	LSA I occupation (layers 10 - 12)
Compton 2001	4500		South-west-Coast, Langebaan Lagoon	+1 m AMSL	LSA I occupation (layers 10 - 12)
Ramsay 1995	4480		South-east, coastal region	+3,5 m AMSL	LSA I occupation (layers 10 - 12)
Miller *et al.* 1995	4330		South-western Cape, Lagoons and caves	? m AMSL (Sea level high stand)	LSA I occupation
Wundsch *et al.* 2016		4300	Southern Cape, Groenvlei Lake	? m (A decreasing but still elevated sea level)	LSA I occupation
Wundsch *et al.* 2016		4210	Southern Cape, Groenvlei Lake	? m (Higher sea level)	LSA I occupation
Miller *et al.* 1995	4200		South-western Cape, Lagoons and caves	0 m AMSL	LSA I occupation
Miller *et al.* 1995	4020		South-western Cape, Lagoons and caves	±2 m AMSL	LSA I occupation
Baxter & Meadows 1999	4000		West Coast, Verlorenvlei Lake	? m AMSL (transgressed to maximum extent)	LSA I occupation
Strachan *et al.* 2014		4000	East Coast, Kariega Estuary	+2 m AMSL	LSA I occupation
Miller *et al.* 1995	4000		South-western Cape, Lagoons and caves	2 m AMSL (short-lived rise)	LSA I occupation
Ramsay 1995	3880		South-east, coastal region	0 m AMSL (present sea level)	LSA I occupation
Miller *et al.* 1995	3500		South-western Cape, Lagoons and caves	? m (slightly below present)	LSA I occupation

Baxter & Meadows 1999	3500		West Coast, Verlorenvlei Lake	-2 m below MSL (regression phase)	LSA I occupation
Strachan *et al.* 2014		3500	East Coast, Kariega Estuary	? m (sea level below the present level)	LSA I occupation
Ramsay 1995	3360		South-east, coastal region	0 m AMSL	LSA I occupation
Ramsay 1995	3360		South-east, coastal region	-2 m below MSL	LSA I occupation
Wundsch *et al.* 2016		3300	Southern Cape, Groenvlei Lake	? m (decreasing sea level trend; however higher than present mean sea level)	LSA I occupation
Compton 2001	3200		South-west Coast, Langebaan Lagoon	±1 m AMSL	LSA I occupation
Ramsay 1995	3000		South-east, coastal region	-2 m below MSL	LSA I occupation
Strachan *et al.* 2014		2800	East Coast, Kariega Estuary	? m (below the present level)	LSA II occupation (layers 4 - 6)
Butzer (in Singer & Wymer 1982)	2845		Southern Cape, Klasies River	? m (Sea near present)	LSA II occupation (layer 4 - 5?)
Butzer 1978	2850 (-2450)		Southern Cape, Klasies River	? m (Sea near present)	LSAII occupation (layers 4 - 6)
Wundsch *et al.* 2016		2710	Southern Cape, Groenvlei Lake	0 m (present sea level)	LSAII occupation (layers 4 - 6)
Butzer (in Singer & Wymer 1982)	2575		Southern Cape, Klasies River	? m (Sea near present)	LSAII occupation (layers 4 - 6)
Butzer 1978	2500+		Southern Cape, Klasies River	2-4 m (temporary sea rise)	Storm surges between layer 4 and 3
Compton 2001	2500		South-west Coast, Langebaan Lagoon	±1 m AMSL	LSA II occupation
Compton 2001	2500		South-west Coast, Langebaan Lagoon	-1 to -2 m below MSL	LSA II occupation
Nami *et al.* 2016		2340	Southern Cape, Klasies River	? m (seal level near present)	LSA II occupation
Butzer 1978	2300		Southern Cape, Klasies River	? m (Sea levels near present level)	LSA II occupation (layers 1-3)
Strachan *et al.* 2014		2000	East Coast, Kariega Estuary	? m (sea level low stand)	LSA II occupation (layers 1-3)
Compton 2001	1800		South-west Coast,	-1 to -2 m below MSL	No occupation

			Langebaan Lagoon		
Miller *et al.* 1995	1800		South-western Cape, Lagoons and caves	? m AMSL (short-lived sea level rise)	No occupation
Ramsay 1995	1610		South-east. Coastal region	+1,5 m AMSL	No occupation
Baxter & Meadows 1999	1500		West Coast, Verlorenvlei Lake	+ 1 m AMSL	No occupation
Strachan *et al.* 2014		1500	East Coast, Kariega Estuary	+0.5 m AMSL	No occupation
Compton 2001	1500		South-west Coast, Langebaan Lagoon	-1 to -2 m below MSL	No occupation
Compton 2001	1300		South-west Coast, Langebaan Lagoon	+0.7 m AMSL	No occupation
Strachan *et al.* 2014		1300	East Coast, Kariega Estuary	+0.5 to 0.7 m AMSL	No occupation
Wundsch *et al.* 2016		1210	Southern Cape, Groenvlei Lake	0 m (present sea levels)	No occupation
Strachan *et al.* 2014		1100	East Coast, Kariega Estuary	~-0.5 m below MSL	No occupation
Ramsay 1995	900		South-east, coastal region	0 m AMSL	No occupation
Miller *et al.* 1995	800		South-western Cape, Lagoons and caves	? m AMSL (minor sea level rise)	No occupation
Compton 2001	700		South-west Coast, Langebaan Lagoon	-0,5 m below MSL	No occupation
Compton 2001	500		South-west Coast, Langebaan Lagoon	-0.2 m below MSL	No occupation
Strachan *et al.* 2014		300	East Coast, Kariega Estuary	~-0.5 m below MSL	No occupation

APPENDIX 3 List of the comparative species from the contemporary Klasies River landscape along with the description of their microscopic features

Family	Genus	Species	Voucher#	Vessels									Parenchyma		Rays						
				Diam.	Freq.	P.Plate	Arr.	GRB	Pits	H.Thckn	Lngth	V.less	TS arr.	LW	Ho/He	Arr.	Cw	Cht	Uw (µm)	Uht (mm)	Freq.
AMARANTHACEAE	*Exomis*	sp.	BZ069	55,96	50-100	simple	s,srm	dist					para,unilat			sq,					
ANACARDIACEAE	*Searsia*	*crenata*	BZ008/17	35,72	100-150	simple	s, srm	indist	alt, bord		156,3		para, unilat	present	het	sq,u	1c	13c	19,05	<1mm	3
ANACARDIACEAE	*Searsia*	*glauca*	BZ004	41,56	50-100	simple	s, rm, cl?	indist	bord, alt		93,75		rare-absent		het	sq, u	1-2c	12c	20,46	<1mm	5-10
ANACARDIACEAE	*Searsia*	*lucida*	BZ013	43,72	100-150	simple	s	indist	alt		242,2		para,scanty		homo	sq	1-2c	9c	14,52	<1mm	1
ANACARDIACEAE	*Searsia*	*pyroides*	BZ031	30,04	50-100	simple	s	indist	alt, bord		183,6		apo,rare-absent		homo?	sq	1c	7c	14	<1mm	1?
APOCYNACEAE	*Carissa*	*bispinosa*	BZ033	26,76	50-100	simple	s	indist	alt				apo, absent		het	sq,u	1c	3-5c	17	<1mm	
AQUIFOLIACEAE	*Ilex*	*mitis*	BZ050/51	20,16	200-250	simple	s	dist?	alt,				apo,band (4)	present	het	p,u	1-2c	8c	17	<1mm	10-15
ARALIACEAE	*Cussonia*	*thyrsiflora*	BZ036/37	50,68	50-100	simple	cl, s	dist	bord,		195,3		rare-absent		homo	sq/u	1-2c	8c	30	<1mm	4
ASTERACEAE	*Metalasia*	*muricata*	BZ046	34,16	100-150	simple	clus	dist-wdp	alt		164,1		?present		homo?	sq	1-2-3c	12c	50	<1mm	2-3
ASTERACEAE	*Osteospermum*	*moniliferum*	BZ011	36	50-100	simple	lrm	indist	simp,alt		101,6		absent		homo?	sq/ u					
ASTERACEAE	*Stoebe*	*plumosa*	BZ005	17,12	100-150	simple	cl	indist-wdp	alt		125		vesicentric			sq,					
ASTERACEAE	*Tarchonanthus*	*littoralis*	BZ010/24	33,48	150-200	simple	lrm	indist	alt		281,3		absent		het?	sq/p	1-2-3c	6-8c	29	<1mm	5-10
CELASTRACEAE	*Cassine*	*peragua*	BZ019/52	22,62	150-200	simple	s	indist	alt		265,6		apo, band(7)(4-5)	present	homo	sq	1-2c	10c	25	<1mm	6-10
CELASTRACEAE	*Eleodendron*	*croceum*	BZ018	27	200-250	simple	s	indist	alt		164,1		apo,band(7)(5-6)	present	het?	sq,u	1-2c	16c	21	<1mm	10-20
CELASTRACEAE	*Gymnosporia*	*nemorosa*	BZ060	31,84	100-150	simple	s,srm	indist	alt		218,8		apo,band(6)(4-6)	present	het	sq,u	1c	17c	21	<1mm	4-10
CELASTRACEAE	*Mystroxylon*	*aethiopicum*	BZ032	18,46	150-200	simple	sol	indist	alt?		132,8		apo,band(8-9)(3-4)	present	het	sq,u,p	1-2-3c	13c	23	<1mm	7
CELASTRACEAE	*Pterocelastrus*	*tricuspidatus*	BZ007/42	27,4	100-150	simple	s	indist	alt,		144,5		apo, band(5)(4-5)	present	het	sq,u	1-2c	10+c	28	>1mm	3-4
EBENACEAE	*Diospyros*	*dichrophylla*	BZ003/12/14	53,08	50-100	simple	lrm	indist	alt		207		rare-absent		het	sq,p	1c	6c	17	<1mm	3-4
EBENACEAE	*Euclea*	*racemosa*	BZ026/66	38	200-250	simple	s	dist?	alt				absent		homo	u	1-2c	11c	26	<1mm	4-5
ERICACEAE	*Erica*	*glandulosa*	BZ023	33,04	200-250		s	dist					rare?		homo	sq	1-2-3c	10c	27	<1mm	4-8
LAMIACEAE	*Salvia*	*africana-lutea*	BZ048	19	100-150		srm	dist-wdp	alt				rare-absent		homo	u					
MALVACEAE	*Grewia*	*occidentalis*	BZ053	54,62	100-150	simple	s	dist	alt		195,3		absent		het	u,sq,p	1-2-3c	25c	28	0,5	7-10
MORACEAE	*Ficus*	*burtt-davyi*	BZ015/43/44/55	39,62	10-50	simple	s	indist	opp				apo,band(5)(3-5)	present	het	sq,p	2-5c	30c	65	<1mm	2-7
MORACEAE	*Ficus*	sp.	BZ062	34,27	100-150	simple	srm	indist	alt				apo,band(4)(3-4)	present	het	sq,u					
MYRICACEAE	*Morella*	*cordifolia*	BZ056	43,5	100-150	simple	s	indist	bor, alt				absent		homo	p	1-2-3c	14c	27	<1mm	7-10
MYRSINACEAE	*Rapanea*	*melanophloes*	BZ025	25,19	50-100	simple	srm, clu	indist	opp, bord				absent		het	sq,p,u	1-2-3c	20c	35	>1mm	5
MYRSINACEAE	*Rapanea*	*giliana*	BZ068	33,73	200-250	simple	srm	indist	alt, bord				para, vesi	present	het	u,sq	1-2-3c	27c	47	>1mm	4
PITTOSPORACEAE	*Pittosporum*	*viridiflorum*	BZ016	36,5	200-250		s	dist?					absent		homo	p/sq	1-2-3c	7c	21	<1mm	12
POLYGALACEAE	*Polygala*	*myrtifolia*	BZ065	35,31	100-150	simple	s	dist	bord,alt				absent		homo	sq/p	1-2c	12c	23	<1mm	
RHAMNASCEAE	*Phylica*	*axillaris*	BZ057	36,27	150-200	simple	srm	indist	alt,		187,5		absent		homo	u,	1c				
RHAMNASCEAE	*Rhamnus*	*prinoides*	BZ021	35,85	200-250	simple	dendr	dist	?	present			absent		homo	sq	1-2c	6c	15	<1mm	3
RUBIACEAE	*Pavetta*	*revoluta*	BZ061	42,23	100-150	simple	srm	dist	alt,				rare-absent		het	sq,p,u	1-2c	11c	25	<1mm	5-10
RUTACEAE	*Agathosma*	*apiculata*	BZ006	34,36	100-150		s						absent		het	sq,p					
RUTACEAE	*Agathosma*	*ovata*	BZ067	21,5	100-150	simple	lrm	indist					absent		homo	sq					
RUTACEAE	*Clausena*	*anistata*	BZ049	31,8	100-150		s, srm						iband(	present	homo	sq	1-2c	10c	23	<1mm	5
RUTACEAE	*Coleonema*	*pulchellum*	BZ027	38,73	100-150	simple	srm,s	indist	alt		132,8		rare-absent		het?	sq,p	1c	3-10c	10	<1mm	6-11
RUTACEAE	*Zanthoxylum*	*davyi*	BZ035	49,62	50-100	simple	dendr	indist	alt		296,9		iband(5-6)(2-4)	present	het	sq,p,u	1-2c	9c		<1mm	
SALICACEAE	*Dovyalis*	*caffra*	BZ040	29,46	100-150	scal,8-10	srm,s	indist	alt		117,2		rare-absent		het	sq,u	1-2?	10c?			
SALICACEAE	*Dovyalis*	sp.	BZ047	26,73	100-150	simple	s,srm	indist	alt				apo,diff?		het?	sq,u	1-2c	10c	35	<1mm	4-5
SANTALACEAE	*Colpoon*	*compressum*	BZ002/58/64	51,35	100-150	simple	s	indist	alt,simp		144,5		absent		het	sq,u	2 to 3c	10+c	20	<1mm	5
SAPOTACEAE	*Sideroxylon*	*inerme*	BZ034,41	32,92	50-100		clus, srm	indist	bord				apo, iband(8)(2-4)	present	homo	u	1-2c	3-9c	17	<1mm	1-2
SOLANACEAE	*Lycium*	sp.	BZ039	35,15	10-50	simple	clus?	indist	opp, bord				apo,diff		homo	sq	1-2c	5c	20	<1mm	
STILBACEAE	*Halleria*	*lucida*	BZ070	44,92	200-250	simple	s, srm	dist	simple?		203,1		absent		het	sq,u	2-3-4c	10-20c	53	<1mm	5
STILBACEAE	*Nuxia*	sp.	BZ022	34,42	100-150	simple	srm, s	dist	alt		179,7		present(ls)		het?	sq,p	1-2-3c	17c	41	±1mm	10-11
STILBACEAE	*Nuxia*	*floribunda*	BZ059	54,23	50-100	simple	s, srm	dist	alt,simple		218,8		rare (present)	present	het	sq,p, u?	1-2-3c	10-20c	47	<1mm	5-8
STILBACEAE	*Nuxia*	sp.	BZ054	47,5	100-150	simple	ltm, s	dist	alt		156,3		rare?		het	sq, u,	1-2-3c	10-20c	55	0,5-1mm	6
THYMELAEACEAE	*Passerina*	*rigida*	BZ009	30,77	200-250	simple	ltm	indist	alt?	present	121,1		rare			p?,sq?	1c	3 - 6c	10	<1mm	8
VITACEAE	*Rhoicissus*	*tridentata*	BZ020	72	50-100	alt,	s	indist	scal,				para,vesi	present	het	sq,u					

Family	Genus	Species	Voucher#	Fibres			Inclusions		S. elements	
				WT (TS)	Pits (LW)	Spir. Thckn	TS	LW	TS	LW
AMARANTHACEAE	*Exomis*	sp.	BZ069	thin-thick	min,sept					
ANACARDIACEAE	*Searsia*	*crenata*	BZ008/17	thin						
ANACARDIACEAE	*Searsia*	*glauca*	BZ004	thin						
ANACARDIACEAE	*Searsia*	*lucida*	BZ013	thin	sept					
ANACARDIACEAE	*Searsia*	*pyroides*	BZ031	thin						
APOCYNACEAE	*Carissa*	*bispinosa*	BZ033	thin-thick						
AQUIFOLIACEAE	*Ilex*	*mitis*	BZ050/51	thick	sept					
ARALIACEAE	*Cussonia*	*thyrsiflora*	BZ036/37	thick						
ASTERACEAE	*Metalasia*	*muricata*	BZ046	thick						
ASTERACEAE	*Osteospermum*	*moniliferum*	BZ011	thick						
ASTERACEAE	*Stoebe*	*plumosa*	BZ00	thick						
ASTERACEAE	*Tarchonanthus*	*littoralis*	BZ010/24	thick						
CELASTRACEAE	*Cassine*	*peragua*	BZ019/52	thick						
CELASTRACEAE	*Eleodendron*	*croceum*	BZ018	thick						
CELASTRACEAE	*Gymnosporia*	*nemorosa*	BZ060	thick	sept					
CELASTRACEAE	*Mystroxylon*	*aethiopicum*	BZ032	thick				crys		
CELASTRACEAE	*Pterocelastrus*	*tricuspidatus*	BZ007/42	thick	pitted					
EBENACEAE	*Diospyros*	*dichrophylla*	BZ003/12/14	thin	sept					
EBENACEAE	*Euclea*	*racemosa*	BZ026/66	thick						
ERICACEAE	*Erica*	*glandulosa*	BZ023	thin-thick						
LAMIACEAE	*Salvia*	*africana-lutea*	BZ048	thin-thick						
MALVACEAE	*Grewia*	*occidentalis*	BZ053	thin-thick						
MORACEAE	*Ficus*	*burtt-davyi*	BZ015/43/44/55	thin-thick						
MORACEAE	*Ficus*	sp.	BZ062	thick						
MYRICACEAE	*Morella*	*cordifolia*	BZ056	thin	min?					
MYRSINACEAE	*Rapanea*	*melanophloes*	BZ025	thick						
MYRSINACEAE	*Rapanea*	*giliana*	BZ068	thick						
PITTOSPORACEAE	*Pittosporum*	*viridiflorum*	BZ016	thin-thick						
POLYGALACEAE	*Polygala*	*myrtifolia*	BZ065	thin-thick						
RHAMNASCEAE	*Phylica*	*axillaris*	BZ057	thin	sept					
RHAMNASCEAE	*Rhamnus*	*prinoides*	BZ021	thin-thick						
RUBIACEAE	*Pavetta*	*revoluta*	BZ061	thin-thick						
RUTACEAE	*Agathosma*	*apiculata*	BZ006	thin-thick						
RUTACEAE	*Agathosma*	*ovata*	BZ067	thin-thick						
RUTACEAE	*Clausena*	*anistata*	BZ049							
RUTACEAE	*Coleonema*	*pulchellum*	BZ027	thin-thick						
RUTACEAE	*Zanthoxylum*	*davyi*	BZ035	thick						
SALICACEAE	*Dovyalis*	*caffra*	BZ040	thin						
SALICACEAE	*Dovyalis*	sp.	BZ047	thin						
SANTALACEAE	*Colpoon*	*compressum*	BZ002/58/64	thick	sept					
SAPOTACEAE	*Sideroxylon*	*inerme*	BZ034,41	thin-thick						
SOLANACEAE	*Lycium*	sp.	BZ039	thin-thick						
STILBACEAE	*Halleria*	*lucida*	BZ070	thin-thick						
STILBACEAE	*Nuxia*	sp.	BZ022	thin-thick						
STILBACEAE	*Nuxia*	*floribunda*	BZ059	thin-thick						
STILBACEAE	*Nuxia*	sp.	BZ054	thin-thick						
THYMELAEACEAE	*Passerina*	*rigida*	BZ009	thick						
VITACEAE	*Rhoicissus*	*tridentata*	BZ020	thick				crys		

APPENDIX 3a Vessel diameters measured from the comparative species. Species are listed according to the alphabetical order of their families (see Appendix 3 for names of species)

Wood voucher	Vessel diameter measurements in micrometres (µm)	Average
BZ017	45,40,40,47,40,40,45,48,39,44,50,40,35,20,20,30,40,40,30,40,40,20,10,20,20	35.72
BZ004	40,47,40,40,35,39,39,40,39,20,37,36,43,50,35,37,64,41,51,45,49,43,43,45,41,	41.56
BZ013	32,30,45,50,50,40,50,32,30,40,39,80,50,40,40,40,40,50,40,40,35,50,50,40,40,20	43.72
BZ031	25,20,18,25,20,20,20,25,20,25,40,50,50,40,40,30,20,40,40,40,30,50,50,60,25	30.04
BZ033	42,41,26,36,24,25.5,31,23,30,30,30,30,40,30,20,20,30,30,20,40,30,40,30,40,30	26.76
BZ050	20,20,19,20,21,22,22, 25,25,25,20,20,30,30,10,20,15,20,20,15,10,20,20,15,20	20.16
BZ036	20,20,40,60,25,20,50,40,60,40,56,72,47,55,50,45,50,67,63,79,60,60,46,51,101	50.68
BZ011	40,45,45,40,40,40,35,40,45,40,40,20,50,50,40,40,50,30,30,40,50,30,40,50,30	36
BZ046	47,47,48,39,32,35,33,35,28,45,32,36,45,50,51,40,52,44,29,35,30,32,42,32,39,37	34.16
BZ005	20,20,18,22,10,20,15,20,20,18,20,20,20,15,20,20,15,15,15,15,10,10,10,20,20,	17.12
BZ024	20,38,27,27,32,28,36,28,33,34,36,26,39,37,29,30,32,25,30,31,37,37,28,31,32,34	33.48
BZ010	40,40,50,40,40,40,45,40,35,35,50,40,40,40,40,30,40,20,40,30,40,40,40,50,40	39.4
BZ052	43,32,27,26,30,22,25,17,21,19,16,20,22,21,34,20,18,18,21,19,17,18,19,19,19,25,	22.62
BZ018	30,30,20,20,20,30,20,30,20,20,25,28,32,31,32,25,27,29,25,27,25,22,28,31,39,36	27
BZ060	20,30,25,20,39,30,39,25,30,25,37,44,34,34,35,29,36,33,40,29,40,26,33,28,35	31.84
BZ032	15,25,17,16,19,20,15,15,15,16,21,19,17,19,17,19,29,23,14,18,26,15,20,14,18,18	18.46
BZ042	30,35,30,30,25,30,35,25,35,30,30,30,25,30,30,40,30,25,30,30,40,40,40,30,30	27.4
BZ069	60,60,100,100,90,80,90,30,30,30,59,34,29,70,56,82,43,57,28,25,59,34,61,36	55.96
BZ014	50,45,60,60,45,40,50,60,50,60,50,60,50,50,60,60,40,60,60,60,50,60,40,80,40,40	53.08
BZ066	30,30,40,60,30,40,30,60,60,50,35,40,34,35,41,39,36,41,28,22,23,23,41,42,37,41	38
BZ023	20,30,30,30,30,30,20,30,40,30,41,35,36,46,36,36,30,36,42,31,40,35,32,50,36,29	33.04
BZ048	20,20,19,20,30,35,20,30,30,20,20,15,15,15,10,20,20,20,25,20,10,10,10,30,20,10	19
BZ053	50,50,80,60,60,60,30,70,50,40,58,62,50,63,64,66,42,63,50,48,71,54,62,41,33,43	54.62
BZ043	40,40,50,40,40,40,40,30,40,40,40,30,40,40,40,50,40,50,40,50,40,30,40,40,30,30	39.62
BZ062	40,30,40,40,30,20,40,30,40,40,29,23,32,28,33,32,29,37,37,40,36,32,28,35,46,42	34.27
BZ056	40,40,30,30,35,60,70,50,40,40,70,40,56,45,45,50,38,62,38,52,49,66,53,63,60,50	43.5
BZ025	20,15,15,15,20,15,15,20,20,20,27.5,31,32,28,25,31,31,30,42,33,30,31,32,41,35	25.19
BZ068	30,20,20,20,30,40,30,30,20,30,31,44,42,43,43,38,37,37,37,35,40,37,27,39,35,42	33.73
BZ016	30,20,30,30,30,40,30,30,30,40,46,47,42,41,43,38,34,36,37,58,36,38,28,42,39,34	36.5
BZ065	40,45,30,45,40,50,40,40,20,30,32,31,28,31,26,31,29,49,44,27,38,32,37,42,36,30	35.31
BZ057	40,40,50,50,40,40,40,50,30,50,29,26,37,32,37,30,39,29,21,37,30,41,40,36,22,27	36.27
BZ021	45,40,40,45,30,20,50,40,35,40,36,40,36,37,20,38,45,43,40,18,18,38,38,32	36
BZ006	30,20,30,20,20,40,50,40,40,40, 39,55,31,33,32,19,36,36,31,26,30,43,33,44,41	34.36
BZ061	44,34,44,46,51,40,48,44,61,41,45,47,45,50,52,39,36,50,49,44,34,28,32,32,32,30	42.23
BZ067	20,20,25,20,35,15,20,20,20,20,40,30,20,20,30,20,20,10,40,30,10,30,20,20,30,20	22.3
BZ049	30,40,35,30,20,35,25,30,25,40,40,35,20,20,25,40,35,35,40,20,35,40,35,30,35	31.8
BZ027	28,38,30,25,32,42,29,40,29,41,35,25,42,40,44,42,44,56,41,40,43,45,35,46,37,48	38.73
BZ035	40,60,60,40,60,60,70,50,60,70,50,50,40,45,50,45,30,30,45,50,50,50,40,60,65,40	49.62
BZ040	33,27,32,31,22,25,36,31,34,29,30,34,23,28,21,23,29,36,40,39,28,24,32,21,26,31	29.46
BZ047	20,30,20,20,40,30,25,30,20,25,25,25,20,25,30,30,30,25,20,25,30,25,20,35,35,35	26.73
BZ064	50,40,40,30,50,50,40,60,40,40,54,49,50,47,53,52,38,54,90,45,51,32,42,38,57,58	51.35
BZ041	30,30,40,30,40,40,40,30,40,30,21,22,20,24,45,31,32,41,35,35,30,21,27,38,36,38	32.92
BZ039	60,30,40,30,30,30,20,20,40,30,31,56,36,29,21,44,35,35,27,39,39,41,41,40,38,42	35.15
BZ070	40,35,30,30,40,35,25,40,50,40,51,60,48,37,53,40,64,47,57,56,55,46,42,47,48,42	44.92
BZ022	20,35,20,30,20,10,25,25,10,35,20,20,25,30,20,20,30,45,45,70,70,60,65,40,60,45	34.42
BZ059	65,40,50,60,70,60,70,50,40,40,80,50,60,70,60,50,50,70,60,75,20,40,60,80,80,40	54.23
BZ054	30,30,40,40,50,50,60,50,60,50,45,50,60,40,50,40,60,60,40,60,40,60,60,40,40,30	47.5
BZ009	40,40,30,30,40,40,20,20,40,40,25,20,40,20,30,20,25,40,20,25,20,40,50,20,25,40	30.77
BZ020	40,100,60,80,80,100,80,80,60,60,80,40,50,50,80,80,100,60,90,70,80,90,60,60,70	72

APPENDIX 3b Vessel frequencies calculated from the comparative species. Species are listed according to the alphabetical order of their families (see Appendix 3 for names of species)

Wood #	Fields	Frequency/mm²	Average frequency(mm²)
BZ017	1 2 3 4	74 131 86 129	105
BZ004	1 2 3 4	51 70 66 74	65.25
BZ013	1 2 3 4	146 154 159 161	155
BZ031	1 2 3 4	151 126 122 131	132.5
BZ033	1 2 3 4	118 124 126 114	120.5
BZ050	1 2 3 4	133 154 162 166	153.75
BZ036	1 2 3	94 44 68	68.67
BZ011	1 2 3 4	74 66 82 64	71.5
BZ046	1 2 3 4	65 98 132 70	91.25
BZ005	1 2 3	81 91 79	83.67
BZ024	1 2 3 4	122 134 134 143	133.25
BZ010	1 2 3	168 134 173	158.33
BZ052	1 2 3 4	225 227 239 210	225.25
BZ018	1 2 3 4	250 206 194 225	218.75
BZ060	1 2 3 4	201 195 186 215	199.25
BZ032	1 2 3 4	212 230 189 184	203.75
BZ042	1 2 3 4	110 108 96 92	101.5
BZ069	1 1 3	88 76 92	83.25

	4	77	
BZ014	1	124	106.75
	2	102	
	3	97	
	4	104	
BZ066	1	279	254
	2	254	
	3	222	
	4	261	
BZ023	1	279	196.75
	2	170	
	3	186	
	4	152	
BZ048	1	158	143.25
	2	144	
	3	132	
	4	139	
BZ053	1	90	71.75
	2	76	
	3	59	
	4	62	
BZ043	1	29	32.25
	2	34	
	3	36	
	4	30	
BZ062	1	130	122
	2	122	
	3	127	
	4	109	
BZ056	1	112	116
	2	122	
	3	124	
	4	106	
BZ025	1	140	123.75
	2	115	
	3	127	
	4	113	
BZ068	1	142	147.5
	2	148	
	3	152	
	4	148	
BZ016	1	307	286
	2	288	
	3	278	
	4	271	
BZ065	1	125	119.25
	2	114	
	3	117	
	4	121	
BZ057	1	188	160.75
	2	154	
	3	144	
	4	157	
BZ021	1	252	241.75
	2	274	
	3	222	
	4	219	
BZ006	1	156	110.75
	2	96	
	3	89	
	4	102	
BZ061	1	139	140.25
	2	133	
	3	147	
	4	142	
BZ067	1	152	152.5
	2	158	
	3	151	
	4	149	
BZ049	1	132	124.5
	2	117	
BZ027	1	152	159.5
	2	147	
	3	165	
	4	174	

BZ035	1 2 3 4	82 74 70 79	76.25
BZ040	1 2 3 4	152 147 149 134	145.5
BZ047	1 2 3 4	167 146 149 152	153.5
BZ064	1 2 3 4	104 74 72 77	81.75
BZ041	1 2 3 4	94 76 86 71	81.75
BZ039	1 2 3 4	88 78 64 81	77.75
BZ070	1 2 3 4	252 211 197 225	221.25
BZ022	1 2 3 4	121 88 86 92	96.75
BZ059	1 2 3 4	52 48 42 41	45.75
BZ054	1 2 3 4	154 156 144 150	151
BZ009	1 2 3 4	271 223 256 247	249.25
BZ020	1 2 3 4	111 89 129 96	106.25

APPENDIX 3c Measurements of the ray structures of the comparative species. Species are listed according to the alphabetical order of their families (see Appendix 3 for names of species)

Wood #	cw	ch	Uw (µm)	uh (µm)	Frequency/mm^2
BZ017	1. 1 2. 1 3. 1	12 14 13	17.62 25.13 14.40	305.08 310.08 326.55	2-4
BZ004	1. 1 2. 1 3. 1 4. 1-2	12 13 7 15	24.40 17.60 15.39 24.44	304.00 295.36 165.39 320.92	5-10
BZ013	1. 1 2. 1-2	5 12	14.04 15.00	128.14 250.00	2-4
BZ031	1. 1 2. 1	7 8	12.6 15.39	160.01 154.89	2-4
BZ033	1. 1 2. 1 3. 1(-2)	5 6 10	10.5 11.00 10.18	121.12 210.20 116.11	4-8
BZ050	1. 1 2. 1 3. 1-2 4. 1-2	10 11 5 5	15.36 13.78 16.02 24.48	313.96 263.59 162.61 195.11	10-16
BZ036	1. 1-2 2. 1-2 3. 1	12 5 7	15.27 20.00 55.26	201.70 100.00 560.32	4
BZ011	-	-	-	-	-
BZ046	1. 3 2. 3 3. 2	7 23 5	46.84 62.08 40.05	225.79 600+ 292.92	2-4
BZ005	-	-	-	-	-
BZ024	1. 1-2 2. 1 3. 1-2 4. 1-2	6 8 8 6	33.00 22.00 24.40 35.05	171.63 217.94 186.57 189.64	5-10
BZ052	1. 1-2 2. 1-2 3. 1-2 4. 1-2	16 7+ 10 12	19.09 20.66 21.27 25.00	230.00 132.54+ 154.22 196.00	9-10
BZ019	1. 1-2 2. 1-2 3. 1-2 4. 1-2	11 7 11 11	17.00 18.31 20.66 21.28	220.00 162.00 221.29 235.00	4-12
BZ018	1. 1 2. 1-2 3. 1 4. 1	26+? 11 12 9	19.89 23.52 19.90 19.11	1mm 300 300-500 300-500	10-20
BZ060	1. 1 2. 1-2 3. 1 4. 1-2	10 21 24 12	17.46 26.57 19.86 19.86	199.83 500.00 400.00 300.00	7-10
BZ032	1. 3 2. 1	11 14	22.80 30.60	170.21 161.62	7
BZ042	1. 1-2 2. 1-2	10+ 15+	24.11 32	>1mm >1mm	3-4?
BZ069	-	-	-	-	-
BZ014	1. 1 2. 1 3. 1 4. 1	4 6 9 5	14.42 18.24 18.24 16.81	152.41 210.46 330.00 196.76	3-4

BZ066	1. 1-2 2. 1-2 3. 1-2	13 10 10	27.45 26.56 25.13	330.00 326.00 308.66	4-5
BZ023	1. 3 2. 1-2 3. 1-2-3	14 6 9	35.91 15 29.92	285.00 200.00 267.76	4-8
BZ048	-	-	-	-	-
BZ053	1. 2-3 2. 3-3 3. 2-3 4. 1-2-3	14 21 50+ 10-15	23.67 24.52 36.35 26.85	203.12 326.85 1mm+ 500.00	8-12
BZ043	1. 2-5 2. 3-5 3. 1-2 4. 1-2	30+ 28+ 10 10-15	14.70 82.00 16.83 12.96	600+ 600+ 154.12 215.33	4-8
BZ062	-	-	-	-	-
BZ056	1. 1-2 2. 1-2 3. 1-2-3 4. 1-2-3	11 15 18 12	18.61 29.00 25.00 33.69	241.07 327.6 400.00 224.27	4-12
BZ025	1. 1-2 2. 2-3 3. 1-2-3 4. 1-2	20+ 20+ 10-20 20+	35.81 41.12 38.91 29.8	>1mm >1mm >1mm >1mm	3-4
BZ068	1. 1-2 2. 1-5 3. 2-3-4	20+ 30+ 30+	36.05 57.20 48.14	>1mm >1mm >1mm	<5
BZ016	1. 1-2-3 2. 1-2 3. 1-2	10+ 6 6	20-30 18.01 21.00	314-1mm? 127.00 122.00	12?
BZ065	1. 1-2 2. 1-2	10 14	26.00 19.17	166.00 500.00	
BZ057	-	-	-	-	-
BZ021	1. 1 2. 1 3. 1-2	8 3 7	13.78 14.65 16.80	213.51 97.87 285.86	2-4
BZ006	-	-	-	-	-
BZ061	1. 1-2 2. 1-2 3. 1-2	16 9 9	25.12 20.60 27.53	325.00 214.74 254.89	4-12
BZ067	-	-	-	-	-
BZ049	1. 1-2 2. 1	10 6	24.62 18.01	160.97 109.30	4-8
BZ027	1. 1 2. 1 3. 1 4. 1 5. 1	3-10 8 7 8 11	11.14 9.23 9.26 8.44 13.94	166.12 151.28 133.54 112.82 194.25	4-12
BZ035	1. 1-2	8	161.52	<1mm	-
BZ040	1. 1-2?	10?	-	-	-
BZ047	1. 1-2 2. 1-2	10 9	35.39 34.48	278.16 290.09	4-5
BZ064	1. 1-2 2. 2 3. 1-2	14 17 11	28.17 26.83 30.71	252.19 300-500 292.51	5-7
BZ041/34	1. 1 2. 1 3. 1-2	3-4 5 9-10	18.60 16.18 18.99	206.4 84.89 235.60	1-4
BZ039	1. 1 2. 1-2 3. 1 4. 1	4 7 5 5	15.20 27.00 16.29 21.50	147.00 206.00 135.50 120.00	4-5

BZ070	1. 2-3-5 2. 2-3-4 3. 2-3 4. 2-3-4	10-20 20+ 20+ 16-20	64.89 47.00 49.35 52-54	500-600 1mm 1mm 800-1000	7-11
BZ022	1. 1-2 2. 1-2 3. 1-2 4. 1-2	18 30+ 8+? 10	51.00 41.00 32.00 40.48	0.5-1mm >1mm >1mm 306.20	8-12
BZ059	1. 1-2-3 2. 1-2 3. 1-2	19 8 19	39.0 55.69 45.60	325.00 275.00 600.00	4-8
BZ054	1. 2-3 2. 1-2 3. 1-2-3	20+ 10-20 10-15	68.82 26.45 68.91	>1mm >1mm 300-500	2-4
BZ009	1. 1	3-6	10.00	110.00	4-8
BZ020	1. 1-8	30+	100+	>1mm	?

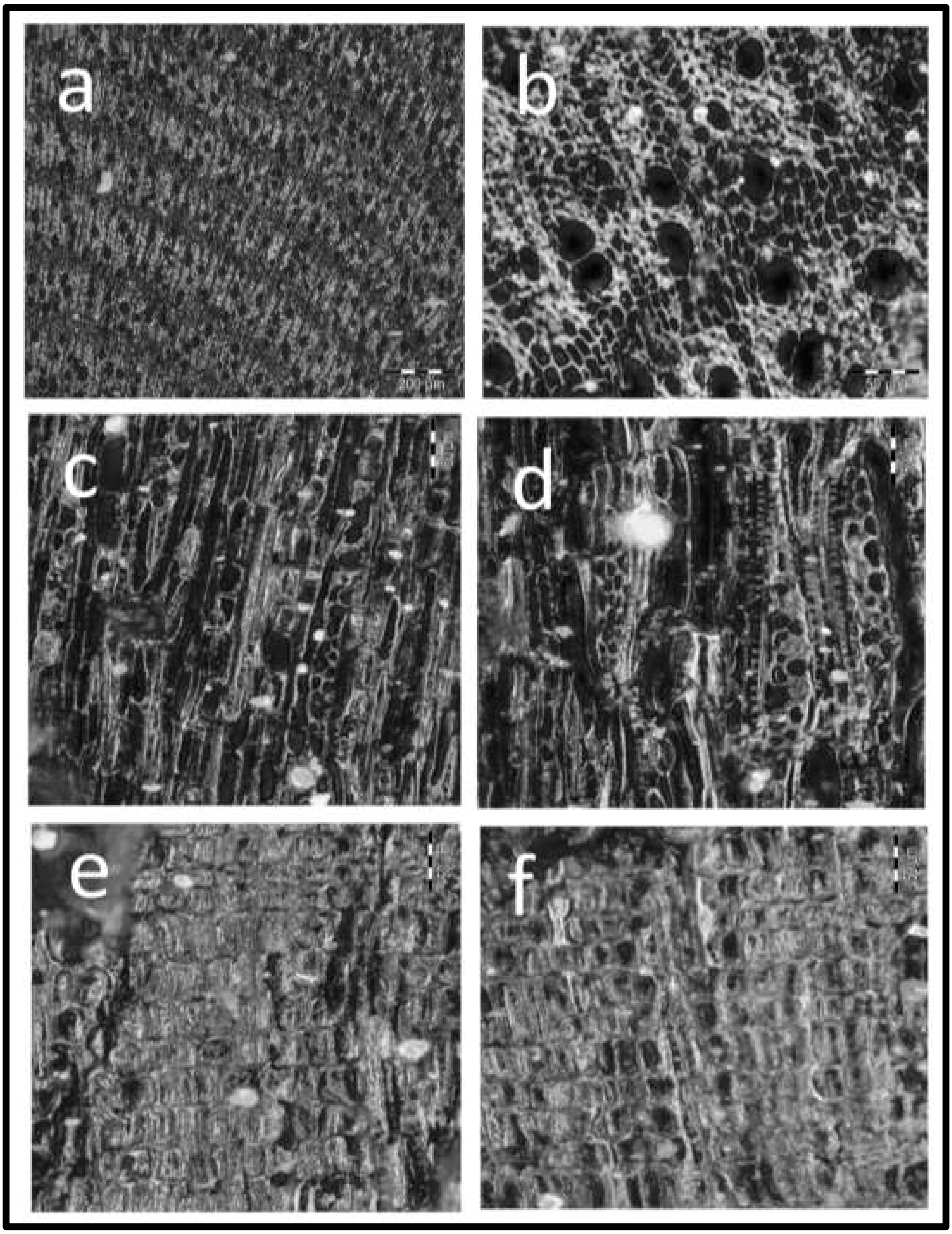
APPENDIX 4 Key to the abbreviations used in and APPENDIX 3 and APPENDIX 6.

Features		Abbreviations		Expansion
		Headings	Descriptions	
Anatomical	Vessels	Diam.		Tangential diameter of vessel lumina measured in micrometres (µm)
		Freq.		Frequency of vessels per square millimetres (mm^2)
		P.Plate		Perforation plates
			sim	Simple perforation plate
			scal	Scalariform perforation plate
		Arr.		Vessel groupings or arrangement
			s/sol	Solitary vessel arrangement
			srm	Vessels short radial multiples
			clus	Vessel clusters
			dendr	Dendritic vessel arrangement
			lrm	Long radial multiples
		GRB		Growth ring boundaries
			indist	Indistinct growth ring boundaries
			dist	Distinct growth ring boundaries
			wdp	Wood diffuse porous
			srp	Semi-ring porous
		Pits		Intervessel pits: arrangement and size in micrometres
			alt	Intervessel pits alternate
			opp	Intervessel pits opposite
			scal	Intervessel pits scalariform
			elong	Elongated or gash-like Intervessel pits
		H. Thckn		Helical thickenings
		Lngth		Mean vessel element length in millimetres (µm)
		Vless		Wood is vesselless

	Parenchyma	TS arr.		Axial parenchyma along the Transverse Section
			para	Paratracheal axial parenchyma
			apo	Apotracheal axial parenchyma
			apo, band	Banded parenchyma (bands/ linear millimetres) (cells per band)
		LW		Presence of parenchyma cells on the longitudinal walls
	Rays	Ho/He		Homocellular or Heterocellular ray cellular composition
		Arr.		Ray cell composition types
			sq	Square ray cells
			u	Upright ray cells
			p	Procumbent ray cells
		Cw		Cell width based on the number of cells per ray
		Cht		Cell height based on the number of cells per ray
		Uw		Cell width based on measurements in micrometres (µm)
		Uht		Cell height based on the measurements in micrometres (µm)
		Freq.		Frequency of rays per linear millimetres (mm)
	Fibres	WT(TS)		Fibre wall thickness along the Transverse Section
			thin	Thin; lumina diameter more than twice of the size wall
			thin-thick	Thin to thick; lumina diameter equals the size of the wall
			thick	Thick; lumina diameter less than size of the wall
		Pits		Fibre pits on the Longitudinal walls
			bord	Bordered pits
			sept	Septate fibres
		S. Thckn		Spiral thickenings on fibre walls
Miscellaneous	Inclusions	TS		Inclusions on the Transverse Section
			tyl	Tyloses and deposits in vessels
		LW		Inclusions on the Longitudinal Walls
			crys	Prismatic crystals
			sil	Silica bodies
			drus	Druses
	S. elements			Secretory elements
		TS		Secretory elements over the Transverse Section
		LW		Secretory elements over the Longitudinal Walls
			can	Intercellular canals
			cam	Other cambial variants

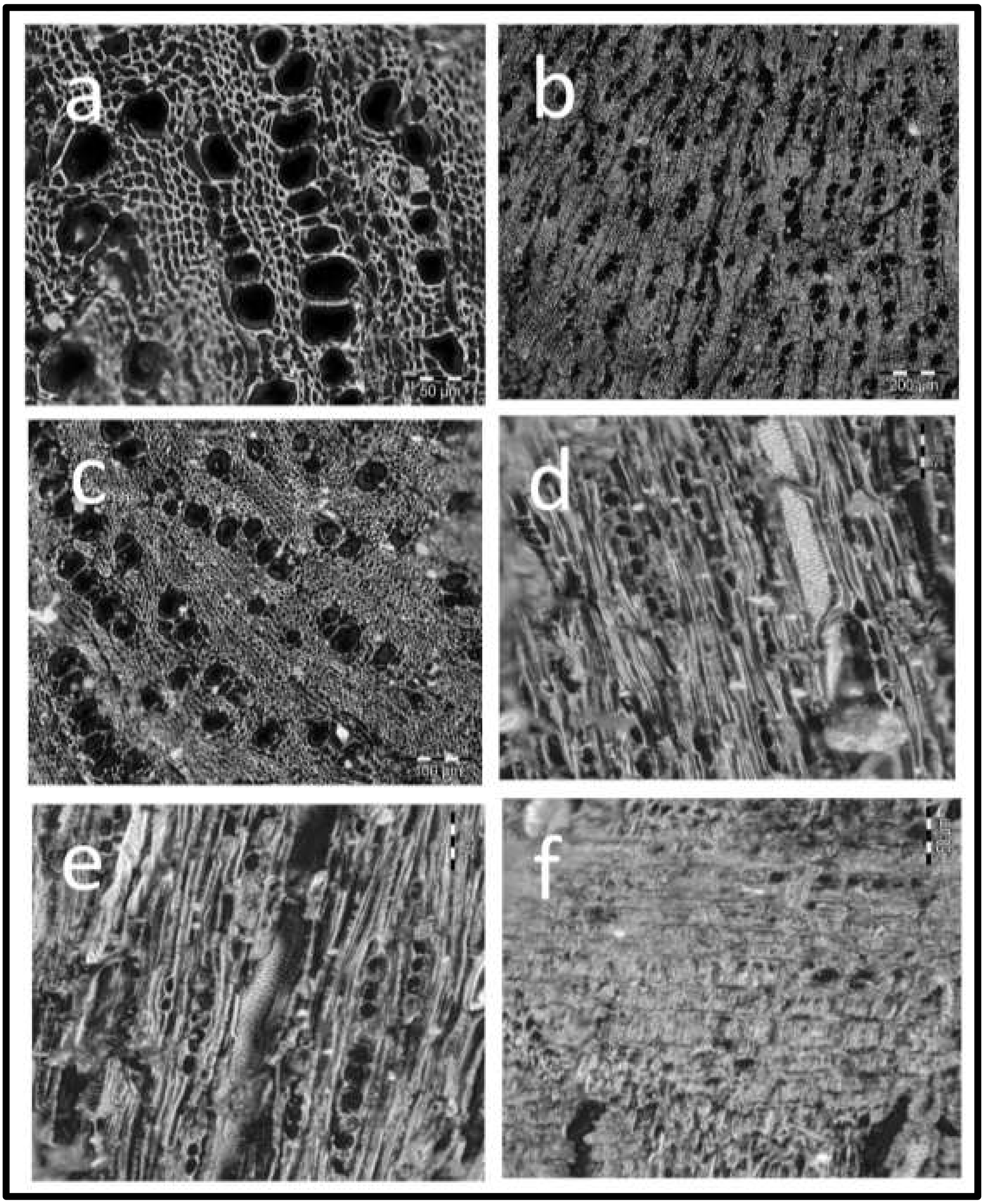
APPENDIX 5 Micrographs of 20 selected comparative species. Species are presented in alphabetical order of their genera.

1. *Cassine peragua*



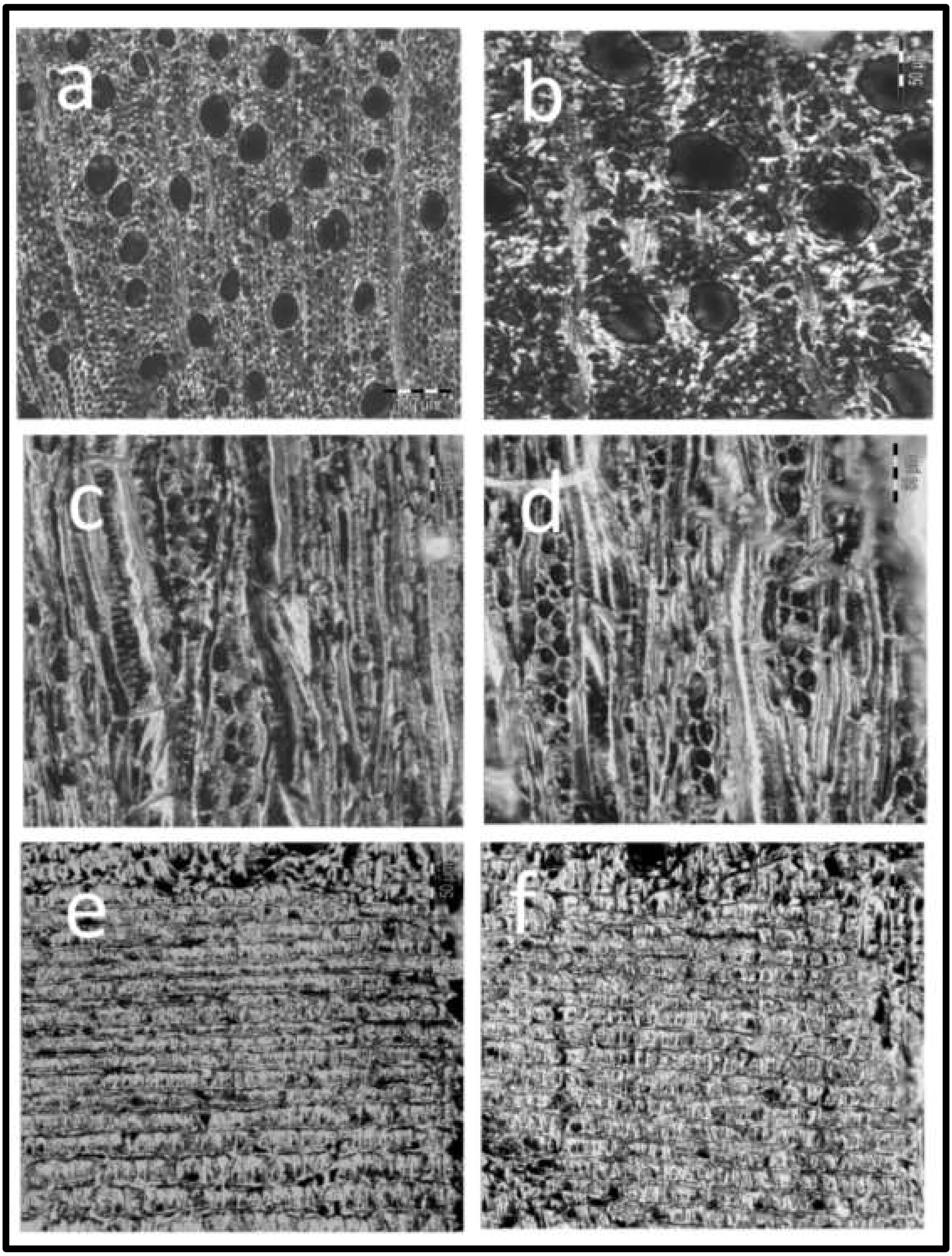
The microstructure of *C. peragua* showing (a) the solitary vessel arrangement and banded parenchyma; (b) parenchyma cells per band and diameter of vessel lumina (23µm); (c) parenchyma cells on the longitudinal walls; (d) the biserriate rays and (e), (f) the square ray cells.

2. Coleonema pulchellum



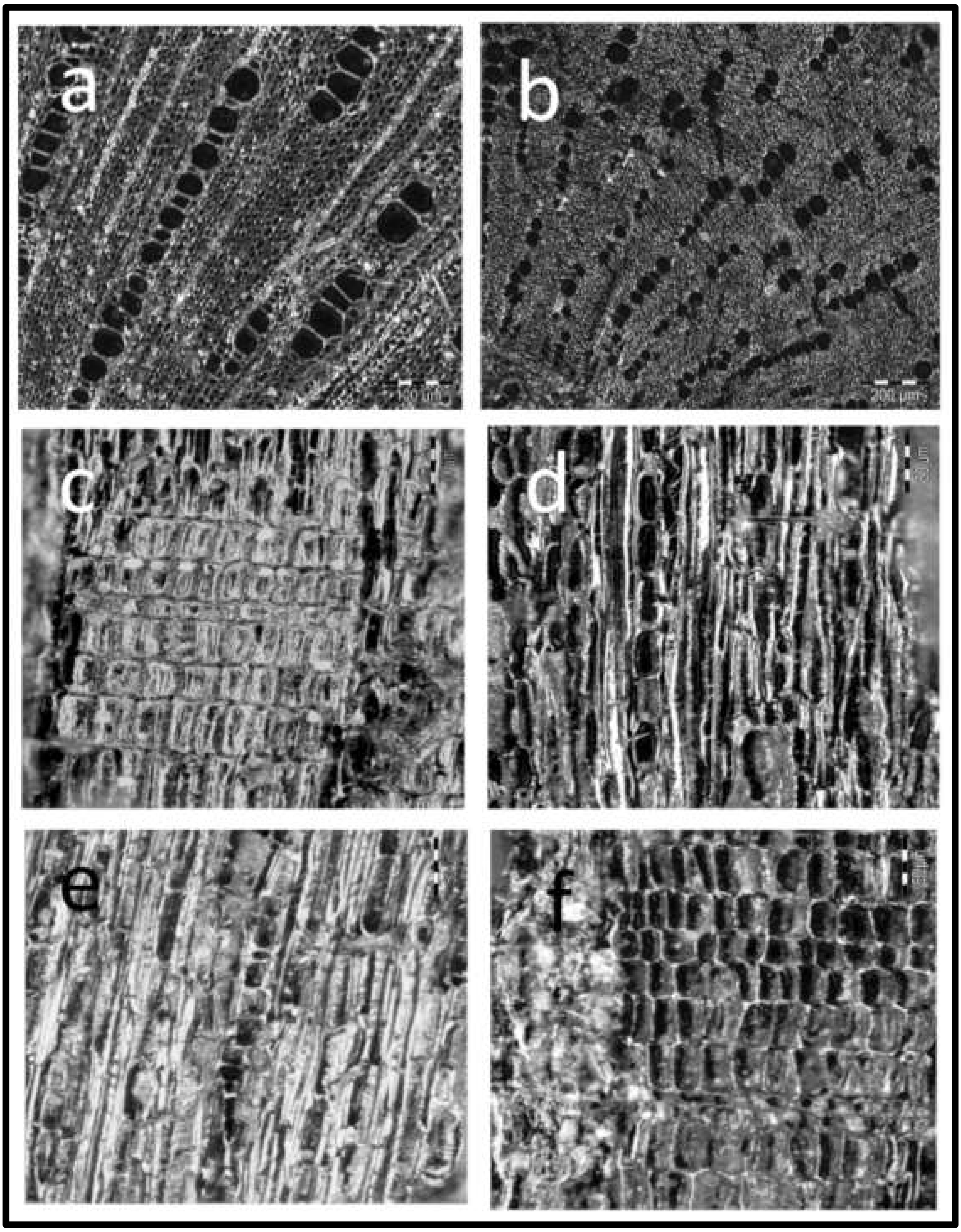
The microstructure of *C. pulchellum* showing the diameter of vessel lumina (39µm); (b), (c) the short radial multiple vessel arrangement, (d), (e) the uniserriate and biserriate rays, vessel elements, simple perforation plates and alternating intervesssel pits and (f) square and procumbent ray cells.

3. Colpoon compressum



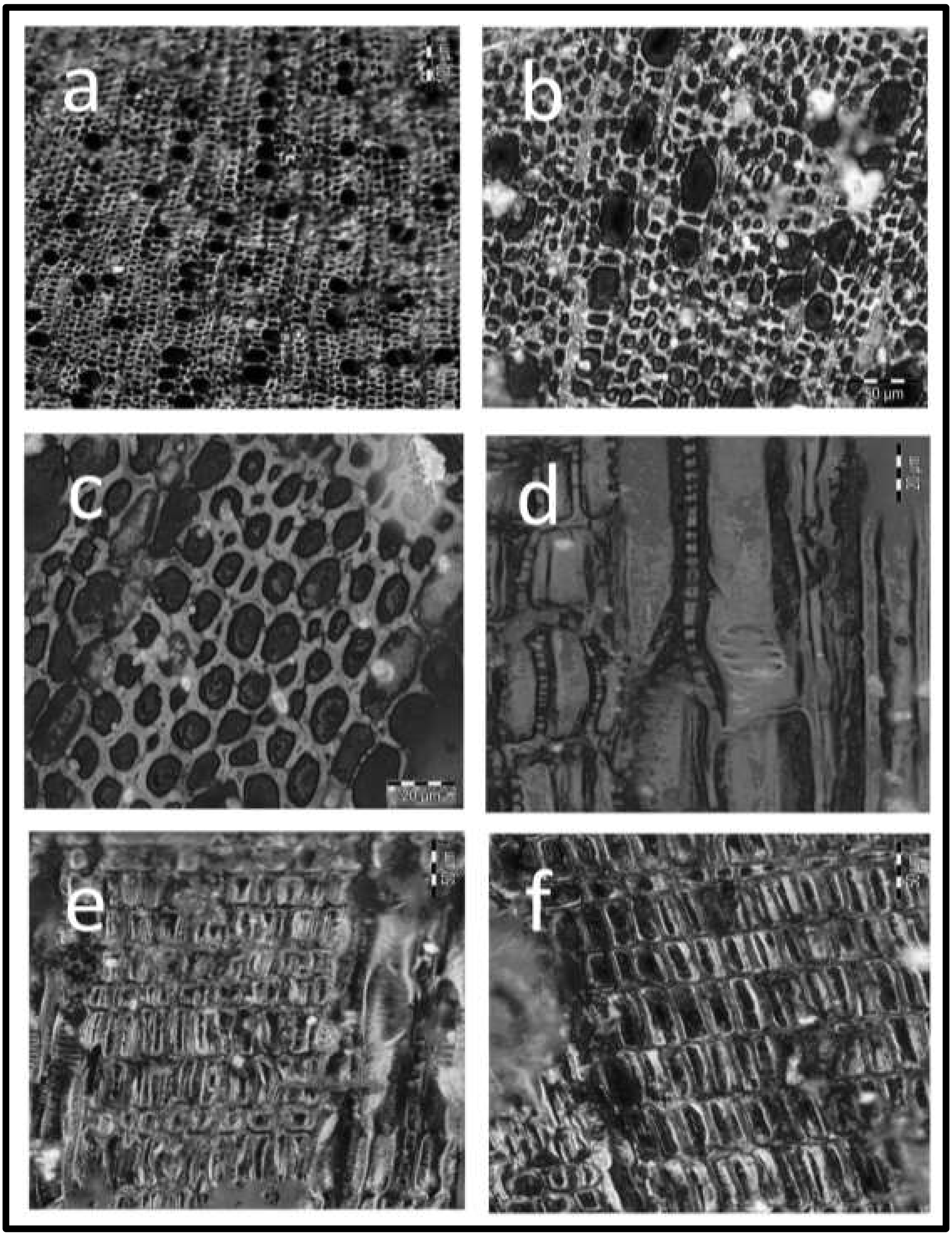
The microstructure of *C. compressum* showing (a) the vessel arrangement; (b) the diameter of the vessel lumina and thick fibres; (c) biserriate rays and vessel elements with alternating inter-vessel pits; (d) biserriate rays and septate fibres and (e), (f) square and upright ray cells.

4. Diospyros dichrophylla



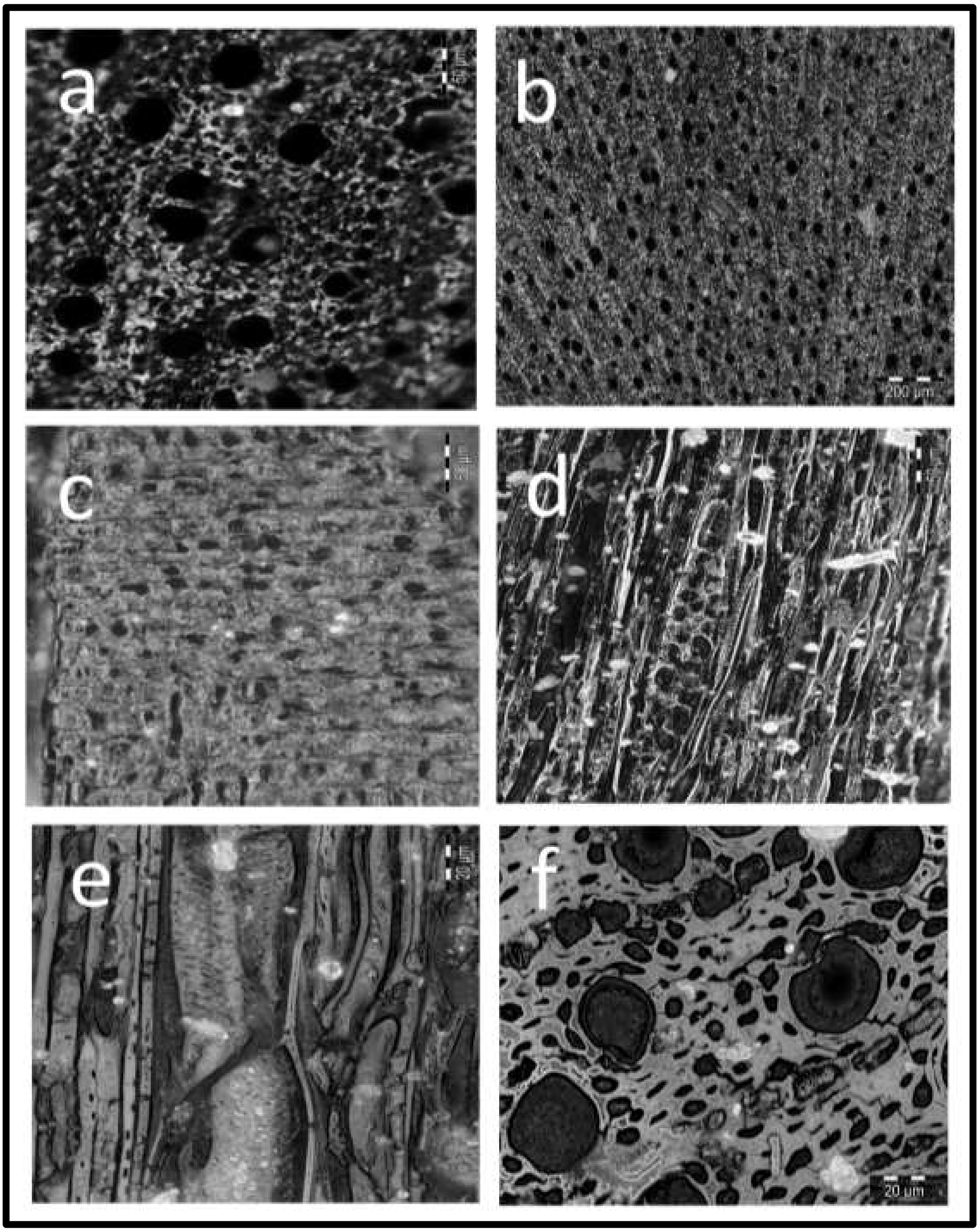
The microstructure of *D. dichrophylla* showing (a) the diameter of vessel lumina and thin fibres; (b) the long radial multiple vessel arrangement; (c), (f) square, procumbent and upright ray cells and (d), (e) uniserriate rays and septate fibres.

5. *Dovyalis caffra*



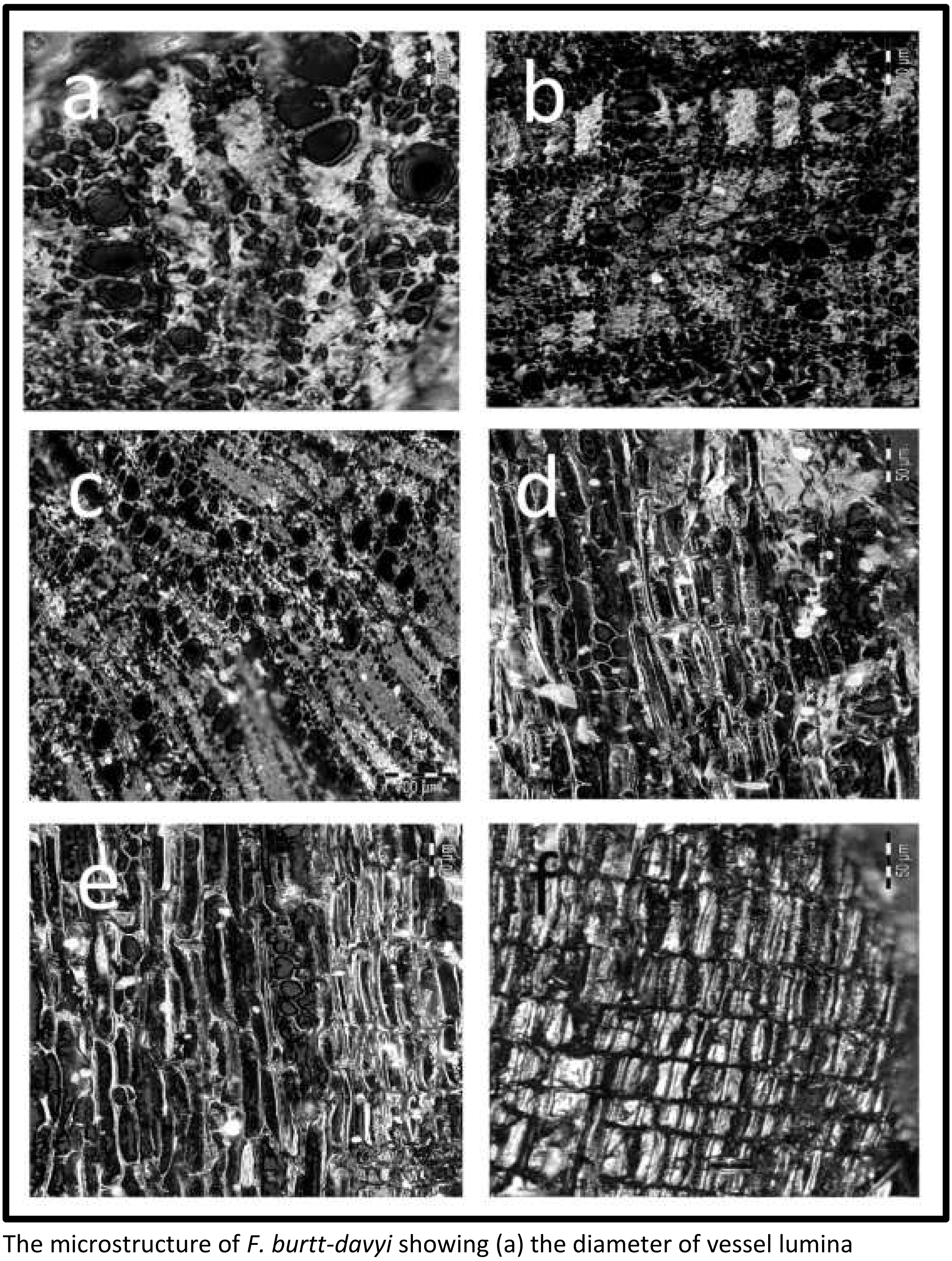
The microstructure of *D. caffra* showing solitary and short radial multiple vessel arrangement; (b) diameter of the vessel lumina; (c) thin fibres; (d) vessel elements with scalariform perforation plates (5-6 bars) along pitted fibres and e), (f) vessel elements as well as square and upright ray cells.

6. Erica glandulosa



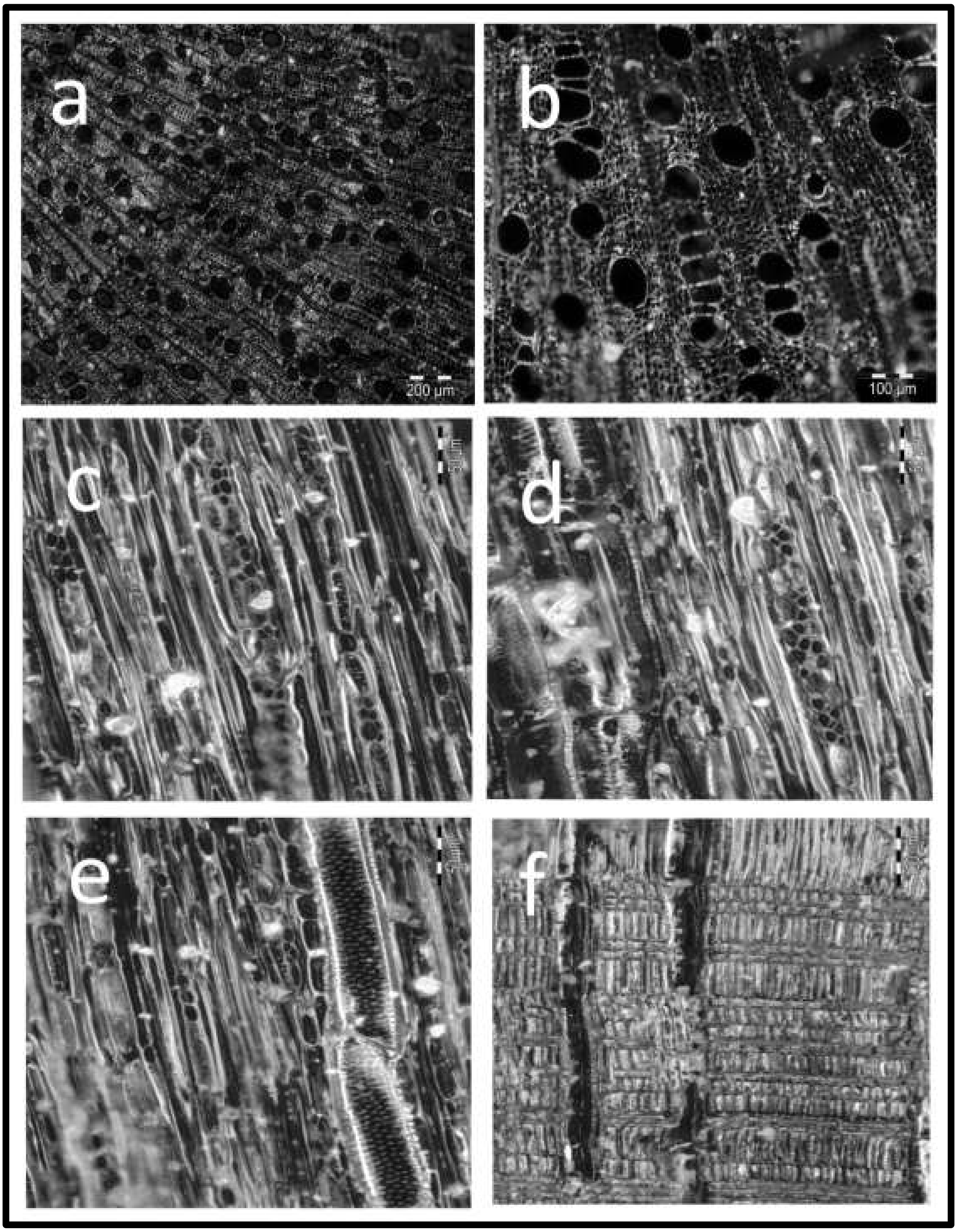
The microstructure of *E. glandulosa* showing (a) the diameter of vessel lumina; (b) the solitary vessel arrangement; (c) square and procumbent ray cells; (d) biserriate rays; e) vessel elements with simple perforation plates and alternating intervessel pits along pitted fibres and (f) thick fibres on the TS.

7. Ficus burtt-davyi



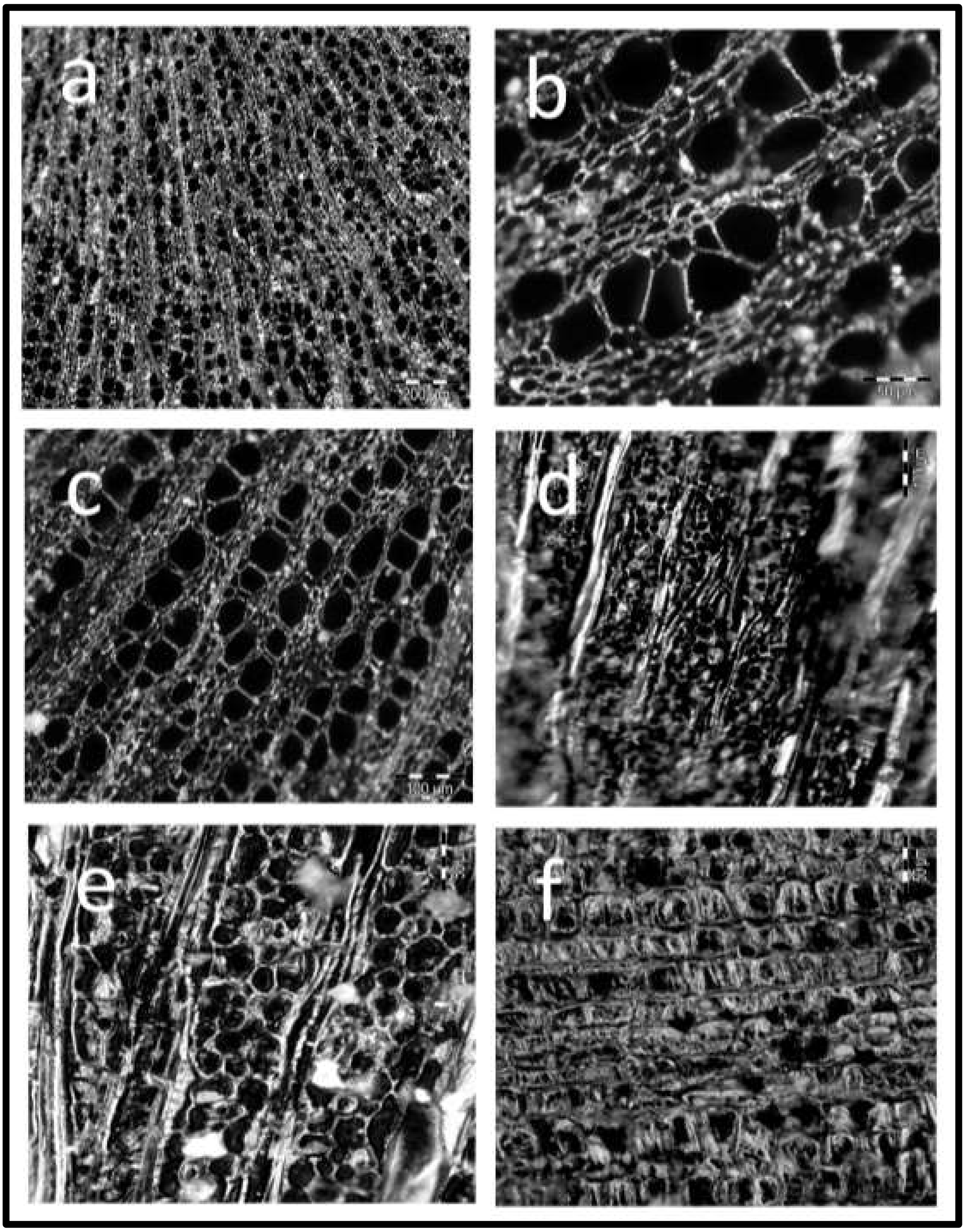
The microstructure of *F. burtt-davyi* showing (a) the diameter of vessel lumina and very thick fibres; (b) irregularly bended parenchyma; (c) the radial/tangential multiple vessel arrangement; (d) biserriate rays; e) rays and vessel elements with simple perforation plates and (f) square and upright ray cells.

8. Grewia occidentalis



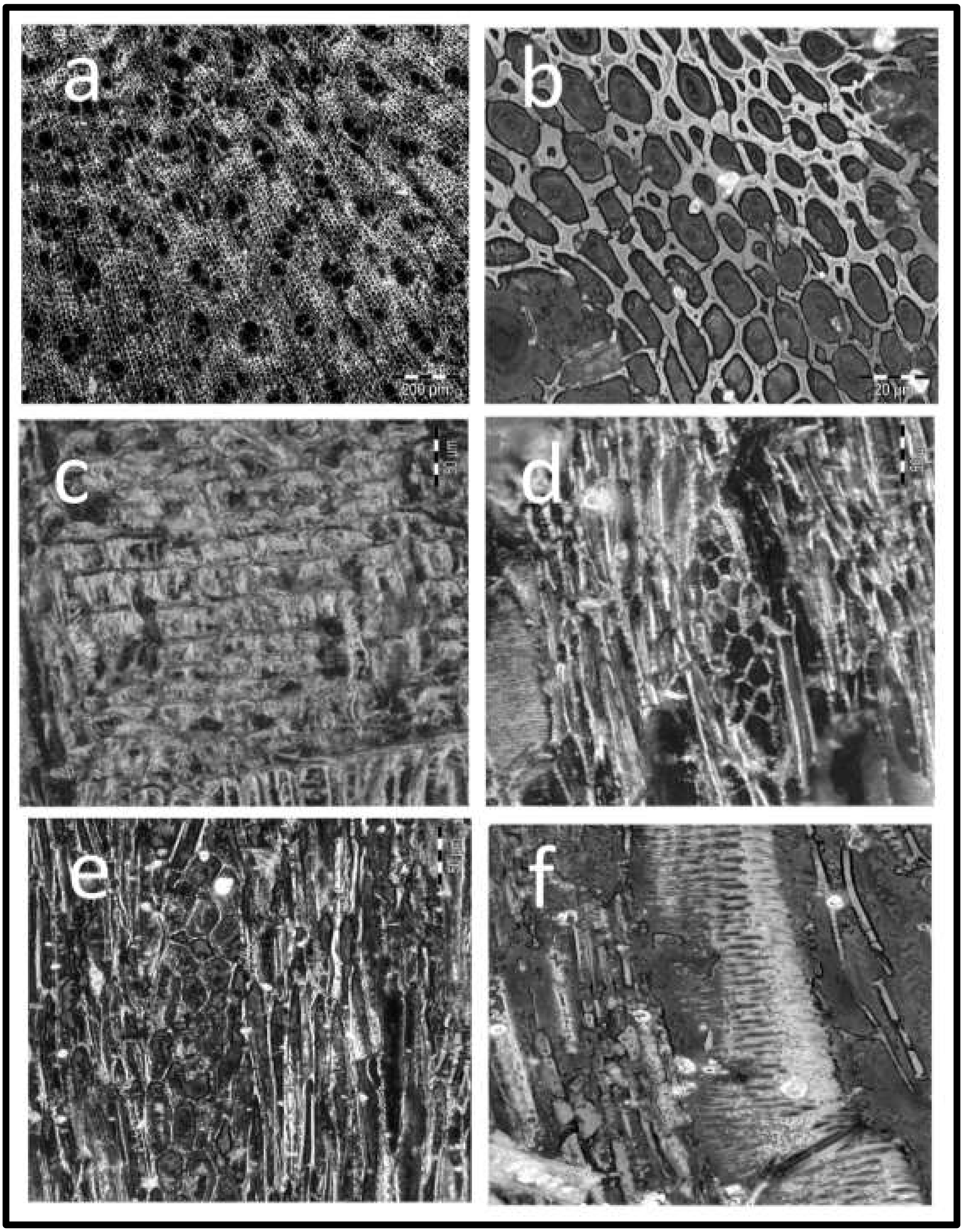
The microstructure of *G. occidentalis* showing (a) solitary and short radial multiple vessel arrangement; (b) diameter of the vessel lumina (55µm) and thin-thick fibres; (c), (d) biserriate and triserriate rays along non-septate fibres; e) parenchyma cells, vessel elements with simple perforation plates and alternating polygonal intervessel pits and (f) procumbent, square and upright ray cells.

9. Halleria lucida



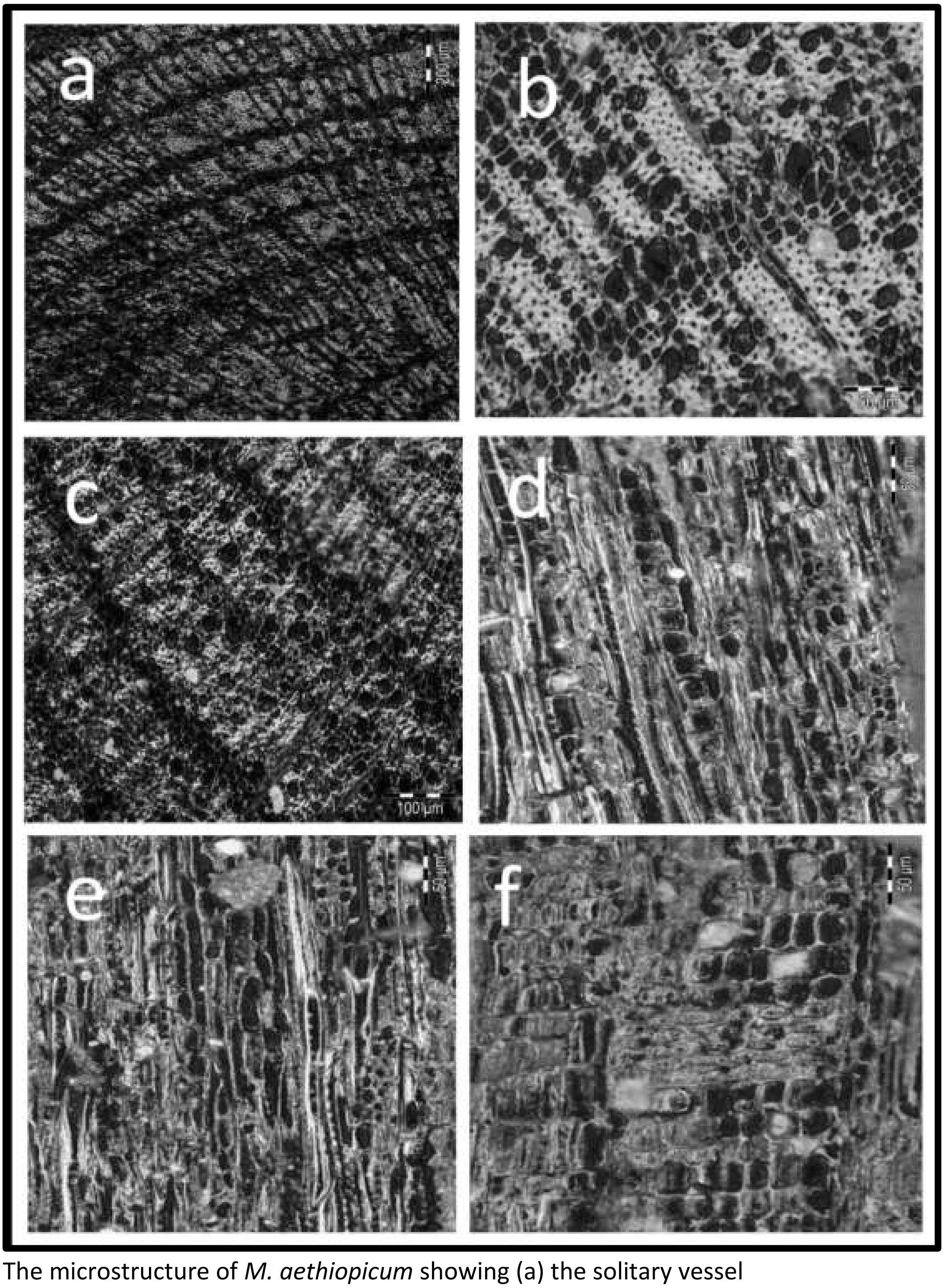
The microstructure of *H. lucida* showing (a) short radial multiple vessel arrangement; (b) thin to thick fibres; (c) diameter of vessel lumina; (d), (e) 1-2-3-4 serriate rays as well as fibres and (f) square, procumbent and upright ray cells.

10. Metalasia muricata



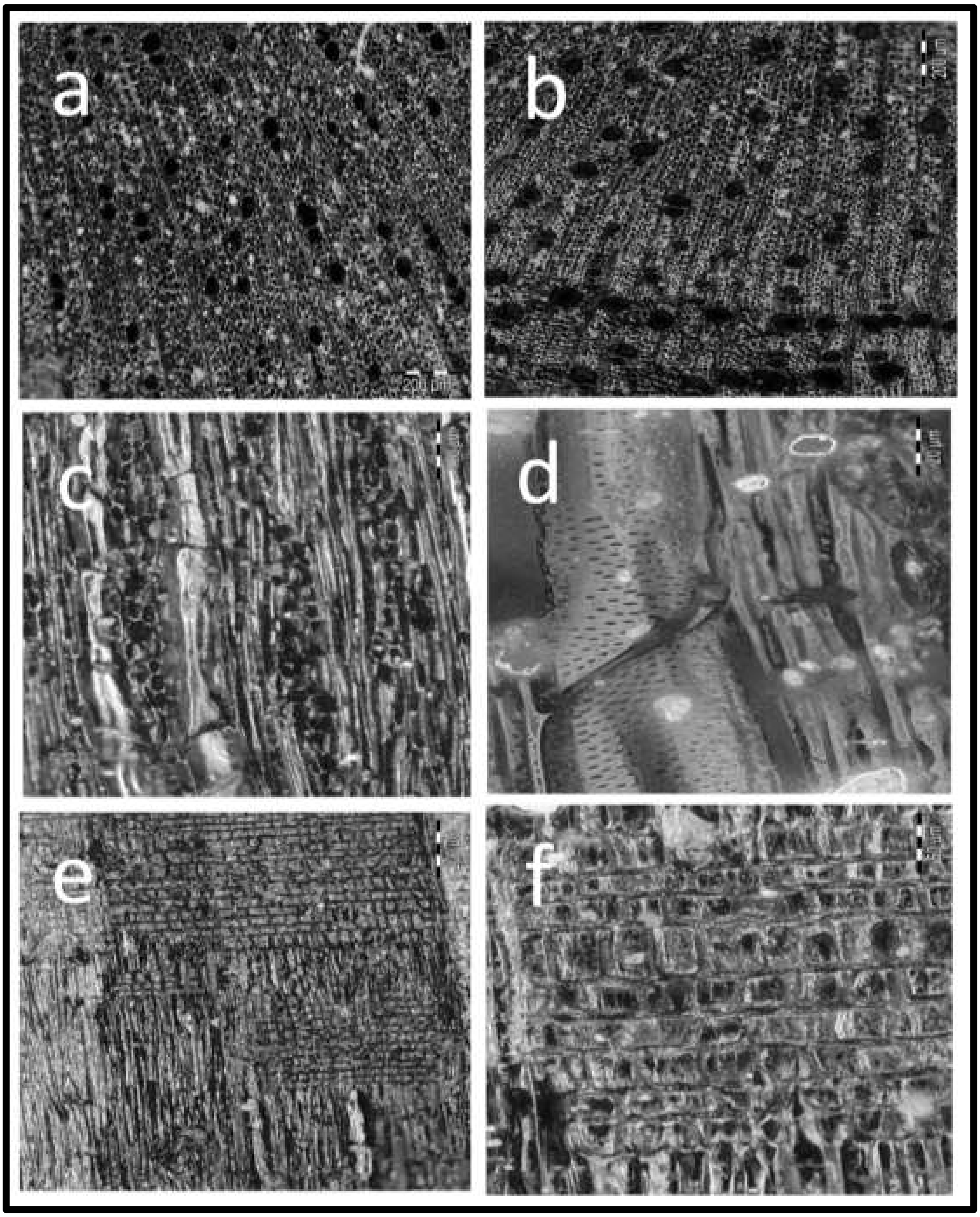
The microstructure of *M. muricata* showing (a) clustered and tangential band vessel arrangement; (b) thin fibres; (c) square ray cells; (d) fibres, rays and vessel elements; e) 1-2(-3) cells serriate ray and (f) vessel element with simple perforation plate and wide alternating inter-vessel pits.

11. Mystroxylon aethiopicum



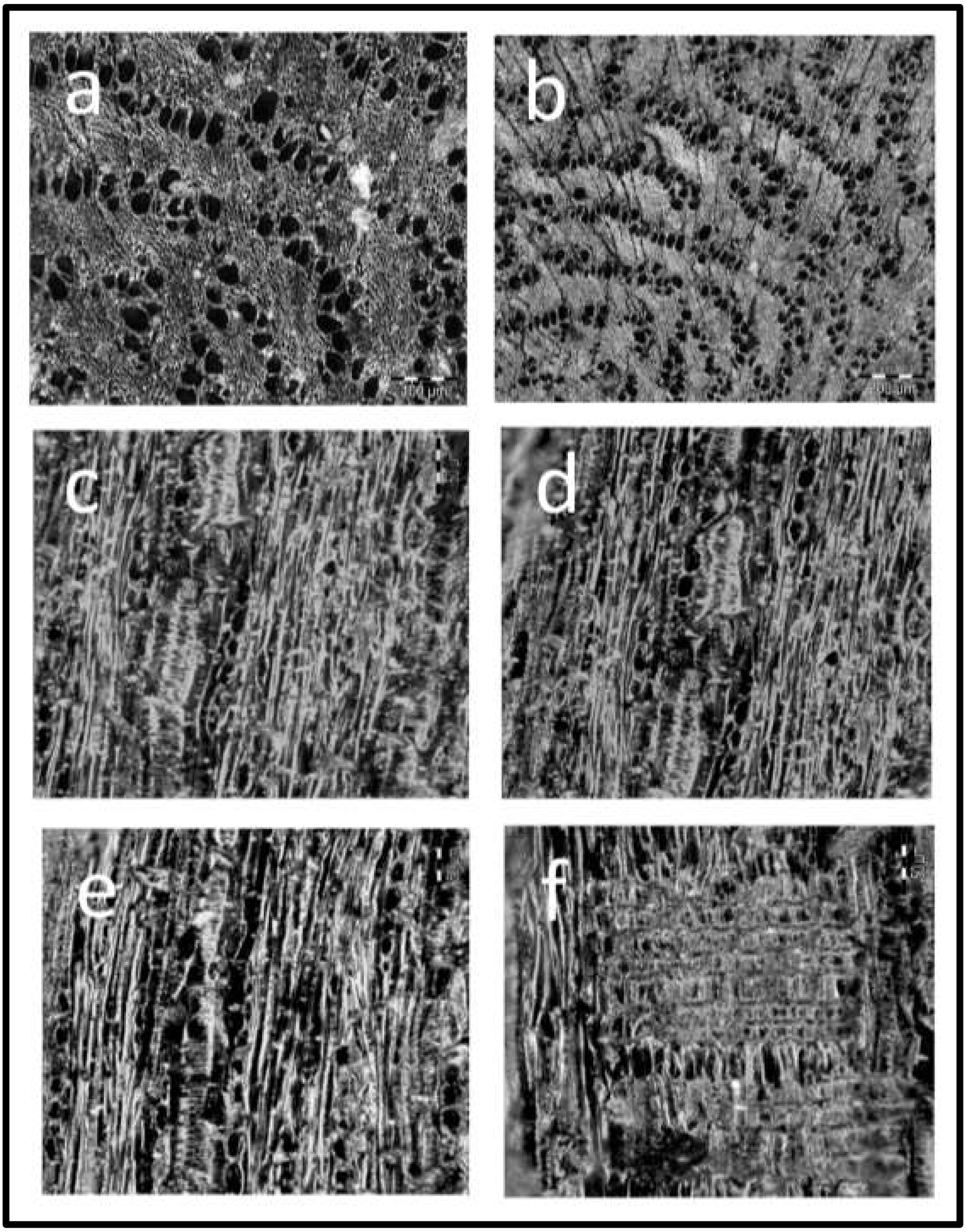
The microstructure of *M. aethiopicum* showing (a) the solitary vessel arrangement and banded parenchyma; (b) thick fibres and parenchyma cells in one band; (c) diameter of the vessel lumina (19µm); (d) uniseriate and biserriate rays; e) triserriate rays along pitted fibres and (f) procumbent, square and upright ray cells with prismatic crystals included within the ray cells.

12. Nuxia floribunda



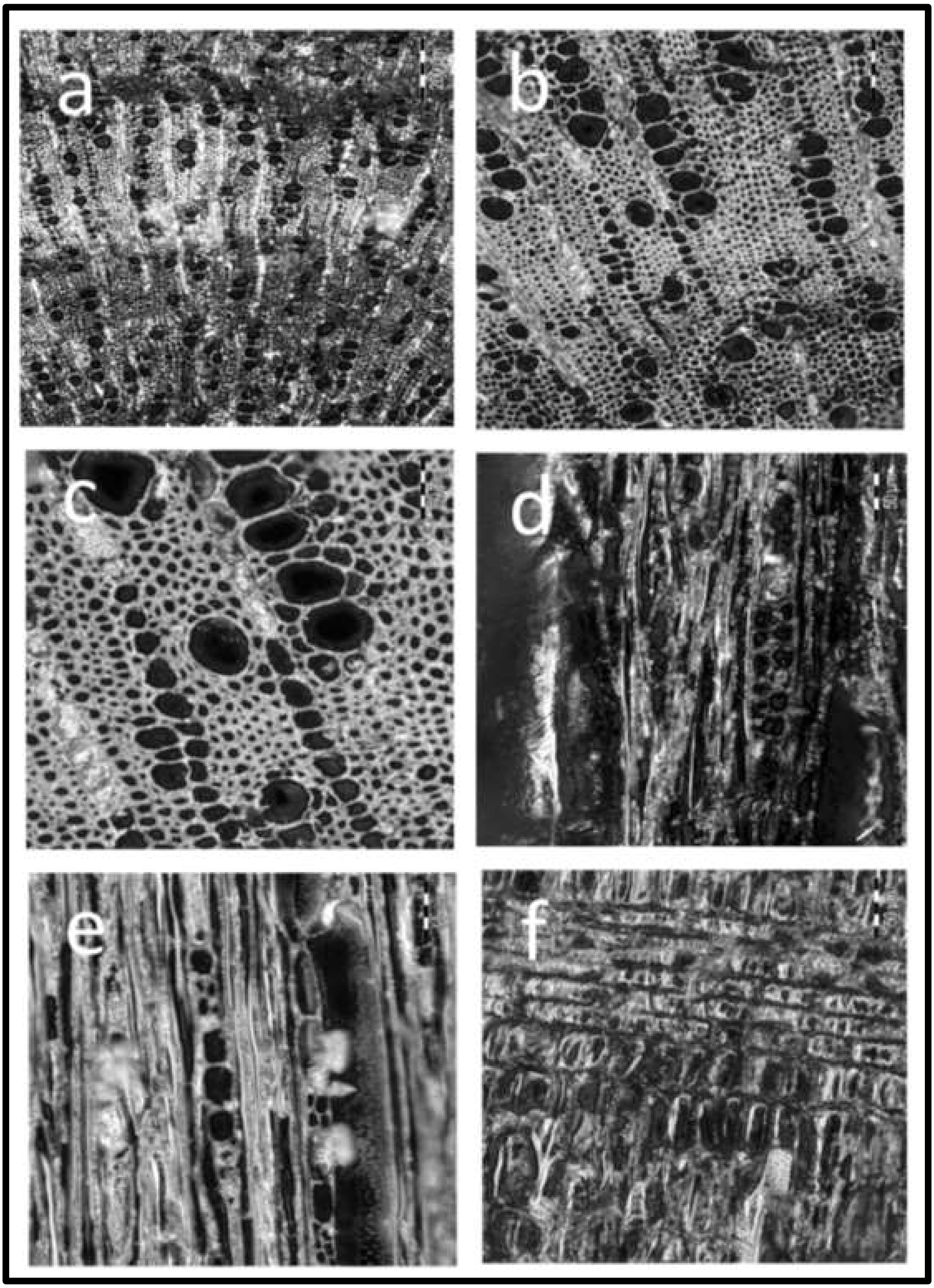
The microstructure of *N. floribunda* showing (a), (b) the solitary vessel arrangement and thin fibres; (c) biserriate rays and vessel elements with simple perforation plates; (d) alternating minute intervessel pits and (e), (f) square and procumbent ray cells.

13. Passerina rigida



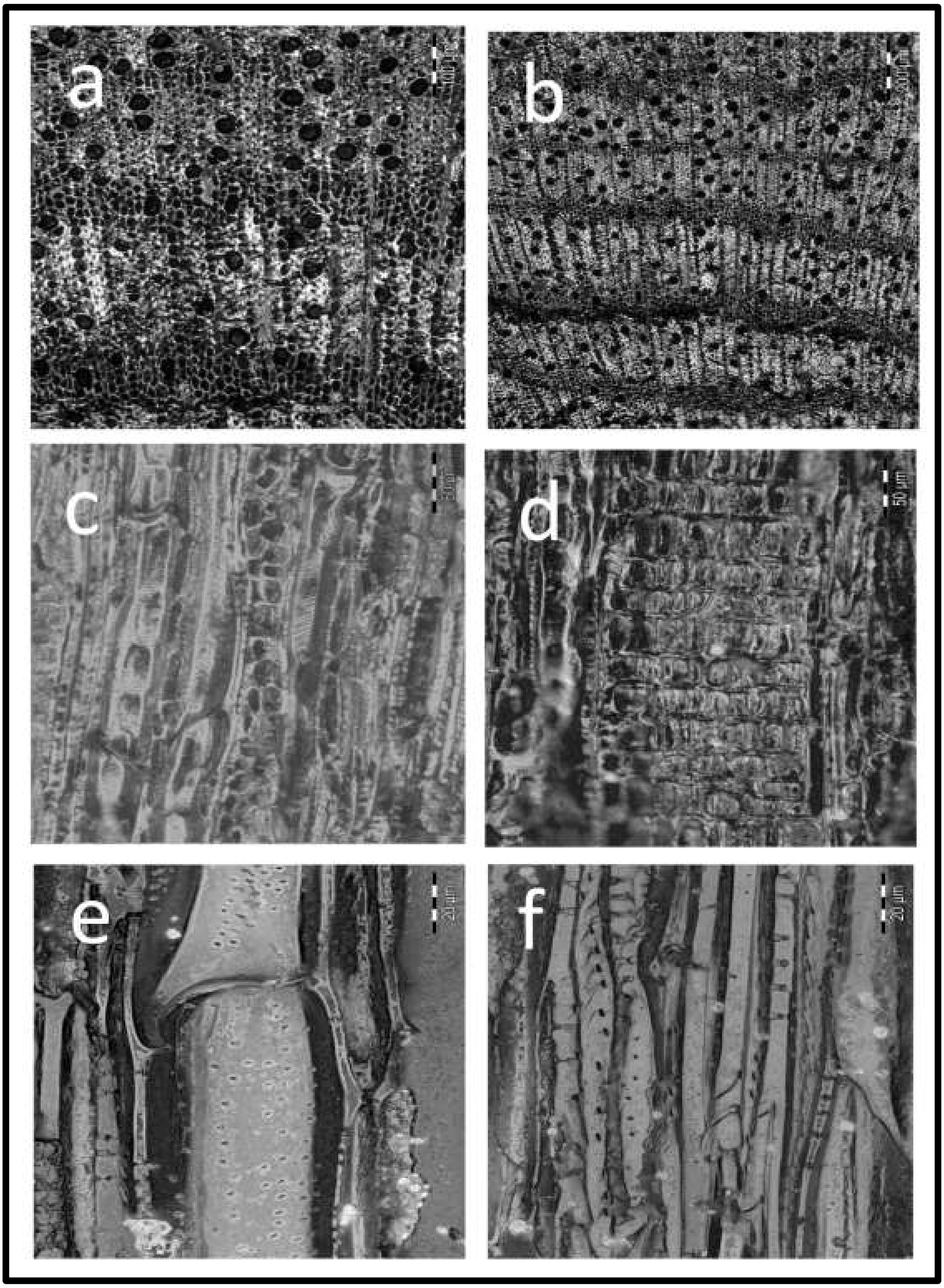
Microstructure of *P. rigida* showing (a) diameter of vessel lumina (31µm) and thin fibres; (b) the long tangential multiple vessel arrangement; (c), (d) uniserriate rays and pitted fibres; e) uniserriate rays and vessel elements with simple perforation plates and (f) procumbent and square ray cells.

14. Pavetta revoluta



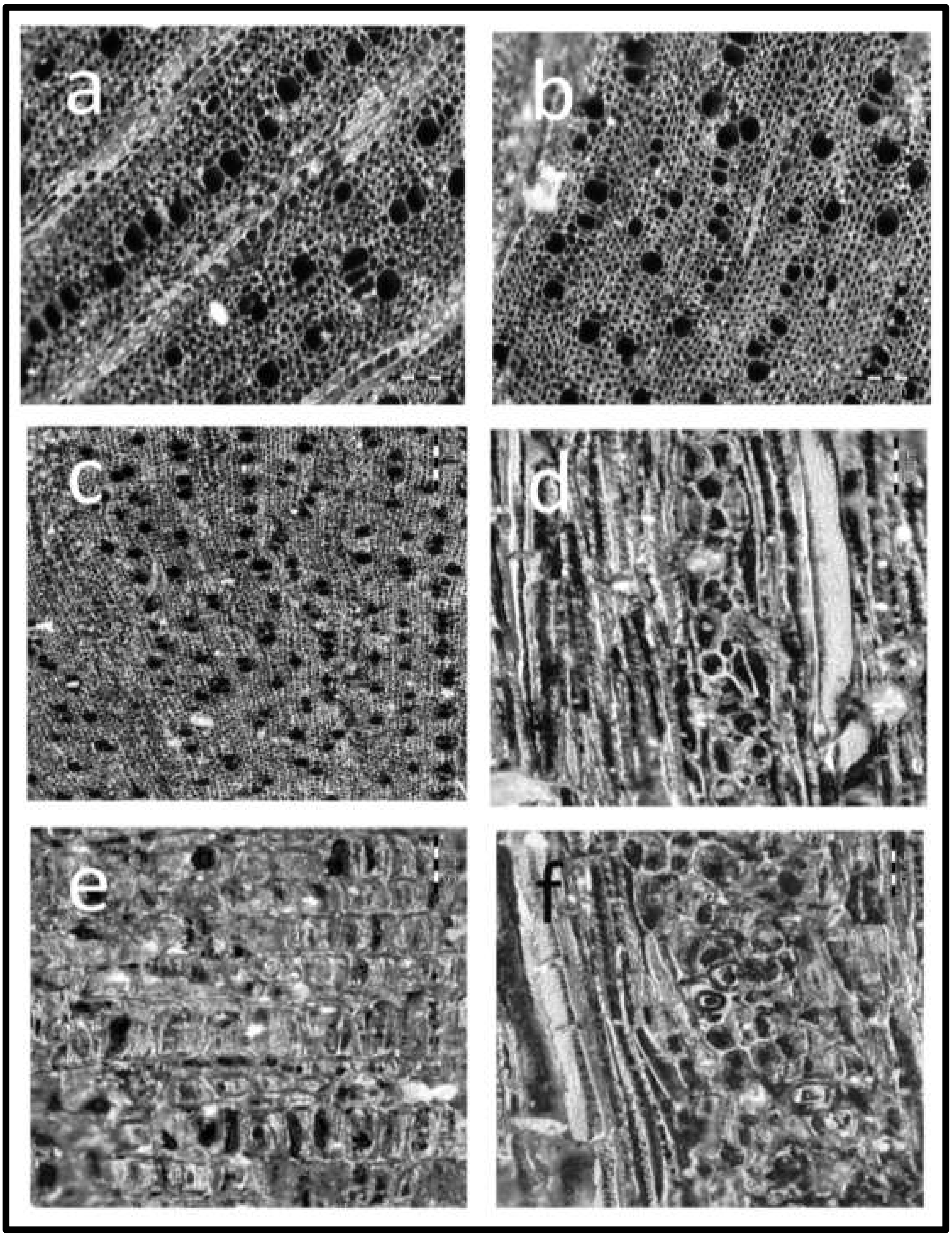
The microstructure of *P. revoluta* showing (a) short radial multiple vessel arrangement; (b) the diameter of vesell lumina (42µm); (c) thin -thick fibres; (d) biserriate rays; e) fibres, biseriate rays and vessel elements showing alternating intervessel pits and (f) procumbent, square and upright ray cells.

15. Pterocelastrus tricuspidatus



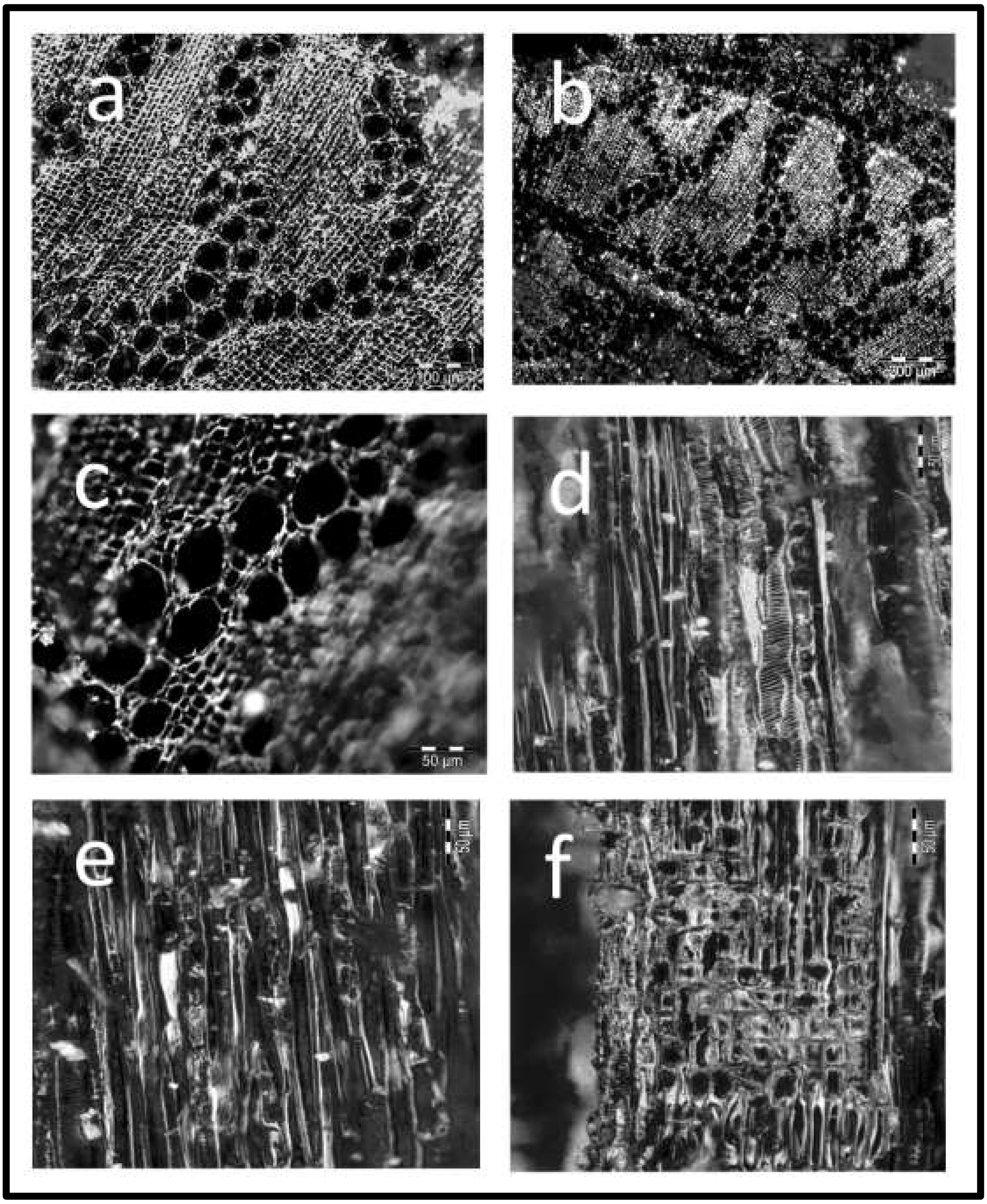
The microstructure of *P. tricuspidatus* showing (a) diameter of vessel lumina (27µm) and parenchyma cells in two of the parenchyma strands; (b) solitary vessel arrangement and banded parenchyma; (c) biserriate rays and vessel elements with simple perforation plates; (d) square and upright ray cells; e) minute intervessel pits and (f) pitted fibres.

16. Rapanea melanophloes



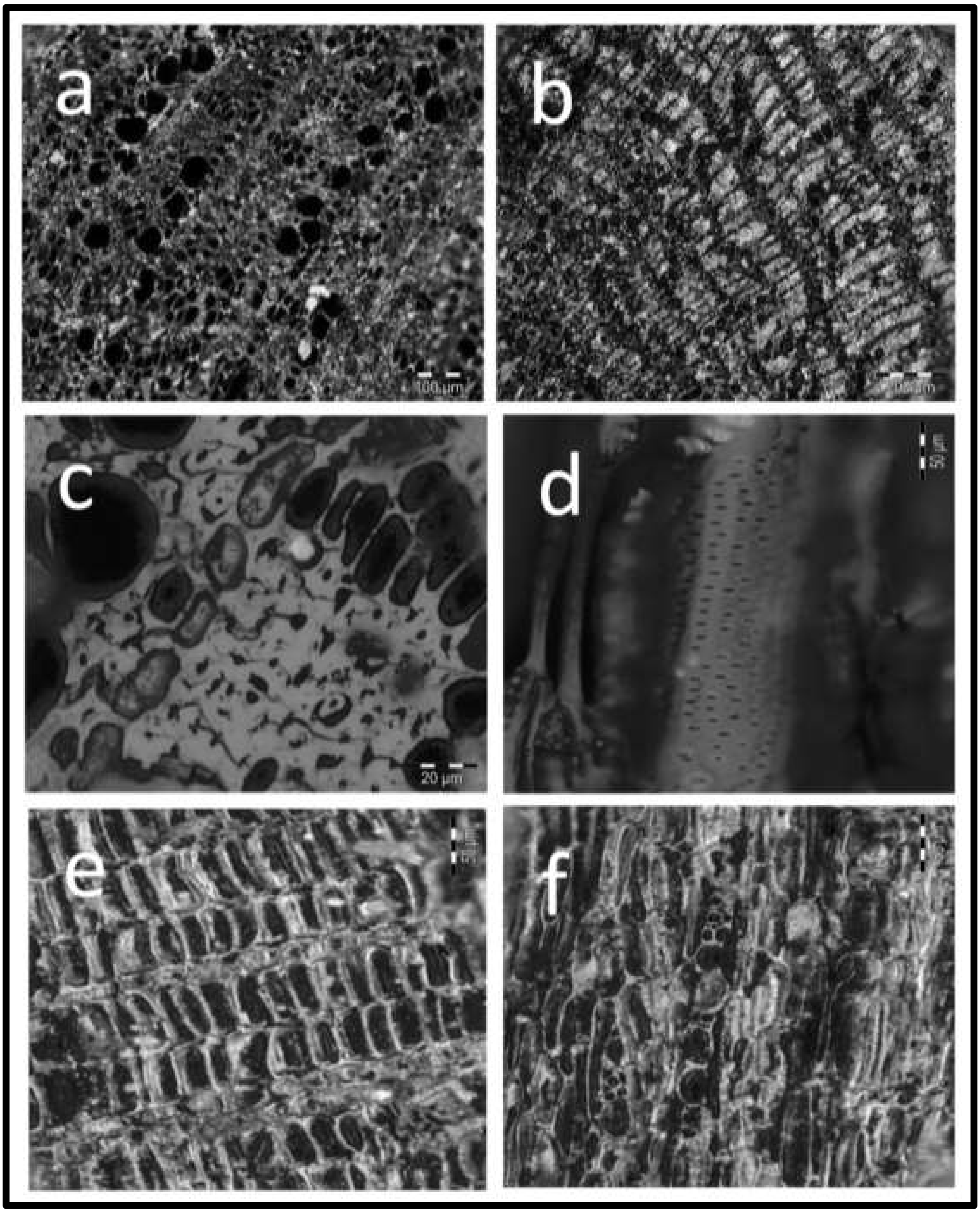
The microstructure of *R. melanophloes* showing (a), (b) diameter of vessel lumina and thin fibres; (c) short radial multiple vessel arrangement; (d) triserriate rays and vessel element with alternating intervessel pits; e) procumbent, square and upright ray cells and (f) ray cells with inclusions.

17. Rhamnus prinoides



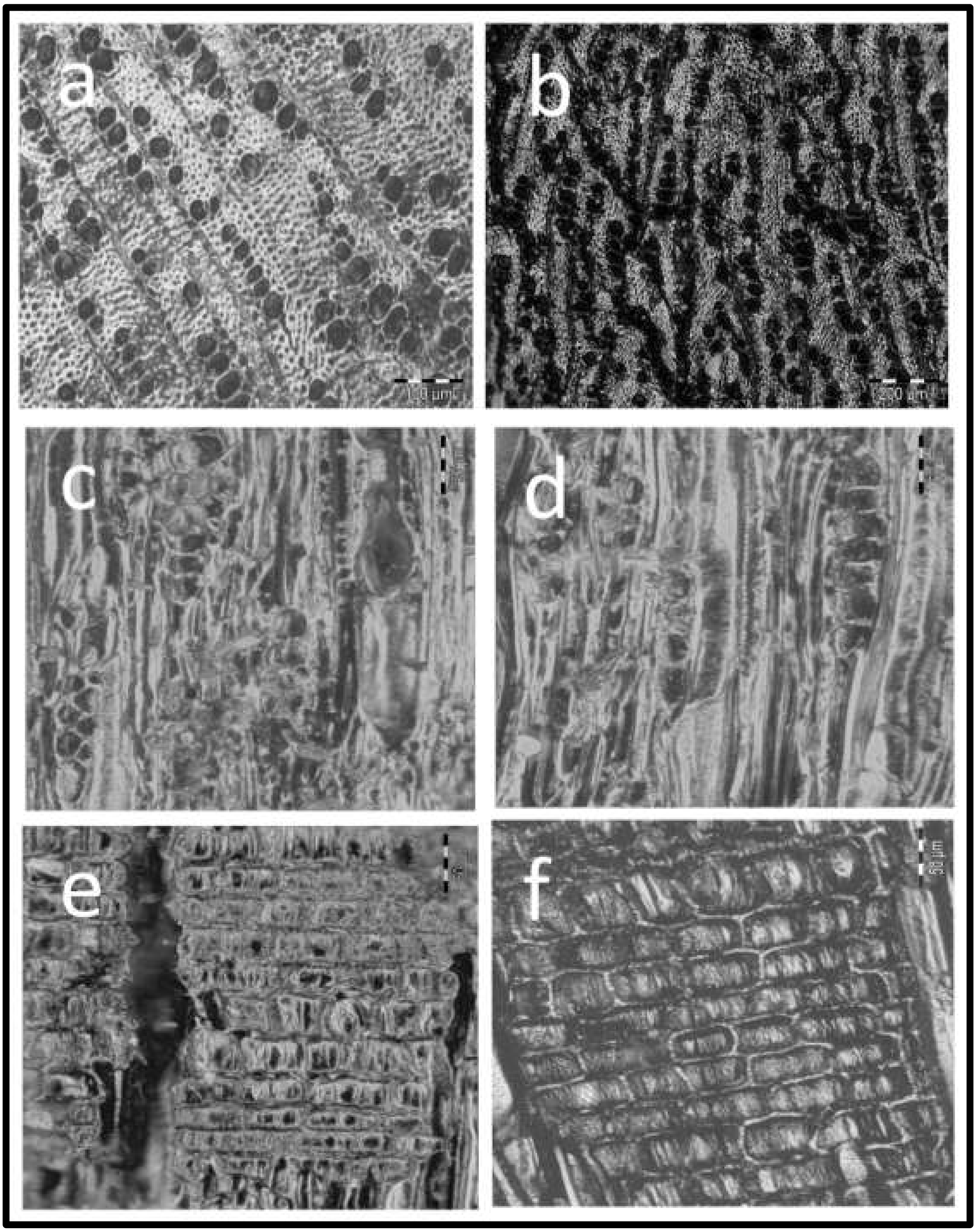
The microstructure of *R. prinoides* showing (a) the diameter of vessel lumina; (b) the dendritic vessel arrangement and growth ring boundaries; (c) thin -thick fibres; (d) vessel elements with helical thickenings along uniserriate ray; e) uniserriate rays and non-septate fibres and (f) square ray cells.

18. Sideroxylon inerme



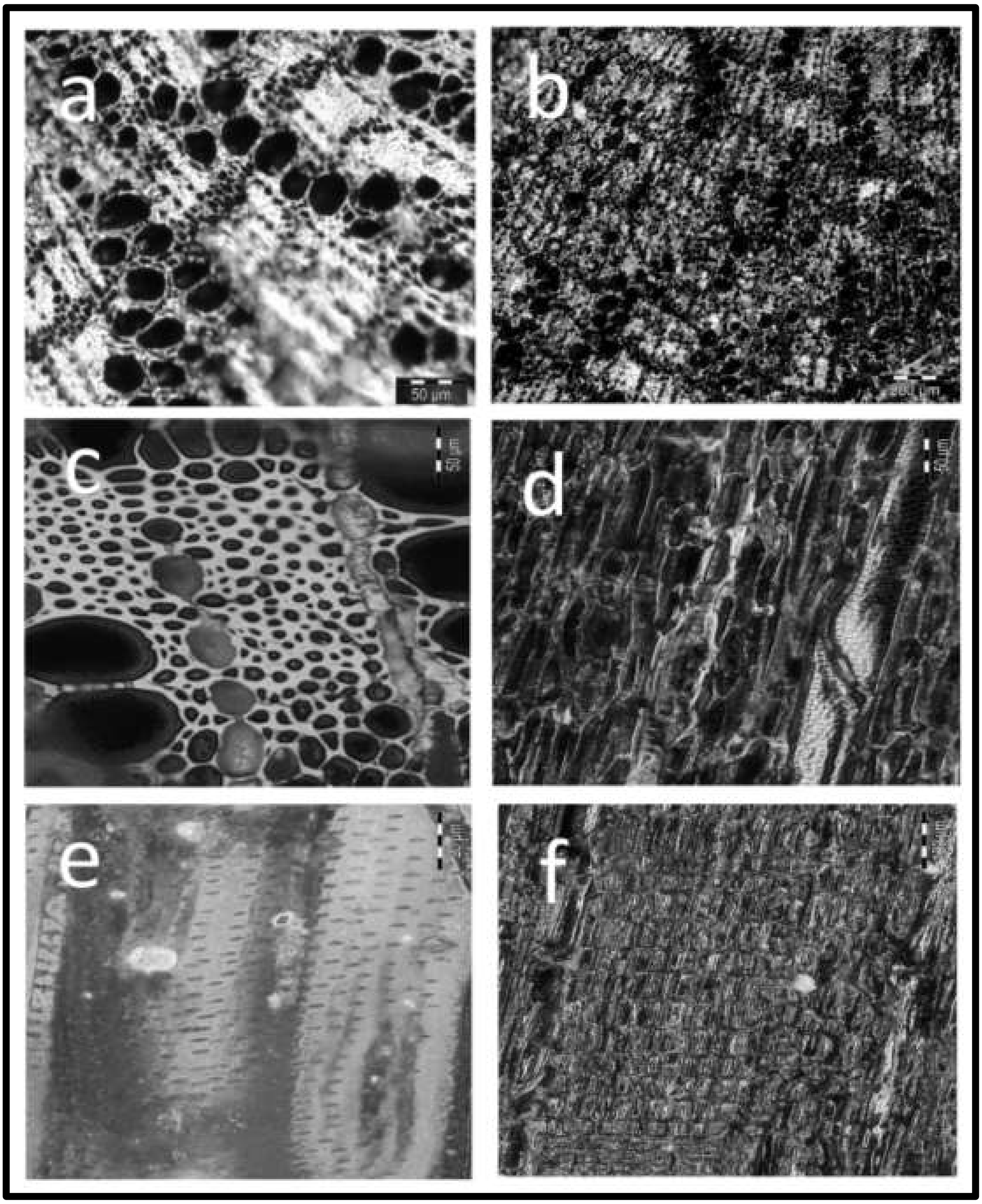
The microstructure of *S. inerme* showing (a) diameter of vessel lumina and cells in parenchyma strands; (b) sortradial multiple vessel arrangement and irregularly banded parenchyma; (c) verythick fibres; (d) minute opposite intervessel pits; (e) procumbent and upright ray cells and (f) biserriate rays.

19. Tarchonanthus littoralis



The microstructure of *T. littoralis* showing (a) the diameter of vessel lumina (33µm) and very thick fibres; (b) short and long radial multiple vessel arrangement; (c) biserriate rays; (d) uniserriate rays and vessel elements with simple perforation plates and (e), (f) square and procumbent ray cells.

20. Zanthoxylon davyi



The microstructure of *Z. davyi* showing (a) the diameter of the vessel lumina (50µm) and cells in parenchyma strands; (b) dendritic or tangential multiple vessel arrangement and irregularly banded parenchyma; (c) thick fibres; (d) uniserriate and biserriate rays along vessel elements with simple perforation plates; e) opposite minute intervessel pits and (f) procumbent, square and upright ray cells.

APPENDIX 6 The list of all the archaeological remains analysed for identification along with the descriptions of their microscopic features. Refer to APPENDIX 4 for the key to the abbreviations used in this table.

Layers	Fragment #	Type	Vessels									Parenchyma		Rays							Fibres			Inclusions		S. elements	
			Diam.	Freq.	P.plates	Arr	GRB	Pits	H. thckn	Lngth	V.less	TS arr	LW	Arr	Ho/He	Cw	Cht	Uw (µm)	Uht (mm)	Freq.	WT (TS)	Pits	S.Thckn	TS	LW	TS	LW
WBLSA(SC)	4	Type 1	26	<<50	simple	sol, srm	indist	alt				rare (present)		sq,p	het	1-2-3c	6c	42	<1mm	5	thick						
A152	38	Type 1	46,42	40-50	simple	sol,		alt, 4		271,9		scanty		sq	homo	1-2c	8c	40	<1mm	8*	thick						
B15SC	2	Type 1	52,8	<100	simple	s,srm	dist?	alt				vesi, ali		sq,	homo	1-2c	9c		<1mm	5	thin-thick	sept					
B15(SC)	1	Type 2	60,84	60-100	simple	rm, cl?	indist?	scal,				rare-		sq, p	het	1-2c	9c	38	<1mm	7	thin	pitted ,					
A151	1	Type 2	40,72	50-100	simple	1-2, sol,	indist?	elong				absent	absent	p, sq	het	1-2c	12c	31	<1mm	7-10	thin-	bordered pits, sept					
A151	7	Type 2	57,52	50-100	simple	sol,	indist?	elong,	present			absent	absent	sq,p	het	1-2c	10c	42	<1mm	5-6	thin						
A151	8	Type 2	42,52	50-100		sol, 1-2rm	indist?	elong,				absent	absent	sq,p	het?	1-2c	10c	44	<1mm	3-5		pitted					
A151	18	Type 2	53,4	45-50	simple	clus,srm	indist?	opp?, elong				scanty?	present?	sq,p	het	1-2c	10c	35	<1mm	4-5	thin-	pitted					
B151	37	Type 2	55,8	50-100	simple	sol, 1-2rm	dist	elong				rare		p/sq	homo ?	1-2c	15c	41,6	<1mm		thin-						
B151	119	Type 2	46	50-100	simple	srm, sol	indist	elong				rare		sq/p	homo	1-2c	7c	35	<1mm		thin						
A152	28	Type 2	68,8	50-100	simple	sol,1-2rm	indist	elong				scanty	present	p,sq	het	1-2(-3)c	12c	40	<1mm		thin-thick		bord				
B162	9	Type 2	64,4	50-100	simple	clus,sol,	indist	elong						sq,p	het	1-2c			<1mm								
A153	32	Type 2	46,6	50-100	simple	srm,clu,s	indist	scal, 20			absent	rare				1-2c	13c	30	<1mm	8	thin	bord, <4					
A154	13	Type 2	65,5	50-100	simple	s	indist	scal, 28			absent	rare, diff		p,u	het	1-2c	11c	20	<1mm	8	thin	bord					
A154	42	Type 2	71,2	50-100	simple	srm,clus		elong?			absent	rare, diff		p,sq	het	1-2c	12c	50	<1mm	12	thin						
A154	161	Type 2	52	50-100		clus,s	indist				absent	rare				1-2c	9c	45	<1mm	8	thin						
A154	163	Type 2	50,2	50-100		s,srm	indist, wdp				absent	rare-absent		sq,p	het						thin						
A154	166	Type 2	49,2	50-100	simple	s, srm	indist	elong, 20		281,3	absent	rare-absent		sq,p	het	1-2c	11c	20	<1mm	16	thin						
A154	214	Type 2	62,5	50-100		s, srm, clus	indist				absent	rare									thin						
B162	35	Type 2	40,6	50-100	simple	clus,1-2rm	indist					scanty				1-2c			<1mm	8-12							
B151	154	Type 2	55	50-100	simple	1-2rm,clus	indist	elong,alt				rare		sq,p	het	1-2c	15c	35	<1mm		thick		pitted		?		
A154	186	Type 2	53,2	50-100		s	indist				absent	rare		sq,p	het						thin						
A153	4	Type 2	59,6	50-100	simple	sol, 1-2rm	indist	elong(18)		179,7		para, scan		proc	homo	1-2c	11c	35	<1mm	4-8							
B151	29	Type 2	38,8	50-100	simple	sol,1-2rm	indist	alt(elong)				absent	absent	sq,p	het	1-2c	12c	36,6	<1mm		thin		pits				
B151	57	Type 3	39,2	100-150	simple	sol,1-2rm	indist	alt				rare		sq	homo	1-2c	15c	25	<1mm		thin						
A152	45	Type 3	38,2	150-200	simple	sol,srm	indist					scanty?		p	homo	1-2c	11c	25	<1mm		thin						
B151	18	Type 3	42,2	100-120	simple	srm,clus	dist	bord				scanty	present	sq	homo	1-2c	14c	43,3	<1mm		thin-t		bord, pit		sil		
B162	37	Type 3	49,8	100-150	simple	sol	indist(srp)					scanty	present	sq	homo	1-2c			<1mm		thin				sil		
A154	39	Type 3	42,2	100-150	simple	s,srm,clus	indist																				
B154	2	Type 3	50,6	100-150	simple	s	indist			148,4	has trach	absent	absent	p,sq	het	1-2(-3)	10c	45	<1mm	8	thin	bord, <4					
B164	5	Type 3	52,2	50-100	sim,	srm,s,	indist		absent	140,6	absent	scanty				1-2c	12c	40	<1mm	4-8	thin		absent				
B151	4	Type 4	44,35	50-100	simple	s-lrm	indist	alt				rare-abs		u,sq	het	1-2c	10+	45	<1mm		thin	pitted					
B151	81	Type 4	33	50-100		srm	indist					rare		u,sq	het												

B151	105	Type 4	35,8	40-50	simple ?	sol,srm	indist					rare		p,sq,u	het	1-2c	12c	40	<1mm		thin-thick						
B151	156	Type 4	26,4	50-100	simple	sol,1-2rm	indist	alt				rare	present	u,sq,p ?	het	1-2c	9c	25	<1mm		thin-thick						
B16SC	1	Type 4	48,52	50-100	simple,	s,srm	indist?	alt				present		sq,p	het	1-2(-3)c	14c	52	<1mm	9-11	thin-thick	pit,sept,					
B153	7	Type 4	45,4	50-100	simple	s, srm	indist			265	absent	absent	absent	p,sq	het	1-2(-3)c	13c	40	<1mm	6	thin	bord, sept					
A154	71	Type 4	37,4	50-100	simple	s,srm	indist	alt,<4		242,2	absent	rare, diff		p,sq,u	het	1-3c	17c	30	<1mm	4	thin						
A154	188	Type 4	36,2	50-100		srm	indist	alt, <4			absent	para, vesi	present	p,sq,u	het	1-2(-3)c	16c	20	<1mm	12	thin						
A154	244	Type 4	37,6	50-100		srm,	indist				absent	rare		p,sq	het						thin-thick						
A154	195	Type 4	35,8	50-100			srm				absent					1-2(-3)c	9c	15	<1mm	4	thin						
A154	22	Type 4	56,8	50-100	simple	s, srm	indist	alt,<4		218,8	absent	rare, diff	present	p,sq,u	het	1-2c	14c	25	<1mm	8	thin						
A154	65	Type 4	34,6	50-100	simple	s,srm	wdp	alt,4		85,94	absent	rare, diff		p, sq	het	1-2c	15c	25	<1mm	4	thin						
A154	172	Type 4	31,6	50-100	simple	s,srm	indist	alt, <4			absent	rare		sq,u	het	1-2c	11c	20	<1mm	4	thin						
B151	16	Type 5	53,39	50-100	simple	sol,1-2rm	indist							sq,p	het	1-2c	12c	30	<1mm						sil		
B151	76	Type 5	57,8	50-100	simple	srm,clus	indist	bord,pits				rare		sq,p	het?						thin		bord pits		sil		
B153	29	Type 5	43,8	50-100	simple	s	indist			164,1	absent	rare		p,sq	het	1-2c	12c	25	<1mm	12	thin				sil		
A154	11	Type 5	69,6	50-100	simple	s	indist			148,4	absent	absent		p,sq,u	het	1-2c	8c	50	<1mm	12	thin	bord			sil		
A154	158	Type 5	34,6	50-100		s,srm	indist				absent	rare		p,sq	het	1-2c	12c	25	<1mm	12	thin						
A154	176	Type 5	56,8	50-100		s,srm	indist				absent	para, scan									thin						
A154	197	Type 5	33,2	50-100		s					absent	rare-absent		sq,p	het	1-2c	18c	15	<1mm	12	thin						
B164	6	Type 5	64,4	50-100	sim,	s, srm	indist		present		absent	rare		p,sq	het	1-2c	12c	40	<1mm	6-8	thin				sil,		
B151	76	Type 5	57,8	50-100	simple	srm,clus	indist	bord,pits				rare		sq,p	het?						thin		bord pits		sil,		
B151	85	Type 5	50,6	50-100	simple	sol,srm	dist					rare		sq/p	het?	1-2c	12c	20	<1mm						sil		
A153	36	Type 5	62,8	50-100	simple	s,srm	indist	scal, 20			absent	rare		p	homo	1-2(-3)c	14c	50	<1mm	8	thin	bord, 4-8			sil		
B164	26	Type 5	44,2	50-100		s	indist				absent	para, scanty		p	homo	1-2(-3)c	11c	30	<1mm	2-4	thin						
A154	139	Type 5	41,2	50-100	simple	s,srm	indist		present	109,4	absent	para,scan		sq,p	het	1-2c	11c	25	<1mm	8	thin						
B151	36	Type 5	28,32	50-100		sol	indist					rare		p	homo	1-2c	8c	23,25	<1mm		thin						
B151	36	Type 5	28,32	50-100		sol	indist					rare		p	homo	1-2c	8c	23,25	<1mm		thin						
A152	26	Type 5	41,8	50-100	simple	sol	indist	scal,				absent		sq,p	het	1-2c	11c	25	<1mm		thin						
B151	1	Type 6	56,96	50-100	simple	sol,	indist	opp/alt ?				rare-abs	present			2-3-4-5c	15c		>1mm?		thick						
A151	6	Type 6	42,6	50-100	simple	sol,1-2	indist	bord,				?		sq,p	het	1-2-3c	17c	23	0,5-1	6-8	thin						
B162	12	Type 6	39,4	50-100	simple	sol	indist			109,4		scanty paratr	present	p	homo	1-(2)-(3)-(4)c			<1mm		thin		pitted				
A153	1	Type 6	37,2	50-100	simpe	sol	dist(SRP)					para,vesi		p,sq	het	1-7c	30c	24	0,5-1mm	<4							
B151	3	Type 7	75,5	50-100	simple	sol, 1-2rm,clu	dist	elong,opp,						sq	homo	1-2-	15c	36	<1mm		thin	sept		sil	sil	sil	
B151	12	Type 7	52,5	50-100	simple	1-2rm,clus	dist, wrp	elong				rare-absent		sq,p	het	1-2c	15c	30	<1mm		thin						
B151	16	Type 7	53,39	50-100	simple	sol,1-2rm	indist							sq,p	het	1-2c	12c	30	<1mm						sil		
B151	22	Type 7	60,84	100-120	simple	s,srm	indist?	elong				absent	absent	sq,(u?)	het	1-2c	20c	40	<1mm	6	thin				sil		
B151	23	Type 7	51,2	50-100	simpe	srm,clus	dist	elong				absent?	absent ?	sq,p	het	1-2c	20c	30	<1mm	11	thin		pits		crys?		
B151	28	Type 7	38	100-150	simple	sol	dist,wrp	elong				absent	absent	sq,p,(u?)	het	1-2c	13c	20	<1mm		thin				sil		
B151	35	Type 7	39,8	100-150	simple	sol, 1-2rm	dist, wrp	elong				rare	present	p	homo	1-2c	10c	32,5	<1mm		thin		pitted		sil		

B151	37	Type 7	55,8	50-100	simple	sol, 1-2rm	dist	elong				rare		p	homo	1-2c	15c	41,6	<1mm		thin-						
B151	52	Type 7	32,2	150-200	simple	sol,1-2rm	dist, wrp					rare		sq/p	het?	1-2c	10c	30	<1mm		thin-thick				sil		
B151	55	Type 7	57,8	50-100	simple	clus,sol, 1-2tm	dist	elong								1-2c	16c	40	<1mm		thin-thick		pres		sil		
B151	65	Type 7	65	50-100		sol,1-2rm	dist					rare				1-2c	14c	40	<1mm				bord pits				
B151	103	Type 7	48,6	50-100	simple	srm,clus, sol	indist?	elong				rare		sq/p	het?	1c/1-2c	11c	30	<1mm		thin		pitted		sil		
B151	118	Type 7	55,2	50-100	simple	srm,clus	indist	elong				rare		sq,p	het	1-2c	12c	30	<1mm		thin				sil		
B151	143	Type 7	46,8	50-100	simple	1-2rm,sol	dist					rare	present	p/sq	het?	1-2c	13c	30	<1mm		thin?				sil		
B151	153	Type 7	40,2	100-150	simple	1-2rm,clus	indist	elong				rare	present	sq,p	het	1-2c	13c	30	<1mm		thin-thick				sil		
B151	34	Type 7	34,6	50-100	simple	clus,1-2rm	indist	elong				rare-absent		p	homo?	1-2c	12c	30	<1mm		thin		pitted				
B161	2	Type 7	59,2	50-100	simple	1-2rm	indist	elong				rare	present	sq,p	het	1-2c	11c	25	<1mm		thin	pitted			sil		
A152	9	Type 7	37,2	50-100	simple	sol,1-2rm	indist	elong				rare		p/sq	het?	1-2c	12c	25	<1mm	12	thin						
A152	20	Type 7	58,2	50-100	simple			elong,scal,				rare		p	homo	1-2c	10c	35	<1mm		thin						
B162	2	Type 7	57,6	100-150	simple	sol, srm	indist	elong				scanty		p/sq	homo	1-2c (1=2)			<1mm		thin-thick		pitted	gum/resin			
B162	26	Type 7	44,6	50-100	simple	sol	indist	elong,scal,				rare									thin		pitted		sil		
A153	38	Type 7	54	50-100	simple	s, srm	indist				absent	absent	absent	p,sq	het	1-2c	9c	30	<1mm	4	thin	bord, 4			sil		
B153	13	Type 7	44,2	100-150	simple	s	srp	scal, 25		210,9	absent	rare		sq,p	het	1-2c	15c	20	<1mm	12	thin	bord, 4-8			sil		
B153	14	Type 7	40,6	100-150	simple	s, srm	indist			109,4	trach	absent	absent	sq,p	het	1-2c	15c	30	<1mm	8	thin	bord, 4-8			sil		
B153	19	Type 7	42	100-150	simple	s	srp	scal,20		203,1	absent	absent	absent			1-2c	12c	20	<1mm	12	thin	bor		sand, crys	sil		
B153	25	Type 7	43,6	50-100	simple	s,srm	indist	scal, 25	present	187,5	absent	para, scan		p	homo	1-2c	13c	30	<1mm	12	thin	sept			sil		
A15PC	1	Type 7	42	50-100	simple	s	indist		present	109,4	absent	absent	absent	p,sq	het	1-2c	12c	30	<1mm	12	thin				sil		
B154	1	Type 7	32,6	50-100	simple	sol	indist	scal 28	present	289,1	trach	absent		p,sq	het	1-2c	14c	30	<1mm	8	thin	bord, 4-8			sil		
B154	5	Type 7	41,8	100-150	simple	sol	indist		present	154,3	trach	absent	absent	p,sq	het	1-2c	14c	25	<1mm	8	thin				sil		
B154	9	Type 7	56,4	40-50	simple	s, srm	indist		present	132,8	absent	para, scan		p,sq	het	1-2c	11c	50	<1mm	12	thin				sil		
B161	24	Type 7	52,8	50-100	simple	srm,clus	indist	scal				rare		sq,p	het	1-2c	17c	30	<1mm						sil		
B164	1	Type 7	94	50-100	sim,	sol, srm	indist	scal,(20)	absent	234,4	absent	absent	absent	p,sq	het	1-2c	20c	50	<1mm	4-8	thin	pitted	absent		sil,		
B162	5	Type 7	53,6	50-100	simple	sol	indist					scanty		p/sq	homo?	1-2-3c			<1mm		thin			ray	sil		
B162	19	Type 7	54,2	40-50	simple	sol,	indist					vasicentric		sq,p	het	1-2c			<1mm		thin				sil		
B154	9	Type 7	56,4	40-50	simple	s, srm	indist		present	132,8	absent	para, scan		p,sq	het	1-2c	11c	50	<1mm	12	thin				sil		
B151	9	Type 8	120-	<20	simple	clus	indist	alt				vasi	rare?	sq,p,u	het	1-2c	10c	30	<1mm								
B151	10	Type 8	114,5	<20	simple	1-2rm, clus		alt				vasi	present	sq,p	het	1-2c	16c	35	<1mm	5	thin	sept					
B151	11	Type 8	126,6	<20	simple	1-2rm,clus	indist	alt		171,9		vasi	present	sq,p	het	1-2c	17c	36	<1mm	6	thin	sept					
B151	13	Type 8	105,2	<20	simple	srm,clus	dist!!!	alt				vasi-confl	present	sq,p	het	1-2c	7c	25	<1mm		thick						
B151	14	Type 8	96,6	<20	simple	1-2rm,	indist	alt		312,5		vasi	present	sq,p	het	1-2c	12c	30	<1mm		thin-t						
B151	26	Type 8	96,4	<20	simple	1-2,clus	indist	_	pres			vasi	present	sq,p	het	1-2c	11c	30	<1mm		thick				sil		
B151	39	Type 8	92	<20	simple	1-2rm,clust	indist	alt?				scanty,para	present	p,sq	het	1-2c	10c	35	<1mm		thin-						
B151	46	Type 8	104	20-40	simple	1-2rm,clust	indist	alt				vasi	present	sq,p	het	1-2c	12c	30	<1mm		thin-thick						

B151	53	Type 8	60,2	20-40	simple	clus,1-2rm	indist	alt, 10µm				vasi		p,sq,u	het	1-2c	11c	26,6	<1mm		thin-thick						
B151	58	Type 8	50,8	20-40	simple	clus, srm	indist	alt,10		250		vasi		sq,p	het	1-2c	13c	33,75	<1mm	8	thin-thick						
B151	92	Type 8	80	<<20	simple	1-2rm	indist	alt				vasi	present	sq,u	het	1(-2)c	7c	20	<1mm		thick				crys,		
B151	96	Type 8	67,72	<<20	simple	1-2rm	indist	alt		304,7		vasi	present	sq,u	het	1-2c	10c	40	<1mm		thick						
B151	106	Type 8	92,9	<<20	simple	1-2rm	indist	alt?				vasi		p,sq	het	1-2c	12c	40	<1mm		thick						
B151	15	Type 9	26,6	50-100		excl sol	indist					band (5-6)(5-6)	present	sq,p	het											pres	
B151	25	Type 9	16,72	50-100	simple	sol	indist	alt				band,5(5-6)	present	sq,p,u	het	1-2-(3c)	15c	30	<1mm		thin		pits				
B151	42	Type 9	44,8	20-50	simple	sol	indist	alt		140,6		band(3-4)(4-8)		u,sq	het	1-2c	13c	24	<1mm								
B151	21	Type 10	38,6	100-150	simple	excl,sol	indist	alt, bord		179,7			scanty ?		homo ?	u,(1-2c)	16c	10	<1mm		thin						
B162	29	Type 10	43,4	50-100	simple ?	sol	indist							p	homo	1c?					thin						
B151	27	Type 11	37,8	100-150	simple	sol	indist	elong				absent	absent	sq	homo	1-2c	14c	20	<1mm		thin		bord pits				
B151	28	Type 11	38	100-150	simple	sol	dist,wrp	elong				absent	absent	sq,p,u	het	1-2c	13c	20	<1mm		thin				sil		
B151	61	Type 11	39,6	100-150	simple	clus,srm	dist	elong				rare		u,sq	het	1-2c	9	25	<1mm								
B151	91	Type 11	30,4	150-200	simple	clus,srm	indist					rare		sq,u	het	1-2c	12c	25	<1mm		thin				sil		
A153	15	Type 11	22,6	100-150	simple	sol,srm	indist	(bord,<4um)(elong, 28um)				absent?		p,sq	het	1-2c	12c	30	<1mm	2-4	thin						
A153	22	Type 11	44	100-150	simple	s	indist	scal, 12			absent	absent		p	homo	1-2c	11c	30	<1mm	4	thin	pits, <4					
B153	1	Type 11	63,2	100-150	sim,	s, srm	indist	elong	absent	265	absent	absent	absent	p	homo	1(-2)c	13	25	<1mm	12	thin	bord (8)					
B153	16	Type 11	34,4	150-200	simple	s,srm	indist				absent	para, scan									thin						
A154	16	Type 11	33,8	150-200		s	indist				absent	diff		sq,p	het	1-2c	15c	30	<1mm	12	thin	bord			sil		
A154	23	Type 11	50,8	150-200		s	srp				absent	diff	present	u,p,sq	het	1-2c	12c	30	<1mm	12	thin	bord					
A154	81	Type 11	42,8	100-150	simple	s,srm	indist	elong, 18		117,2	absent	rare		p	homo	1-2c	10c	60	<1mm	12	thin-thick				sil		
A154	97	Type 11	28,6	150-200	simple	srm,s	indist	elong,20		250	absent	para,scan		p,sq	het	1-2c	9c	25	<1mm	12	thin				sil		
A154	98	Type 11	31,6	150-200		s	indist	elong,12			absent	para, scan		sq,u	het						thin	bord					
A154	122	Type 11	36	150-200	simple	s	indist	elong,16			absent	rare		sq,u	het	1-2c	15c	30	<1mm	8	thin						
A154	180	Type 11	40,6	150-200		s	indist				absent	para, diff		p,sq	het	1(-2)c	14c	20	<1mm	12	thin				sil		
A154	208	Type 11	50	100-150		s	indist				absent	rare		sq,p	het						thin						
A154	211	Type 11	59,4	100-150		s,clus	indist				absent	rare									thin						
A154	257	Type 11	38	100-150	simple	s,srm	indist		present		absent	rare		p,sq,u	het	1-2c	11c	30	<1mm	12	thin						
A154	307	Type 11	29,4	150-200	simple	s	dist		present		absent	rare		sq,u	het	1-2c	12c	30	<1mm	8	thin-thick	sept, bord	present		sil		
B164	2	Type 11	54,8	100-150	simple	sol,1-2rm,clus	dist	scal(25)	absent	265,6	absent	scanty		sq/p	homo	1(-2)c	15c	25	<1mm	12	thin-thick	bord, pits	absent				
B154	8	Type 11	58,4	100-150	simple	s, srm	indist	scal, 40			absent	rare		p,sq	het	1-2c	14c	35	<1mm	6	thin	bord, 4					
B164	2	Type 11	54,8	100-150	simple	sol,1-2rm,clus	dist	scal(25)				rare		sq/p	homo ?	1(-2)c	15c	25	<1mm	12		thin-thick			sil		
B151	56	Type 12	36,2	20-40	simple	sol,clus	indist	alt,5	pres			vasi-con		sq,p	het	1-2c	10c	31,6	<1mm		thin-thick						

A154	25	Type 12	38,2	100-150	simple	srm,clus	indist				absent	para, vesi		sq,p	het						thin-thick						
A154	31	Type 12	33,2	100-150	simple	stm,clus,s	indist	alt, 4-8		195,3	absent	para, con		sq,u	het	1-2c	9c	30	<1mm	4	thin						
A154	181	Type 12	34,4	100-150		clus	indist				absent	para, vesi		sq,u	het						thin-thick						
B151	59	Type 12	48,8	50-100		clus,	indist					scanty		sq/p	het?	1-2c	9c	25	<1mm		thin						
A154	76	Type 12	32,6	50-100		clus, s	indist				absent	para, scan		p,sq	het						thin				crys		
B152	22	Type 12	47,6	40-50	simple	clust	indist	alt				vasicentric	present	p	homo?	1-2-3(-4)	12	100	<1mm		thick						
B151	82	Type 13	52,6	50-100	simple	stm	?			328,1		rare		sq/p	het?	1-2-3-4c	>35c	60	1mm?								
B151	116	Type 14	40	20-40	simple?	sol	indist			171,9		rare		sq/p	homo?	1c	10c	15	<1mm	16	thin						
B151	152	Type 15	27,2	300-350	simple?	sol	indist					rare		sq	homo?	1c?											
B152	1	Type 15	27,4	250-300	simple	sol,1-2rm	dist			250		rare				1c	12c	15	<1mm				pitted				
A154	206	Type 15	27,4	300-350		s	indist				absent	para, scan									thin-thick						
B161	16	Type 16	63,6	20-50	simple	sol	indist	alt		171,9		rare		sq,p	het	1-2-3c	26c	60	<1mm								
B161	28	Type 16	103,3	0-20		sol	indist					scanty	present	p,sq	het	1-2(-3)c	8c	40	<1mm		thin			sil	sil		
B161	20	Type 17	50,4	50-100	simple	sol,1-2rm	indist	alt		203,1		iband(5)(4-7)		sq/p	homo?	1c	13c	10	<1mm		thin-thick						
B161	29	Type 18	11	350+		dendritic	indist			156,3		para,con,		p,sq	het?	1c	10c	20	<1mm	8-12	thin-thick		present				
B161	35	Type 19	27,6	50-100	simple	sol,1-2rm	indist	alt		117,2		rare	present	p,sq,u?	het	1-2-3(-4)c	30c	25	<1mm								
A154	159	Type 19	41,6	50-100	simple	s	indist	alt,<4			absent	rare		u,sq	het	1-4c	24c	50	<1mm	8	thin-thick	bord					
B161	27	Type 20	60,6	50-100	simple	clus,srm	indist	alt				scanty	present	sq,p,u	het	1-2-3c	9c	35	<1mm		thin						
B154	30	Type 20	62,8	50-100	simple	srm,clus	indist	alt, 4-8		148,4	absent	para,vesi		p,sq	het	1-2(-3)c	11c	30	<1mm	6	thin-thick						
A154	95	Type 20	48,2	50-100	simple	srm,s	indist	alt,4		218,8	absent	para, vasi		sq,u	het	1-2c	9c	40	<1mm	8	thin-thick						
A154	154	Type 20	39,8	50-100	simple	srm,clus,s	indist	alt,<4		131,3	absent	para, vasi		sq,p	het	1-2c	17c	20	<1mm	16	thick						
A151	5	Type 21	65,56	50-100	scal(6-7)	sol, 1-2rm	indist?	opp?				absent	absent	sq/p	?homo	1-2c	9c	36	<1mm	6-10	thin	bordered pits					
A154	92	Type 21	51	50-100	sim,scal(5-6)	s	indist	scal, 28		187,5	absent	rare		p,sq	het	1-2c	11c	50	<1mm	12	thin						
B154	9	Type 21	56,4	40-50	simple	s, srm	indist		present	132,8	absent	para, scan		p,sq	het	1-2c	11c	50	<1mm	12	thin				sil		
B151	69	Type 22	27,8	50-100	simple	Dendritic,rm	indist?	alt		296,9		band(4-5)	present	u,sq,p	het	1-2c	8c	30	<1mm		thick						
B162	54	Type 22		100-120	simple	dendritic	indist	alt				iband(4-6)(2-4)		p,sq,u	het	1-2c	8c		<1mm		thick!						
A152	12	Type 22	53,2	50-100	simple?	sol,srm	indist	alt				iband(7-8)(2-4)	present	u,sq,p	het	1-2c	9c	35	<1mm		thick						
B152	24	Type 22	28,8	100-150	simple	sol	indist	alt?				band(4-5)(5-7)	present	u,sq?	homo?												
B151	6	Type 23	_	_	_	_	dist?	_	tracheids	_	present	absent	absent	sq/p	homo	1c	8c	15	<1mm	5	thin	bord,					
B151	62	Type 23	_	_	_	_	indist	_	tracheids	_	present	absent	absent	p	homo	1c	7c	10	<1mm	6	thin	bord,					
B151	72	Type 23	_	_	_	_	indist	_	tracheids	_	present	absent	absent	sq/p	homo						thin						
B151	121	Type 23	_	_	_	_	indist	_	tracheids	_	present	absent	absent	p	homo	1c	6c	4	<1mm		thin	bord,					
B151	128	Type 23	_	_	_	_	indist	_	tracheids	_	present	absent	absent	sq/p	homo				<1mm	4	thin	bord,					

B151	129	Type 23	–	–	–	–	indist	–	tracheids	–	present	absent	absent	sq/p	homo						thin						
B151	145	Type 23	–	–	–	–	indist	–	tracheids	–	present	absent	absent	p	homo						thin						
A153	3	Type 23	–	–	–	–	indist	–	tracheids	–	present	absent	absent	sq/p	homo				<1mm		thin	bord,					
A153	11	Type 23	–	–	–	–	indist	–	tracheids	–	present	absent	absent	sq/p	homo	1c	7c	4	<1mm		thin	bord,					
A153	34	Type 23	–	–	–	–	indist	–	tracheids	–	present	absent	absent	p	homo				<1mm		thin	bord,					
B151	60	Type 24	26,2	100-150	simple	exl sol	indist					band(4-5)(5-6)		u,p,sq	het	1-2c	8c	25	<1mm		thick						
B151	80	Type 24	32,4	100-150	simple	sol,1-2rm	indist	alt	242,19			band(5-6)(4-6)		u,sq	het	1-2-3c	12c	30	<1mm		thick						
B151	97	Type 24	32	100-150	simple?	sol	indist		132,81			band(4-5)(4-6)		u,sq	het						thick						
B151	99	Type 24	25,8	100-150	simple	sol	indist	alt	117,19			band(6-7)(4-5)	present	sq,u	het						thick		pitted				
B151	123	Type 24	32	100-150		excl,sol	indist					band(4-5)(4-6)															
B151	47	Type 24	33,4	150-200		excl sol	indist					band(6-7)(5-7)		u,sq,p	het	1-2-3c	17c	30	<1mm		thick						
B152	24	Type 24	28,8	100-150	simple	sol	indist	alt?				band(4-5)(5-7)	present	u,sq?	homo?												
A154	7	Type 24	24,4	150-200		excl,s	indist				absent	band(3-4)(3-6)		u,sq,p	het	1-3c	15c	30	<1mm	8	thick						
B161	1	Type 25	33	100-150	simple,	sol	indist?	alt				band(4-5)(4-5)	present	u,sq	het	1-2c	14c	50	0,25-0,5		thick	pitted			crys		
B151	75	Type 25	42	50-100	simple	excl sol	indist			234,4		band(3-4)(4-7)	present	sq,p,u	het	1-2(-3)c	12c	30	<1mm	12					crys		
B162	8	Type 25	34,6	50-100		sol	indist					band(3)(3-7)	present	sq,u	het	1-2-3c			<1mm		thick				crys		
A152	1	Type 26	36,5	40-50?	simple	sol?clus?	indist					vesicentric		sq,p	het?	1-5c	14c	90	<1mm	10	thin						
A153	1	Type 26	37,2	49,5	simpe	sol	dist(SRP)					para, vasi		p,sq	het	5-6c	30c	160	0,5-1	<4	thin - thick						
A152	11	Type 27	35,8	100-150		clus,dendritic?						scanty/vasi		p/sq	het?	1c	8c	20	<1mm	20	thin-thick	sept					
A152	47	Type 27	37,8	50-100	simple	dendr?,ltm	indist					vesi-confluent		p/sq	homo?	1c	10c	20	<1mm		thin						
A152	11	Type 27	35,8	100-150		clus,dendritic						scanty/vasi		p/sq	het?	1c	8c	20	<1mm	20	thin-thick	sept					
A152	3	Type 27	28.0	50-100	simple	clus,	indist	alt?	pres?			scanty		sq/p		1c	8c	18	<1mm	12	thin-thick						
A154	5	Type 27	40,4	100-150	simple	diag	indist		present	156,3	absent	para,scan		sq,u	het	1c	6c	20	<1mm	20	thin-thick						
A154	25	Type 27	38,2	100-150	simple	srm,clus	indist				absent	para, vasi		sq,p	het						thin-thick						
A154	99	Type 27	47,6	50-100		clus,	indist				absent	para, vasi									thin-thick						
B151	148	Type 27	39,8	50-100	simple	1	indist					rare		u,sq	het	1-2c	8c	20	<1mm								
B153	20	Type 28	93,2	20-40	simple	sol	indist					scanty	present	p,sq	het	1-2(-3)c	17c	30	<1mm	12							
B162	50	Type 28	71,8	40-50	simple	sol,clus,1-2rm	indist	alt				scanty para		sq,p	het	1-2-3-4c											
A154	38	Type 28	88,4	20-40	simple	s,srm	indist			164,1	absent	para, vasi		p,sq	het	1-2c	20c	30	<1mm	12	thin						
A154	119	Type 28	151,8	0-20	simple	clus,s	indist			70,31	absent	para, vasi		sq,p	het	1-3c	14c	40	<1mm	8	thin						
B153	4	Type 29	42,3	200-250	simple	sol	indist	bord,<4				para,scan		p,sq	het	1-2(-3?)c	12c	20	<1mm	4	thick						
B162	15	Type 29	29,4	200-250	simple	sol	indist (wrp?)						pres?	p,u	het	1-2(-3)c			<1mm		thick						
B153	4	Type 29	42,3	200-250	simple	sol	indist	bord,<4um				para, scanty		p,sq	het	1-2c	12c	20	<1mm	4	thick						

A154	17	Type 29	36,8	250-300	simple	s	indist	alt		140,6	absent	diff		u,sq	het	1-2c	10c	40	<1mm	4	thin-thick	bord					
A154	94	Type 29	31,6	200-250	simple	s,clus,srm	srp				absent	rare		p,sq	het	1-2c	11c	25	<1mm	8	thin				sil		
A154	285	Type 29	25,8	200-250	simple	s	indist		present		absent	rare		sq,p,u	het	1-2c	10c	15	<1mm	16	thin		present				
A154	314	Type 29	25,4	200-250		s	indist				absent	rare				1-3c	16c	30	<1mm	4	thin-thick	min pits					
B153	3	Type 30	68,8	50-100	simple	srm, clust	indist	alt, bord, <4um				vasi, aliform	present	p, sq?	het?	1-6c	20c	120	<1mm	4	thick						
A154	106	Type 30	70,2	40-50	simple	srm,s	indist	alt			absent	scan, diff		p,sq,u	het	1-4c	15c	60	<1mm	4	thin						
A154	127	Type 30	70	0-20	simple	clus	indist	bord,4-8		242,2	absent	para,vasi		p,sq,u	het	1-4c	23c	50	<1mm	4	thin-thick						
B153	3	Type 30	68,8	50-100	simple	srm, clust	indist	alt, bord, <4um				para, vasi-ali	present	p, sq?	het?	1-6c	20c	120	<1mm	4	thick						
B153	5	Type 30	53,2	20-50	sim,	clus, srm	indist	alt,4-8	absent	281,3		para,vasi	present	p	homo	1-4c	8c	40	<1mm	4	thick	min,pits					
B162	10	Type 30	37	50-100	simple	clus,srm	indist	alt				vasi-conf		p,sq	het	1-2-3-4c			<1mm		thick						
A154	12	Type 30	100	0-20	simple,	srm	indist	alt,4		101,6	absent	rare, diff		p,sq	het	1-5c	18c	50	<1mm	8	thin						
B154	4	Type 31	67,6	20-40	simple	sol	indist			117,19?		scan, vasi, ali	present	sq,u	het	1c	13c	20	<1mm	12		thin-thick					
B151	45	Type 32	53,6	50-100	simple	sol,1-3rm	indist	alt		132,8		rare,		p	homo?	1-2c	10c	25	<1mm		thin-thick						
A151	21	Type 32	52,4	50-100	simple	s,srm,clus	indist			226,6			present	u,sq,p	het						thin						
B161	9	Type 32	17,4	50-100	simpe	sol,srm	indist	alt				rare		u,sq	het						thin-thick						
B161	9	Type 32	17,4	50-100	simpe	sol,srm	indist	alt				rare		u,sq	het												
A154	78	Type 33	67,8	100-150	simlple	lrm	indist	alt(<4-8um)		171,9		scanty		p,sq	het	1-2-3c	10c	60	<1mm	4-12	thin						
A154	140	Type 33	51	50-100	simple	lrm	indist	alt,4-8		265,6	absent	para,scan		sq,p,u	het	1-2(-3)c	12c	40	<1mm	12	thin	min,, sept			cry		
A153	5	Type 34	44,4	100-150	simple	sol, srm	indist	alt, 4-7um		195,3		para, scan	present	p,sq,u	het	1-2c	17c	25	<1mm	4-8							
A153	17	Type 34	54,4	100-150	simple	s, srm	indist	alt, <4		210,9	absent	rare		p,sq,u	het	1-2c	10c	30	<1mm	4	thin						
A154	34	Type 34	32	100-150	simple	srm,clus	indist	alt,4		132,8	absent	para, scan		sq,u,p	het	1-2c	15c	30	<1mm	8	thin-thick						
A154	112	Type 34	54	100-150	simple	s	indist				absent	rare		p,sq	het	1-2c	16c	30	<1mm	4	thin						
A153	10	Type 35	39	40-50	simple	clus, srm	indist			226,6		iband(4-6)(4-5)		p,sq,u	het	1(-2)c	10c	12	<1mm	8-12	very thick						
B153	10	Type 35	28,4	50-100	simple	stm, clus	indist	alt(4-8)			absent	iband(3-4)(2-6)		p,sq,u	het	1-2c	11c	20	<1mm	12	thick						
B153	21	Type 35	82,8	20-50	simple	diag	indist	alt,4			absent	iband(3-4)(2-6)		p,sq,u	het						thick						
A154	20	Type 35	45,4	50-100		srm	indist	min,pits			absent	iband(3-4)(2-8)		p,u,sq	het						thick						
A154	33	Type 35	66,2	50-100	simple	s,srm,clus	indist				absent	iband(6-7)(3-4)		p,sq,u	het	1(-2)c	14c	20	<1mm	16	thick						
A154	229	Type 35	42,8	20-50		s	indist				abse	iband(6-8)(3-7)		sq,p,u	het						thick						
B152	12	Type 35	48	50-100	simple?	clust, diag	indist					ibands(6-8)(2-3)		p,sq	het												
A154	185	Type 35	26,4	100-150		s	indist				absent	band(6-8)(2-5)		p,sq,u	het	1-2c	8c	20	<1mm	4	thick						
A154	36	Type 35	51	50-100	simple	srm,clus	indist	alt, 4-8			absent	band(3-4)(2-4)		u,sq	het	1-3c	6c	30	<1mm	4	thick						
A153	12	Type 36	28,6	100-150	simple	sol	SRP	round, opp, <4um		117,19?		rare, diff?	present	p,sq,u	het	1-2-3c	13c	20	<1mm	4-6	thick						
A153	26	Type 37	31	50-100		srm, s	indist				absent	rare		sq,p	het	1-5c	11c	120	<1mm	4	thin						

B153	8	Type 37	63,8	40-50	simple	srm	indist	alt		468,8	absent	rare		p,sq	het	1-4c	24c	70	0,5mm	2	thin				sil		
B153	9	Type 38	29,4	50-100	simple	s	indist	v-r, bord(4)		195,3	absent	iband(2-3)(3-7)		p,sq,u	het	1-2(-3)	10c	50	<1mm	4	thick						
A154	101	Type 38	30,2	50-100		s	indist				absent	iband(2-4)(6-7)		sq,p	het	1-3c	15c	35	<1mm	12	thick						
B151	68	Type 39	39,2	50-100	simple	sol,1-2rm	indist					rare		sq	homo	1-2c	11c	30	<1mm								
B151	77	Type 39	48,83	50-100	simple	srm,clus	indist					rare	pres	p	homo	1-2c	12c	40	<1mm		thin						
A152	16	Type 39	41	50-100	simple	sol,1-2rm	dist					rare		p	homo	1-2c	13c	30	<1mm		thin	bord					
A152	43	Type 39	43,6	50-100	simple	sol	indist							p	homo	1-2c	12c	45	<1mm		thin	bord, 4-8					
B152	8	Type 39	38,2	50-100	simple ?	sol,srm	indist							sq/p	homo ?	1-2c	12c	20	<1mm		thin						
B162	22	Type 39	47,2	50-100	simple	sol,	indist						pres	p	homo	1-2c(1=2)			<1mm								
B162	31	Type 39	25	50-100	simple	sol	indist					scan,unilateral				1-2c			<1mm		thin-thick						
A154	32	Type 39	38,6	50-100		s,srm	indist				absent	rare, diff	present	sq	homo	1-2c	14c	30	<1mm	8	thin						
A154	160	Type 39	54	50-100		s,srm	indist				absent	rare		sq	homo						thin-thick						
B154	19	Type 39	38,8	50-100		clus,s	indist				absent	para, scan		p,sq	het	1-2c	17c	30	<1mm	12	thin						
A154	29	Type 39	42,2	50-100		s,srm	indist				absent	rare		p,sq	het	1-2c	13c	35	<1mm	12	thin						
A153	2	Type 39	54,8	50-100		sol,1-2rm	indist					para, scan		p,sq	het	1-2c	15c	30	<1mm	4-8							
A154	1	Type 39	51,6	50-100	simple	s	indist			156,3	absent	rare, diff		p,sq	het	1-2c	12c	40	<1mm	8	thin						
A154	40	Type 39	56,2	50-100	simple	s, srm	indist				absent	rare		p,sq	het	1-2c	13c	40	<1mm	8	thin						
A154	139	Type 39	41,2	50-100	simple	s,srm	indist		present	109,4	absent	para,scan		sq,p	het	1-2c	11c	25	<1mm	8	thin						
A154	164	Type 39	39,8	20-50	simple	s,clus	indist				absent	rare-absent		p,sq	het						thin						
A154	77	Type 40	40,4	50-100	simple	diag, clus,srm	indist	alt,<4		273,4	absent	para, vasi				1-4c	15c	55	<1mm	4	thick						
B162	16	Type 40	33,4	50-100	simple	clus	indist	alt				para, vasi		sq,p	het	1-5c	20c		0,5-1mm				pits				
A154	83	Type 41	31,3	20-40	simple	s,srm	indist	alt			absent	rare, diff	present	sq,p	het	1-2c	12c	30	<1mm	12	thin						
A154	206	Type 42	27,4	300-350		s	indist			85,94	absent	para, scan									thin-thick						
B154	21	Type 43	75,45	0-20	simple	s, srm	indist	alt,4-8			absent	para, vasi		p,sq,u	het	1(-2)c	10c	20	<1mm	16	thin						
B154	23	Type 43	94	0-20	simple	clus, srm	indist	alt,12		78,13	absent	para,vasi		p,sq	het	1(-2)c	8c	20	<1mm	8	thin						
A154	18	Type 44	64,4	50-100		s	indist				absent	rare		u,sq	het	1-2c	10c	30	<1mm	4	thin						
B151	86	Type 44	58,2	50-100	simple	sol,1-2rm	indist	alt		101,6		scanty	pres	p/sq	het?	1-2c	12c	30	<1mm		thin-thick		present				
A153	6	Type 44	20-40	50-100		sol	indist					rare?		p,sq	het	1-2c	14c	25	<1mm	4-6							
A151	11	Type 45	52,84	70-100	simple	sol	indist							p	homo	1-2-3c	9c	38	<1mm	8-9	thin	bord					
A152	31	Type 45	47,8	100-150		sol,1-2rm	indist			226,6				p,sq	het	1-2-3c	11c	50	<1mm		thin-thick						
B162	17	Type 46	31	100-150	simple	sol,	indist							p	homo	1-2-3c											
B154	3	Type 46	43,4	50-100	simple	s	indist				absent	absent	absent	p,sq	het	1-3c	18c	40	<1mm	8	thin				sand crys		
A15PC	2	Type 46	48	50-100	simple	s	indist			125	absent	rare		p,sq	het	1-3c	16c	60	<1mm	12	thin	bord, 4-8					

A154	21	Type 46	44,2	50-100	simple	s	indist	alt		93,75	absent	para, scan		u,sq	het	1-3c	13c	30	<1mm	4	thin-thick						
A154	43	Type 46	44,8	50-100	simple	s	indist				absent	rare, diff		u,sq	het	1-3c	17c	35	<1mm	4	thin-thick						
A154	146	Type 46	47,8	40-50		s	indist			156,3	absent	rare		u,p,sq	het	1-3c	11c	60	<1mm	4	thick						
B154	14	Type 46	77,6	50-100	simple	s	indist			210,9	absent	rare		p,u	het	1-4c	25c	50	<1mm	4	thick						
A154	130	Type 46	38	20-50	simple	s	indist	bord,		187,5	absent	para,scan		p,sq	het	1-2c	14c	35	<1mm	8	thin						
A154	303	Type 46	52,8	100-150	simple	s	indist				absent	rare									thick						
A154	295	Type 46	37	50-100	simple	s	indist				absent	rare		p,u,sq	het						thick						
A154	179	Type 46	36,4	50-100		s	indist				absent	para, scan									thin						
A151	17	Type 47	41,2	50-100	simple	s-lrm		alt				scanty	present		het?	1-2-3(-4)c	20c	30	<1mm	5-6	thin-	sept					
B151	49	Type 47	48,2	40-50	simple	1-2rm,sol	indist	alt				rare		u,sq,p	het	1-2-3c	23c	60	<1mm		thin						
B161	19	Type 47	51,4	100-150	simple	sol,srm	indist?	alt				rare		sq,p,u	het	1-2-3c	12c	45	<1mm		thin	min					
A152	10	Type 47	39,6	50-100	simple	sol,1-2rm	indist					rare		sq,u	het	1-2-3c	14c	50	<1mm?		thin						
B153	6	Type 47	45,4	40-50	simple	s, srm	indist			359,4	absent	rare	present	p,sq,u	het	1-3c	20c	40	<1mm	12	thin				crys,sand		
B162	8	Type 48	34,6	50-100		sol	indist					band(3)(3-7)	pres	sq,u	het	1-2-3c			<1mm		thick				sil		
A154	170	Type 48	22,2	50-100		s	indist				absent	band(9-10)(3-6)		u,sq,p	het	1-2c	12c	25	<1mm	12	thin						
A154	200	Type 48	32	100-150		s	indist				absent	band(5-6)(3-8)		u,sq	het						thick						
A154	228	Type 48	33,8	150-200	simple	s	indist	alt,4		179,7	absent	bands(5-6)(2-9)									thick						
B152	7	Type 49	32,2	100-150	simple ?	sol,1-2rm	indist					rare		sq	homo	1c	7c	15	<1mm								
B161	25	Type 49	30,8	40-50	simple	clus,srm	indist					scanty	pres	sq,p,u	het	1(-2)c	10c	30	<1mm		thin						
A152	30	Type 49	46,4	50-100	simple	sol,	indist							p,sq	het	1,1-2c	15c	35	<1mm		thin	bord,					
B161	10	Type 49	30,4	50-100	simple	sol,srm	indist	alt				rare		u,sq	het	1c	10c		<1mm		thin						
A154	178	Type 49	44,6	40-50	simple	s	indist	roun,4-8		148,4	absent	para, scan		sq,p	het	1-(2)c	7c	20	<1mm	12	thin						
A154	110	Type 50	27,4	200-250		s	dist				absent	rare									thin-thick						
A154	175	Type 50	27,8	200-250	simple	s	indist	elong, 15,63		281,3	absent	rare, diff				1-2c	14c	25	<1mm	12	thin						
A154	227	Type 50	42,6	200-250		srm,clus	indist	elong,16			absent	rare		p,sq	het	1-2c	11c	25	<1mm	12	thin-thick						
A154	328	Type 50	33,2	200-250	simple	s,srm	indist				absent	rare				1(-2)c	20c	15	<1mm	8	thin						
A154	24	Type 51	64,4	50-100		clus, srm	srp			117,2	absent	para, scan		p,sq,u	het	1-2c	11c	45	<1mm	8	thin						
B164	18	Type 51	31,8	100-150		srm, clus	indist					rare-absent		p,sq	het												
B164	27	Type 51	30	150-200		clus,srm	indist				absent	para, scanty		p,sq	het	1-3c	9c	35	<1mm	2-4	thin-thick						
B152	9	Type 51	50,6	40-50		clus,srm	indist					para, vasi		sq,p	het	1-2c											
B162	6	Type 52	57,8	20-40	simple	sol,srm	indist			265,6		absent?		sq/p	het?	1-2(3)c			<1mm		thin				min sil		
B154	26	Type 53	60,2	50-100		srm,s	indist				absent	para,vasi		p,sq,u	het	1-3c	16c	30	<1mm	6	thin						
A152	17	Type 54	56	50-100	simple	sol,1-2rm	dist?					rare		sq/p	homo	1-2-(3)c	14c	70	<1mm		thin				sil		

A151	13	Type 55	42,52	20-40	simple	excl, sol	indist?	alt		218,8		scanty	scanty ?	u	homo	1-2-3c	12c	44	<1mm	4-5	thin	bord					
A154	9	Type 56	92	0-20	simple	excl,s	indist			421,9	absent	rare		p,u	het	1-4c	30c	80	0,5mm	10	thick						
A153	31	Type 57	70,6	20-50	simple	srm,clus	indist	alt, <4		265,6	absent	para,vasi		p,sq	het	1-4c	16c	80	<1mm	8	thin-thick						
A154	57	Type 58	_	_	_	_	_	_	tracheids	_	_	rare?		u,sq	het	1-2c	8c	60	<1mm	4	thin						
A154	4	Type 59	40,4	50-100	simple	srm,s	indist	alt,4		101,6	absent	apo, diff		sq,u	het	1-2(-3)c	13c	35	<1mm	12	thin-thick						
A154	72	Type 59	53,6	50-100	simple	srm,clus, s	indist				absent	rare, diff		u,sq	het						thin-thick						
A154	318	Type 59	53,6	50-100	simple	srm,clus	indist	alt,4-8		281,3	absent	para, vasi				1-2c	10c	40	<1mm	8	thin-thick						
A154	144	Type 59	37	50-100	simple	srm,clus	indist	alt,<4		210,9	absent	para, vasi				1-3c	6c	35	<1mm	4	thick						
B164	14	Type 59	55,4	50-100		srm, s	indist		absent		absent	absent	absent	p	homo	1-3c	6	50	<1mm	2-4	thin-thick						
A154	271	Type 59	44,4	50-100	simple	srm,clus, s	indist				absent	para, vasi		sq,p	het	1-2c	11c	30	<1mm	4	thin						
A152	23	Type 59	41,2	50-100		srm,clus		alt				scanty,vasi		p,sq	het	1/1-2c*					thick						
A154	2	Type 59	50,8	50-100	simple	srm,s,clus	indist	alt,4-8		265,6	absent	para, vasi		u,sq,p	het	1-2c	7c	35	<1mm	12	thin-thick						
A151	16	Type 59	48,57	70-100	simpe	clus,srm	indist?	opp?,						sq,p?	het?												
WBLSASC	3	Type 60	54,6	<50	simple	s,srm	indist	alt				rare				1c	8c	20	<1mm	3-4	thin	sept					

APPENDIX 6a Vessel diameters measured from the archaeological charcoal remains

Fragment #	Measurements in micrometres (µm)	Average
WB LSA: surface cleaning		
3	64,69,65,70,48,42,61,58,74,59,62,57,62,41,49,43,37,46,46,41,46,49,55,46,65	54.6
4	40,30,50,40,20,20,20,40,20,20,10,20,20,30,30,25,50,30,30,15,15,30,15,10,20	26
5	52,35,37,39,36,44,35,30,29,34,22,51	37
10	36,44,33,33,28,46,35,41,43,46,29,41,78,50,63,69,44,29,37,36,50,54,45,40,60	44.4
B15: surface cleaning		
1	54,44,39,42,67,59,43,60,66,89,56,70,60,50,58,61,76,55,75,57,64,78,49,68,81	60.84
2	68,66,33,27,62,68,47,56,71,43,42,28,30,46,61,62,26,50,72,61,62,61,68,59	52.8
4	47,39,44,47,58,44,47,29,47,75,57,46,47,45,33,57,48,18,45,27,30,37,31,27,14	41.56
B16: surface cleaning		
1	36,39,40,46,50,46,36,52,48,65,58,63,59,51,61,58,53,62,49,40,45,45,535,58	48.52
A15: Spit 1		
1	52,51,37,48,38,44,42,40,37,58,45,44,38,60,46,32,29,33,23,32,42,42,27,43,35	40.72
3	63,53,65,50,43,54,61,57,61,59,62,45,38,110,81,67,57,44,46,83,50,55,70,44,56	58.96
4		
5	79,71,64,82,74,80,56,66,60,54,,62,49,76,62,69,53,46,54,74,72,77,77,63,65,54,	65.56
6	50,60,50,55,60,50,55,50,30,30,40,50,30,40,30,30,40,45,30,40,30,40,20,70,40	42.6
7	52,58,58,68,66,63,54,56,63,68,57,53,61,42,62,77,52,33,53,59,46,39,44,76,78	57.52
8	48,38,43,44,45,41,15,49,38,49,38,45,33,52,43,69,49,45,37,46,42,37,32,	42.52
10	30,30,35,40,80,100,50,60,70,50,50,30,40,50,40,40,50,30,80,30,35,40	48.18
11	54,61,57,56,67,50,32,79,48,69,50,68,47,54,42,37,58,50,74,60,61,47,37,32,31	52.84
13	47,41,50,58,49,55,42,37,44,37,26,40,42,29,36,42,43,41,54,35,52,44,32,41,46	42.52
16	50,40,50,45,45,50,60,50,60,60,50,60,60,20,40,50,50,40,40,40,30,40,30,35,60	46.2
17	60,60,30,35,60,30,45,55,40,30,45,50,40,40,45,45,30,40,45,45,20,45,30,40,25	41.2
18	35,55,60,50,55,50,50,50,60,70,70,45,75,60,30,40,45,30,45,45,60,70,60,80,45	53.4
21	30,40,50,70,40,35,40,40,50,60,70,75,35,50,40,50,50,40,70,60,60,65,40,70,80	52.4
B15: Spit 1		
1	55,55,58,58,58,61,62,58,54,53,50,68,55,67,64,64,61,58,64,65,50,74,54,63,53,	56.96
2	82,90,144,77,89,100,116,79,128,115,88,103,101,104,143,105,110,90,82,141,106,109,109,82	103.88
3	101,76,81,81,85,81,62,76,76,74,72,79,88,74,97,93,80,92,60,54,63,54,65,57,76	75.5
4	39,35,43,56,60,51,38,40,35,50,36,45,21,37,49,62,54,54,48,60,57,27,35,57,34,	44.35
5	52,57,46,53,54,46,48,58,50,44,56,36,70,63,36,79,43,48,42,59,40,52,72,63,54	54.97
6	Tracheids- no vessels	
7	Tracheids- no vessels	
8	73,66,91,76,103,67,74,80,82,58,56,95,81,53,52,91,89,75,80,83,80,63,60,88,86,	74.25
9	100,140,140, 140 120 130	128.3
10	91,97,92,125,158,103,100,106,100,115,98,130,93,107,101,139,89,118,145,93,139,131,122,109,110,150,131,	114.52
11	167,152,101,146,116,110,150,119,68,112,110,119,120,130,114,169,138,104,138,176,133,133,121,128,128,133,133,45,158	126.59
12	57,30,37,58,53,60,51,32,51,45,47,50,48,49,54,62,79,51,70,57,86,31,37,47,55	52.52
13	125,112,110,89,82,116,91,61,97,119,85,94,131,107,143,112,86,99,104,112,128,135,153, 82,64,162,146,98,116,116,102	105.19
14	90,95,93,100,49,114,89,78,77,71,126,128,74,106,124,127,70,123,87,165,145,132,62,90	96.6
15	30,30,25,20,30,25,30,35,20,35,30,35,20,20,25,20,25,20,20,30,20,20,20,40,40,30,20,30	26.6
16	40,50,60,50,60,60,55,80,60,50,40,40,45,70,40,60,45,70,30,30,40,70,50,70,75,60,55,60	53.39
17	50,100,60,50,40,50,60,100,60,100,80,40,50,45,50,60,50,30,50,40,40,20,40,80,95,100	59.23
18	55,40,25,30,30,45,35,40,20,25,45,40,45,30,45,60,30,40,40,50,60,60,65,50,50	42.2

19	40,30,40,40,50,60,60,40,60,40,50,80,40,50,30,35,25,70,30,35,40,35,40,45,30	43.8
21	40,40,50,40,50,50,40,40,50,30,40,40,50,50,45,50,40,50,30,40,30,20,45,50,45	38.6
22	80,80,80,75,60,65,70,80,80,40,60,60,70,60,40,65,30,35,60,60,70,50,50,40,60	60.84
23	70,60,60,60,60,40,70,70,60,30,60,30,50,50,50,70,60,40,40,50,40,60,50,20,30	51.2
24	50,30,50,70,40,60,50,50,60,55,70,55,70,40,60,50,75,40,60,40,40,40,45,45,35	51.2
25	20,15,15,20,20,12,10,15,12,15,10,18,10,15,30,18,10,30,20,20,20,10,15,25,18	16.72
26	200,160,140,120,100,180,100,80,140,80,80,80,120,120,120,90,120,80,75,60,80,75,70,90, 80	98.4
27	25,40,35,25,40,60,20,30,50,40,30,60,40,50,40,30,50,25,45,20,45,40,30,40,25	37.8
28	30,40,40,45,35,25,30,40,50,50,50,40,25,30,25,30,35,40,45,35,60,40,40,30,60	38
29	40,45,40,25,55,30,35,50,35,40,45,40,40,40,45,50,25,30,25,50,50,35,30,35,45	38.8
31	30,40,30,40,25,25,35,30,35,35,20,40,30,30,30,40,45,40,40,20,30,20,50,45,60	34.6
34	60,65,80,80,80,60,55,60,80,100,60,70,80,70,50,50,70,50,70,90,70,70,70,40,35	63.4
35	50,30,30,30,40,45,45,50,45,40,30,50,50,30,40,30,60,30,45,50,35,30,50,40,40,	39.8
36	18,22,30,30,30,30,10,30,35,30,38,20,40,30,42,30,35,40,20,20,25,20,30,35,38	28.32
37	42,40,40,45,60,40,45,40,45,60,70,38,80,90,50,45,80,60,60,50,45,60,80,60,70	55.8
39	110,80,120,110,80,40,60,90,80,90,80,60,120,100,80,140,120,60,120,100,120,100,160,60, 40	92
42	70,40,70,90,40,40,70,60,30,40,50,55,50,50,30,40,30,35,35,40,50,40,40,40,35	44.8
45	120,80,80,60,100,110,40,50,75,45,100,100,60,35,40,55,40,45,50,60,20,20,50	53.6
46	140,80,160,80,160,120,120,160,120,80,90,110,100,120,30,30,100,140,120,120,60,40,80, 80,60,	104
47	40,30,40,30,25,20,20,30,40,50,30,35,20,40,35,30,20,30,40,45,50,30,35,40,30	33.4
49	80,90,40,50,50,40,55,50,45,50,50,70,60,80,80,50,40,50,20,60,60,50,40,35,40	48.2
52	40,50,50,20,30,20,40,60,60,40,50,30,40,30,50,50,50,40,30,30,20,25,20,30,	32.2
53	70,60,70,50,50,50,35,30,40,80,40,60,80,40,70,80,70,75,80,100,35,35,80,75,50	60.2
54	30,30,30,40,30,35,40,20,25,30,40,35,20,20,15,45,45,45,40,40,25,40,30,25,30,	32.2
55	45,55,60,55,55,60,80,60,70,40,80,35,40,45,70,80,60,80,50,50,60,40,45,80,50	57.8
56	50,60,40,40,50,30,40,30,30,30,40,60,30,40,30,60,30,20,20,30,40,25,20,30,30,	36.2
57	30,30,40,50,40,40,40,30,30,40,30,60,65,40,40,50,45,45,45,25,35,30,30,25,45	39.2
58	50,60,40,40,60,40,60,80,100,40,45,45,30,20,35,60,50,60,60,80,60,60,40,35,20	50.8
59	50,60,40,40,40,50,60,60,70,60,60,45,55,80,60,60,70,40,30,20,50,25,50,30,15,	48.8
60	35,20,25,25,25,25,35,40,20,35,40,20,30,30,30,30,25,35,30,20,20,25,20,15,20	26.2
61	40,60,30,40,35,30,20,60,40,50,30,50,60,65,50,45,20,20,45,25,30,25,40,45,35	39.6
62	Tracheids- no vessels	
65	40,45,50,80,100,60,100,50,60,60,55,40,45,40,50,40,110,90,100,60,40,40,80,70,120	65
68	50,50,40,30,30,20,50,50,50,40,30,40,40,30,40,40,45,35,40,45,50,50,30,30,45,	39.2
69	65,65,20,25,20,25,20,10,20,15,15,15,10,20,45,40,30,40,25,20,40,30,60,60,20	27.8
72	podocarp	
75	50,70,30,50,50,30,55,40,40,35,60,35,50,45,35,35,30,30,20,20,45,80,40,45,30	42
76	50,60,40,70,50,70,50,80,50,50,60,60,40,60,70,30,30,50,30,90,70,40,85,60,100	57.8
77	60,50,30,40,40,45,70,50,50,50,70,50,30,40,40,50,50,64	48.83
80	30,30,20,25,30,35,40,25,40,40,40,40,40,20,20,30,35,30,30,30,30,30,25,40,20,35	32.4
81	30,20,20,40,40,50,30,20,30,30,40,25,30,25,40,25,30,30,35,30,30,40,45,40,30,20	33
82	40,40,65,60,60,35,20,40,50,50,70,40,30,30,40,50,90,20,25,20,80,50,80,50,40,50	52.6
85	40,45,60,50,50,50,35,50,50,25,50,50,30,50,50,40,60,70,55,55,40,60,35,60,55,60	50.6
86	50,70,60,70,70,50,60,70,35,65,50,60,70,70,50,20,20,30,60,50,80,80,70,40,45,40	58.2
91	25,30,20,40,25,25,30,40,30,25,30,30,40,20,20,20,25,30,30,30,25,30,25,60,25,30	30.4
92	90,110,45,60,100,40,60,100,90,100,150,100,60,95,40,40,	80
96	70,80,100,90,60,40,40,90,100,110,50,40,50,60,60,80,80,60,10,80,80,60,	67.72
97	30,20,40,20,25,30,35,40,40,50,50,40,40,20,25,30,40,20,20,50,30,20,25,30,30,	32
99	40,30,20,15,35,20,20,25,25,30,25,35,30,25,25,25,25,30,30,20,20,20,30,25,25	25.8

103	60,60,80,50,40,40,60,40,55,60,40,65,30,45,50,40,40,40,60,60,50,40,40,30,40	48.6
105	45,30,40,15,45,25,40,35,40,40,40,40,30,30,40,40,35,30,40,40,40,25,40,30,40	35.8
106	120,90,100,50,120,120,70,60,100,	92.9
107	140,100,40,60,100,80,120,80,80,60,40,50,60,90,90,50,60,60,90,90,90,80,60,40,50	74.4
111	20,30,30,20,20,30,20,20,30,15,20,25,30,20,20,40,30,20,20,50,20,20,20,15,30	24.6
116	140,40,60,30,60,20,30,20,20,120,40,50,40,20,30,30,30,40,20,20,20,40,30,30,20	40.0
118	50,50,50,40,60,70,50,40,70,50,60,40,40,60,80,50,80,50,50,90,75,30,70,30,45,	55.2
119	60,40,70,60,80,40,50,60,60,50,40,50,45,30,40,40,40,30,60,45,60,40,20,20,20	46.0
123	30,30,30,40,40,40,40,30,20,20,40,30,20,25,30,40,40,30,30,45,40,40,20,30,20,	32.0
140	50,50,40,30,25,45,40,80,40,50,60,30,40,50,60,50,20,30,30,20,20,40,40,40,30	40.4
142	100,80,60,80,80,70,90,80,50,50,80,40,60,80,50,80,80,60,80,100,80,70,60,80,80	72.8
143	50,50,60,60,40,50,60,30,40,50,30,60,30,40,50,60,60,50,30,70,30,30,30,40,70	46.8
148	40,45,40,60,35,30,30,50,40,20,35,20,60,40,40,50,30,30,40,50,20,40,40,80,30	38.8
152	20,20,20,20,30,30,20,20,25,40,30,25,40,40,20,30,25,30,30,10,25,25,30,35,40,	27.2
153	30,50,50,30,30,20,30,20,20,40,50,60,50,50,40,40,60,60,20,30,50,60,60,25,30,	40.2
154	50,40,50,60,50,70,60,60,50,70,70,50,50,60,80,60,40,40,60,50,60,30,30,70,65	55
156	40,30,30,20,30,30,15,15,20,20,20,15,30,30,30,20,20,20,20,40,40,30,20,30,45	26.4
B16: Spit 1		
1	30,40,40,40,20,25,30,30,30,30,40,40,40,40,20,30,40,30,30,30,40,40,20,20,40	33
2	100,80,70,60,50,80,70,70,70,50,50,90,70,40,30,50,30,40,60,40,60,60,50,50,50,	59.2
9	15,20,20,20,20,15,10,15,15,15,20,30,20,15,15,15,10,20,30,15,15,10,15,15,25,	17.4
10	30,25,20,10,15,10,30,10,15,30,20,35,35,30,35,25,40,25,30,45,40,40,50,60,60	30.4
16	80,60,70,70,90,80,90,70,50,70,70,80,50,60,40,60,80,40,50,70,60,60,40,50,70	63.6
19	60,40,40,60,50,60,60,60,60,30,40,40,60,40,60,40,50,50,60,60,30,20,25,60,30,	51.4
20	30,60,50,60,40,50,30,50,70,50,70,40,50,20,50,70,60,40,60,60,60,30,60,60,40,	50.4
24	30,30,80,50,60,50,50,40,45,50,60,60,60,60,90,30,70,30,50,70,70,30,70,40,45,	52.8
25	40,40,20,30,40,40,20,20,20,20,20,30,30,40,40,40,20,25,30,30,30,25,45,35,40,	30.8
27	60,70,60,70,60,50,70,60,80,50,60,80,80,25,70,50,60,50,60,70,80,50,70,40,40	60.6
28	130,90,100,90,60,120,120,110,110,	103.3
29	10,15,15,10,10,15,20,10,30,30,25,10,10,20,10,10,20,30,15,15,15,25,25,30,25,	18.0
35	25,25,30,30,25,30,15,15,30,30,15,30,35,35,30,25,35,30,30,30,40,20,20,30,30	27.6
A15: Spit 2		
1	35,30,40,30,40,40,45,45,25,35,	36.5
3	25,20,20,20,25,25,30,40,20,20,20,25,30,40,30,30,25,25,25,30,40,30,30,40,25	28
9	30,30,40,60,40,40,30,60,40,30,35,30,20,60,20,35,30,40,35,40,40,40,40,40,25	37.2
10	45,30,40,30,50,50,45,40,45,45,45,35,50,50,40,40,45,30,30,50,30,30,30,30,35	39.6
11	30,20,35,40,40,40,30,20,50,35,40,35,20,35,30,25,25,35,25,60,50,60,30,30,45	35.8
12	80,60,70,45,50,40,50,40,30,60,40,60,60,50,45,60,50,40,40,40,30,90,50,70,80	53.2
16	40,40,30,30,50,30,50,45,45,50,40,50,70,30,30,40,50,60,45,45,50,25,25,30,25	41
17	70,70,75,60,80,60,50,50,30,30,75,30,60,90,80,60,50,70,40,45,40,30,30,40,85	56
20	65,60,60,35,60,50,50,50,40,70,100,60,40,60,80,80,70,60,80,85,30,45,30,30,65,	58.2
22	50,35,50,40,20,30,30,60,30,50,40,30,40,45,40,40,45,40,30,40,40,30,30,30,25,	37.6
23	50,50,30,40,30,80,70,60,30,70,45,40,40,40,40,35,30,25,30,45,45,25,15,35,50	41.2
26	40,60,40,50,35,30,50,40,45,50,30,40,50,50,50,40,30,40,40,30,25,50,30,20,70	41.8
28	100,80,90,100,40,80,60,40,60,40,30,55,80,90,80,50,90,90,90,80,40,40,45,70,100	68.8
30	50,50,50,45,40,50,50,40,50,50,50,35,40,50,55,40,60,60,50,45,40,40,50,40,30	46.4
31	40,60,50,60,40,60,30,60,70,40,40,40,45,50,50,30,40,40,40,60,80,60,20,40,50	47.8
38	65,45,55,20,50,60,30,	46.42
43	25,35,25,15,20,20,20,20,25,30,25,30,35,35,30,30,40,30,15,25,25,20,15,15,10	24.6
45	50,40,40,30,20,20,40,40,50,50,50,50,40,40,30,20,20,40,50,50,40,50,30,40,25	38.2
47	40,50,20,25,40,45,40,40,35,30,40,50,35,25,45,20,40,40,50,40,35,40,40,50,30	37.8
B15: Spit 2		

1	25,25,35,30,30,25,30,30,30,40,25,30,30,15,35,25,20,25,15,40,30,30,25,20,20	27.4
7	40,35,25,30,40,30,25,25,25,50,40,40,45,30,20,40,40,20,20,40,40,20,25,30,30	32.2
8	40,35,40,30,30,30,30,40,35,30,20,30,70,50,50,30,40,40,40,60,40,30,30,50,35	38.2
9	60,60,40,50,45,50,60,60,70,50,80,40,60,50,30,50,60,50,55,60,30,60,45,30,20	50.6
12	45,40,30,60,50,60,40,60,70,50,60,35,40,50,50,30,60,35,60,30,50,45,60,50,40	48
22	60,50,50,50,35,60,40,40,50,40,40,50,50,50,40,60,50,50,50,50,45,45,45,40,50	47.6
24	20,35,30,30,20,15,40,35,30,20,30,20,25,40,40,30,25,25,40,20,30,25,40,30,25	28.8
32	100,80,90,60,50,60,35,70,45,60,80,50,50,80,40,60,40,80,80,70,30,20,40,80,120	62.8
	B16: Spit 2	
2	80,60,80,30,60,60,60,50,50,60,40,60,70,70,40,45,70,45,80,70,40,40,40,60,80	57.6
5	60,60,50,70,65,50,35,35,50,60,60,60,100,60,40,30,60,80,30,45,60,80,30,20,50	53.6
6	75,60,60,80,45,50,45,45,50,60,80,40,40,70,80,60,70,60,90,50,40,45,50,60,40,	57.8
8	45,40,40,30,40,40,30,35,30,50,30,30,50,50,30,20,20,25,20,30,40,30,40,30,40,	34.6
9	80,80,60,70,70,60,45,40,40,100,50,50,90,80,60,70,100,40,40,45,80,60,60,40,100	64.4
10	40,30,30,55,30,30,40,20,30,40,40,50,40,40,30,30,25,30,50,50,40,40,55,30,30	37.0
12	30,30,40,35,40,50,40,40,30,40,30,30,35,30,30,20,40,40,50,70,30,70,50,45,40	39.4
15	25,30,40,30,30,30,20,30,40,40,40,30,40,30,30,30,20,25,30,30,20,25,30,20,20	29.4
16	30,30,50,60,30,40,40,30,20,30,30,30,30,30,25,20,30,30,35,30,20,45,40,30,50	33.4
17	30,30,40,20,30,40,30,30,25,30,25,30,25,30,25,30,40,30,35,40,25,40,30,35,30	31.0
19	50,60,40,80,50,60,90,90,50,40,40,40,40,30,30,30,70,70,60,60,65,30,80,50,40	54.2
22	85,70,60,40,50,50,80,40,50,40,60,70,25,50,50,50,45,30,35,40,35,45,30,25,30	47.4
26	40,45,20,60,40,20,40,30,35,25,50,50,30,50,35,80,85,60,25,50,60,50,50,50,30	44.6
29	30,35,30,40,50,40,40,30,20,50,60,50,90,60,40,40,50,40,60,45,35,40,45,20,45	43.4
31	50,50,40,45,35,45,45,30,50,50,60,30,45,45,40,40,40,50,50,35,30,60,40,30,40	25.0
35	70,75,65,30,30,45,28,45,45,45,40,45,38,38,30,42,40,30,39,25,40,30,30,40,30	40.6
37	50,75,40,50,50,40,50,55,40,40,50,40,70,70,65,60,40,50,50,40,50,45,40,45,40	49.8
50	80,100,100,55,70,80,80,60,80,60,30,80,70,80,80,70,90,90,80,80,70,50,40,40,80	71.8
54	70,100,100,80,90,80,90,90,90,90,80,90,70,60,80,60,40,50,40,40,60,70,120,80,65	75.4
	A15: Spit 3	
1	30,40,40,35,40,40,35,40,45,35,35,25,30,40,40,35,25,35,30,50,30,45,40,50,40	37.2
2	60,50,40,50,50,40,30,80,80,50,50,50,50,60,50,50,50,60,60,50,50,50,45,55,50	54.8
3	Tracheids- no vessels	
4	60,30,40,70,70,60,60,60,70,90,50,60,50,80,50,80,40,40,30,50,80,90,70,60,50	59.6
5	50,40,45,50,50,40,30,40,35,30,50,55,50,60,55,40,45,35,40,35,45,40,40,50,60	44.4
6	40,30,20,40,25,20,30,20,20,30,30,30,25,30,25,40,50,50,30,30,30,30,30,35,35	31
10	30,40,45,40,35,35,50,30,30,35,20,55,40,30,35,30,60,40,40,40,60,40,30,45,40	39
11	Tracheids- no vessels	
12	30,20,30,20,25,20,20,40,40,30,30,25,25,30,30,40,30,30,25,20,20,25,40,30,30	28.6
15	25,20,25,20,28,30,15,25,25,25,15,20,15,25,18,35,30,35,25,12,20,25,20,20,22	22.6
17	70,80,60,60,45,30,30,40,50,80,40,40,60,40,40,60,80,60,60,60,60,60,80,40,35	54.4
22	50,40,40,40,30,45,50,40,50,30,45,45,30,60,30,60,60,45,40,45,30,45,40,60,50	44
26	35,20,45,50,50,70,25,20,20,30,25,25,50,50,50,40,40,40,40,40,50,50,40,50,20	39
29	40,40,30,60,70,30,40,40,50,50,60,60,40,70,60,50,40,60,90,70,60,60,50,60,80	54.4
31	80,50,40,50,100,90,45,70,60,80,70,60,60,70,70,70,90,80,80,90,60,70,80,60,80	70.6
32	65,60,30,50,40,60,30,70,30,45,55,30,40,40,70,30,60,40,40,40,40,30,50,70,50	46.6
34	Tracheids- no vessels	
36	60,60,60,50,50,40,100,80,60,60,70,70,80,60,40,70,90,80,50,40,50,70,80,50,50	62.8
38	60,50,60,60,60,60,60,60,50,60,30,50,50,60,50,40,50,40,60,60,50,60,50,60,60	54
	B15: Spit 3	
1	90,80,50,60,40,60,50,40,60,80,40,80,80,80,70,90,80,70,80,60,40,50,50,40,60	63.2
3	80,60,80,80,40,40,80,70,70,90,70,65,60,60,70,80,100,60,60,55,50,90,80,80,50	68.8
4	45,40,50,38,40,50,40,60,45,50,35,50,50,40,50,40,40,60,30,35,50,30,40,40,50	42.32

5	70,60,45,60,60,60,60,60,70,70,40,45,60,50,60,50,60,40,40,50,55,40,40,30,55	53.2
6	40,40,40,60,50,50,50,40,50,50,50,60,60,40,50,60,50,60,70,50,40,80,60,70,90	54.4
7	45,30,30,50,45,35,40,40,50,60,50,40,80,60,50,40,50,45,40,50,60,30,30,35,50	45.4
8	60,50,80,70,70,60,60,50,40,60,60,80,70,50,80,60,60,90,120,70,70,60,50,80,70	66.8
9	25,40,35,20,25,15,40,40,20,30,30,25,35,20,45,40,30,25,40,30,15,40,35,20,15	29.4
10	25,25,20,30,30,20,25,40,15,30,20,20,20,30,20,20,40,30,45,35,30,45,35,30,30	28.4
13	40,40,45,40,45,60,40,30,20,40,40,30,60,60,45,40,45,40,50,50,35,60,40,40,70	44.2
14	40,30,30,30,70,50,40,40,40,30,30,50,45,30,40,45,40,40,50,40,50,50,40,45,20	40.6
16	40,30,30,45,30,40,20,20,30,25,40,30,25,30,40,30,30,20,35,30,35,35,25,30,40	34.4
19	60,50,40,40,40,40,30,20,30,50,40,60,40,30,40,40,30,40,60,40,60,50,40,30,50	42.00
20	90,100,100,90,70,100,100,80,80,70,60,80,80,90,80,90,100,120,100,100,120,90,80,120,140	93.2
21	100,70,80,100,70,120,80,100,60,120,70,100,80,80,90,60,90,80,60,60,70,70,80,80,100	82.8
25	35,50,30,40,40,35,45,50,40,50,40,30,30,40,40,50,40,50,40,45,60,40,45,40,60	42.6
29	30,30,40,50,60,40,60,40,30,40,35,35,60,60,50,40,50,30,50,50,30,40,45,40,60	43.8
A15: Profile Cleaning		
1	30,40,40,40,20,30,40,40,50,60,50,40,30,40,40,30,40,30,45,30,50,50,40,45,40,50	42.00
2	60,40,30,60,60,50,30,40,40,60,40,30,50,40,60,40,45,40,45,60,60,40,60,60,60	48.00
A15: Spit 4		
1	60,40,40,50,50,40,50,60,40,60,60,45,50,45,30,60,40,60,60,60,70,60,50,60,40	51.6
2	40,60,50,60,90,50,60,50,40,40,60,40,50,40,40,60,60,60,60,50,30,50,40,40,50	50.8
4	30,40,40,40,40,40,40,50,50,50,30,30,50,40,40,50,30,40,50,30,40,40,50,40,30	40.4
5	45,50,50,50,60,60,50,30,40,20,50,40,30,50,50,30,50,45,30,40,40,30,20,40,20	40.4
7	25,25,30,30,20,30,30,30,20,30,20,25,25,15,20,30,25,30,25,20,20,20,30,40,15	24.4
9	100,100,120,120,80,60,80,140,140,100,80,80,80,80,70,80,80,80,110,90,90,60,110,90,80	92.00
11	90,100,60,80,60,50,80,80,60,80,60,50,50,50,80,70,70,70,60,80,70,60,60,90,80	69.6
12	90,120,120,100,120,140,80,100,90,80,80,80	100
13	50,60,45,70,50,60,100,70,80,90,60,60,80,70,60,60,70,50,80,90,60,50,60,65,50	65.5
16	50,30,25,25,45,25,30,40,30,35,35,35,35,40,35,35,30,30,25,25,25,25,35,50,50	33.8
17	40,30,40,40,35,25,40,50,40,30,25,40,35,35,20,40,20,40,40,35,45,40,45,40,30	36.8
18	50,60,60,60,70,60,50,90,60,60,50,70,100,60,60,50,50,70,70,50,70,80,80,70,60	64.4
20	60,40,60,30,50,40,50,60,40,40,30,50,60,30,30,40,30,30,50,50,50,50,60,45,60	45.4
21	40,40,40,40,70,50,30,40,50,40,60,70,70,30,40,60,60,20,40,40,30,30,40,30,35	44.2
22	60,60,40,40,30,60,40,50,40,60,70,80,80,80,80,70,50,60,30,50,60,70,60,50,50	56.8
23	60,60,70,50,50,70,40,40,50,50,50,60,50,30,20,40,60,60,60,60,40,40,70,40,50	50.8
24	50,60,40,80,70,90,70,70,60,70,60,70,70,40,50,50,90,100,60,70,40,60,70,40,80	64.4
25	25,35,30,35,40,45,50,40,30,35,40,40,20,25,25,20,20,40,40,40,30,30,35,30,30	38.2
29	50,40,40,45,40,50,45,30,50,30,30,30,50,40,60,50,45,50,50,60,40,40,20,30,40	42.2
31	30,20,30,30,35,25,30,25,30,30,30,50,30,30,30,30,30,25,45,45,50,35,30,35,50	33.2
32	40,30,40,30,40,50,50,30,40,40,40,40,40,30,40,35,45,35,45,50,30,40,40,40,25	38.6
33	80,100,80,60,60,60,80,70,40,80,60,70,70,60,80,80,90,60,50,70,40,50,50,65,50	66.2
34	30,30,30,30,30,20,40,40,20,30,45,20,25,30,30,30,30,30,30,40,40,30,40,30,30	32.0
36	60,40,40,50,60,60,40,40,60,50,50,40,60,70,60,60,60,60,50,40,50,30,40,45,60	51.0
38	90,80,100,110,100,80,80,70,90,110,70,120,120,90,90,80,80,120,90,80,90,80,80,60,50	88.4
39	40,50,30,40,30,40,40,40,40,60,60,50,40,40,30,30,30,40,50,40,60,60,50,30,35	42.2
40	30,50,40,60,80,50,60,60,60,50,80,50,35,60,30,50,60,50,80,80,80,50,60,50,50	56.2
42	60,70,100,120,80,80,80,100,90,70,60,80,70,80,70,70,60,60,40,60,60,80,70,70	71.2
43	60,40,20,50,50,40,60,60,50,40,60,30,50,40,40,50,30,40,40,40,30,50,60,45,45	44.8
57	softwood	
65	30,20,30,35,30,40,40,30,50,40,30,50,20,50,30,30,30,25,30,30,25,50,45,45,30	34.6
71	50,30,40,40,50,40,45,40,50,30,50,40,40,20,30,30,20,30,40,40,40,40,30,40,30	37.4
72	40,50,90,80,70,70,60,50,40,40,40,50,50,60,40,50,50,40,40,50,60,50,50,60,60	53.6

76	25,30,60,25,30,30,30,25,45,25,30,35,40,30,40,25,40,15,40,40,30,30,40,25,30	32.6
77	50,35,30,30,35,45,30,30,25,40,45,40,40,50,45,35,30,40,20,45,60,70,40,40,60	40.4
78	80,80,70,80,85,60,45,75,100,70,50,80,80,75,60,60,80,70,60,70,50,60,60,50,45	67.8
81	33,44,42,34,33,35,45,57,36,54,47,44,44,37,45,29,42,38,43,38,38,60,66,43,43	42.8
83	30,30,20,50,40,60,40,60,40,30,45,20,20,35,25,20,20,30,25,20,25,20,30,30,20	31.4
92	60,50,70,40,50,70,80,30,35,50,30,40,55,40,45,60,60,40,40,45,70,40,50,45,80	51
94	30,30,35,25,25,30,25,25,20,30,40,25,25,25,40,35,30,35,30,60,70,60,40,40,35	31.6
95	40,60,60,35,50,40,40,50,80,50,45,45,30,50,60,60,40,45,40,45,40,60,40,30,70	48.2
97	30,20,20,30,20,25,40,25,25,40,20,40,30,30,40,30,30,30,25,25,30,30,25,25,30	28.6
98	35,25,30,25,25,30,30,25,40,25,25,25,35,30,30,25,25,40,45,30,35,40,45,30,40	31.6
99	50,40,50,60,40,50,50,40,40,60,30,50,45,50,60,30,40,60,40,40,40,45,60,60,60	47.6
101	40,40,30,50,20,20,30,20,25,40,20,40,20,40,30,25,30,30,20,30,25,40,30,40,20	30.2
106	40,50,50,100,90,80,60,90,50,90,70,50,120,100,50,80,80,70,70,60,65,60,80,50,50	70.2
110	30,25,25,20,35,25,20,25,25,30,25,25,15,20,25,30,20,20,30,25,30,45,45,35,30	27.4
112	50,60,50,70,50,60,80,50,40,50,50,60,50,40,40,60,50,60,30,60,40,50,70,80,50	54.00
119	140,200,160,180,100,160,120,200,120,160,160,160,140,90,180,160	151.8
122	45,25,30,25,35,30,30,20,45,35,25,40,50,40,40,30,30,25,35,40,45,50,45,45,35	36
127	80,100,80,60,60,50,70,90,70,40	70
130	35,50,40,30,40,50,40,30,40,30,20,20,50,25,40,30,30,40,50,30,60,40,40,40,50	38
139	70,40,60,50,30,45,60,60,40,35,40,35,25,40,35,50,45,45,45,35,30,25,30,30,30	41.2
140	50,40,50,50,60,60,60,60,50,60,40,50,50,40,50,50,50,40,50,60,50,60,40,60,45	51
144	20,50,60,30,40,40,40,30,30,35,30,35,40,40,30,50,45,40,40,40,30,35,30,30,35	37
146	40,60,40,30,30,40,40,40,40,35,50,40,30,40,40,70,70,50,50,50,50,70,60,50,80	47.8
154	45,40,50,50,30,40,45,40,40,40,30,40,40,40,40,50,50,30,40,40,50,30,30,25,40	39.8
158	25,35,25,30,45,30,40,35,35,30,35,45,35,30,40,30,30,30,30,35,30,45,40,30,50	34.6
159	50,40,30,40,40,30,50,40,30,50,30,30,50,40,60,45,40,45,40,40,50,60,40,40,30	41.6
160	60,60,50,40,50,50,60,40,40,60,50,60,70,60,70,40,50,50,60,40,50,60,70,50,60	54.0
161	60,50,40,40,50,70,60,30,50,50,50,50,60,50,80,60,60,50,70,50,40,70,30,40,40	52.0
163	50,40,50,50,50,55,50,50,40,40,40,50,60,60,40,60,40,40,60,50,50,70,50,50,60	50.2
164	40,40,45,40,40,30,40,40,30,40,40,40,20,30,50,50,30,40,40,30,60,50,40,50,40	39.8
166	30,40,40,60,40,45,60,45,40,60,60,50,60,40,50,40,40,40,50,60,50,50,60,40,80	49.2
170	20,15,15,20,20,25,30,15,25,25,20,20,25,20,20,30,25,25,20,15,20,30,20,30,25	22.2
172	30,15,40,30,25,25,30,20,40,25,50,45,25,20,20,25,30,35,35,30,35,40,35,25,40	31.6
175	20,30,25,35,25,15,30,25,25,25,25,30,30,30,25,35,45,35,30,30,35,40,30,25,25	27.8
176	50,40,60,50,50,50,60,60,70,70,40,45,40,40,50,50,45,50,45,40,50,120,90,80,85	56.8
178	30,40,50,45,40,30,40,45,30,50,25,40,50,40,60,50,60,30,60,60,40,45,50,60,45	44.6
179	30,30,25,40,60,30,50,40,40,30,40,30,30,30,40,50,40,40,30,30,25,40,40,40,30	36.4
180	50,30,30,40,30,30,40,40,20,50,40,30,30,30,30,40,30,30,70,50,60,60,45,70,40	40.6
181	50,35,25,30,30,30,35,15,35,20,40,35,45,35,40,20,30,25,30,45,40,50,40,40,40	34.4
185	25,20,20,30,30,30,20,25,30,25,30,25,20,20,25,30,25,25,25,30,30,40,20,25,35	26.4
186	50,70,80,80,70,80,80,60,40,60,60,50,40,40,40,40,30,70,30,40,50,50,50,40,30	53.2
188	40,40,30,50,50,30,50,30,40,50,50,40,40,30,30,30,30,40,30,25,30,20,30,20,50	36.2
189	80,35,70,60,50,50,100,50,70,50,60,70,80,60,60,60,60,65,75,80,85,90,60,80,90	67.6
195	30,35,30,40,40,30,30,60,30,40,40,50,40,30,30,30,30,40,30,40,30,30,20,50,40	35.8
197	40,30,35,30,30,40,40,30,30,30,45,20,40,40,30,30,45,35,30,35,20,30,30,35,30	33.2
200	30,35,35,25,30,30,30,20,30,40,30,30,40,30,25,35,30,25,45,35,30,30,40,35,35	32.0
206	20,15,10,35,25,20,25,30,30,30,35,30,25,25,25,25,40,30,20,30,30,30,30,40,30	27.4
208	70,40,40,40,30,30,45,60,60,30,45,45,45,60,80,50,60,30,45,40,45,70,90,50,50	50
211	60,40,50,40,80,60,40,60,30,60,90,60,45,70,50,60,40,50,60,30,70,100,80,70,90	59.4
214	90,80,50,120,80,50,60,80,70,60,70,90,60,70,60,50,40,60,60,60,70,60,40,50,50	65.2
227	30,25,30,40,40,30,35,30,45,60,60,60,45,60,40,35,60,25,30,45,40,50,50,50,50	42.6
228	35,30,30,35,40,40,30,30,30,40,40,35,40,35,30,30,40,35,20,30,30,30,30,40,40	33.8

229	30,30,30,50,30,40,60,50,60,50,50,45,40,30,60,30,35,40,30,60,50,35,40,30,65	42.8
244	40,35,30,20,30,50,50,50,30,45,45,30,30,40,30,40,40,30,30,35,40,45,40,40,45	37.6
257	45,40,35,20,40,45,50,45,40,30,35,30,45,40,30,30,35,40,45,50,40,40,30,30,40	38
271	60,30,40,20,30,40,40,40,60,40,40,50,50,40,50,60,40,55,35,50,45,50,60,60,25	44.4
285	25,25,10,25,25,30,25,25,25,25,25,25,25,30,25,30,30,25,30,20,15,30,30,30,35	25.8
295	40,40,50,40,40,40,30,35,30,20,30,40,50,45,40,30,40,30,35,30,30,40,30,40,50	37
303	60,60,50,40,50,60,60,50,50,80,50,50,60,40,40,70,45,50,50,50,50,60,40,40,60	52.8
307	30,25,20,30,20,25,30,20,35,25,25,25,30,25,25,35,35,35,30,25,30,40,35,40,30	29.4
314	20,20,30,20,25,20,30,25,20,25,25,25,30,25,20,20,25,45,30,25,30,20,20,30,30	25.4
318	60,60,60,40,50,45,60,60,45,40,50,40,40,50,80,60,70,60,60,60,50,50,50,60,40	53.6
328	50,40,30,40,40,30,20,20,25,20,25,25,35,35,30,30,40,35,40,30,25,50,35,30,50	33.2
	B15: Spit 4	
1	30,30,30,30,35,30,25,30,25,30,40,30,30,30,30,30,35,30,30,50,50,30,40,40,25	32.6
2	70,50,70,40,40,45,60,60,60,45,50,50,50,60,25,50,40,50,60,45,40,60,50,50,45	50.6
3	50,60,50,60,40,40,30,35,40,40,40,40,55,50,45,40,45,40,35,45,35,40,50,40,40	43.4
4	60,60,50,50,60,60,70,70,80,60,60,80,80,70,70,80,60,120,80,70,40,60,60,50,90,	67.6
5	40,40,30,45,50,60,40,30,30,25,40,45,40,60,60,40,40,45,30,60,50,40,40,40,25	41.8
8	60,70,60,40,50,50,50,70,50,60,50,60,60,80,60,50,50,80,55,55,80,60,40,60,60	58.4
9	60,50,80,80,60,50,40,70,60,50,50,50,50,50,40,50,30,30,30,80,80,70,80,60,60	56.4
14	50,70,80,90,90,60,80,80,70,120,80,100,80,90,60,60,50,80,50,60,110,70,50,120,90	77.6
19	50,40,50,60,50,40,30,50,40,25,40,40,40,35,45,30,35,50,35,40,35,25,30,20,35	38.8
21	60,80,60,90,60,60,80,70,60,80,100,80,50,50,70,80,80,80,60,120,100,90	75.45
23	90,100,120,120,120,80,140,80,90,80,80,80,70,90,80,80,80,80,100,120	94
26	60,70,80,30,30,50,100,60,80,50,50,40,70,60,45,80,70,50,50,60,70,30,30,50,60	60.2
30	40,60,60,80,70,70,80,70,40,50,60,50,50,70,90,60,60,70,80,80,70,40,60,80,30	62.8
	B16: Spit 4	
1	100,90,60,130,100,90,80,80,120,80,70,90,130,100,80,80,90,100,120,120,100,100,80,80,80	94
2	60,40,60,50,70,70,50,60,60,50,40,50,70,60,40,40,30,60,60,50,55,50,45,50,80	54.8
5	70,70,60,70,60,50,60,50,50,45,50,50,50,40,40,40,40,50,50,60,40,60,50,40,60	52.2
6	80,60,80,60,60,50,60,80,50,70,70,50,80,50,50,60,60,60,60,70,60,70,60,80,80	64.4
14	70,60,60,80,60,40,40,50,50,50,40,60,40,60,70,60,55,50,60,50,50,50,60,50,70	55.4
18	25,30,20,25,20,30,30,20,30,35,50,40,25,30,25,30,40,40,40,50,40,40,30,25,25	31.8
26	45,40,30,30,40,40,50,45,50,30,50,40,60,50,60,60,40,40,40,40,40,35,30,30,30	44.2
27	30,30,30,30,35,30,25,25,30,40,30,30,30,25,20,20,40,40,20,20,20,25,30,35,20	30

APPENDIX 6b Vessel frequencies calculated from the archaeological charcoal remains

Fragment #	Fields	Frequency/ mm²	Average
		WB LSA	
3	1 2	34 26	30
4	1 2	10 12	11
		B15: Surface cleaning	
1	1	29	29
2	1	27	27
		B16: Surface cleaning	
1	1 2	51 42	46.5
		A15: spit 1	
1	1 2	68 50	61.3

	3	66	
3	1 2 3	100 125 110	111.67
4	1 2	69 63	66
5	1 2	43 60	51.5
6	1 2	84 78	81
7	1 2	73 44	58.5
8	-	-	-
10	1 2	25 24	24.5
11?	1 2	87 63	75
13	1 2 3	25 29 30	28
16	1 2	111 87	99
17	1 2	89 85	87
18	1	45	45
21	1 2 3	60 59 68	62.3
B15: spit 1			
1	1 2 3 4	85 68 62 47	65.5
2	1 2 3	32 18 27	25.7
3	1 2 3 4	83 81 66 74	76
4	1 2 3	66 90 46+-	82
5	1 2 3	46 48 52	49
6		Tracheids- no vessels	
7		Tracheids- no vessels	
8	1 2 3	38 35 28	33.6
9			
10	1 2 3	19 18 14	17
11	1 2 3	20 16 13	16
12	1 2 3	59 85 59	67.67

13	1	21	19.67
	2	23	
	3	15	
14	1	14	14
	2	11	
	3	17	
15	1	86	77
	2	73	
	3	72	
16	1	63	65.6
	2	68	
	3	66	
17	1	74	65.3
	2	56	
	3	66	
18	1	140	112
	2	132	
	3	64	
19	1	62	67
	2	72	
21	1	146	135.75
	2	143	
	3	139	
	4	115	
22	1	106	100.25
	2	99	
	3	106	
	4	90	
23	1	72	70.6
	2	90	
	3	50	
24	1	99	91.3
	2	93	
	3	82	
25	1	71	91.5
	2	112	
26	1	19	19.5
	2	25	
	3	20	
	4	14	
27	1	106	110.6
	2	104	
	3	122	
28	1	178	154.6
	2	166	
	3	120	
29	1	98	91
	2	101	
	3	74	
31	1	62	71
	2	59	
	3	92	
34	1	57	57
35	1	112	123.33
	2	142	
	3	116	
36	1	60	54
	2	48	
37	1	92	77.5
	2	99	
	3	64	
	4	60	

39	1	15	12
	2	13	
	3	8	
42	1	127	110
	2	108	
	3	96	
45	1	48	42
	2	52	
	3	26	
46	1	25	21.75
	2	21	
	3	22	
	4	19	
47	1	202	178
	2	184	
	3	148	
49	1	46	45
	2	44	
52	1	166	164.3
	2	179	
	3	148	
53	1	20	21
	2	21	
	3	22	
54	1	152	170
	2	168	
	3	190	
55	1	79	81.3
	2	87	
	3	78	
56	1	35	35
57	1	134	134
58	1	36	32
	2	38	
	3	22	
59	1	78	83
	2	88	
60	1	110	109.66
	2	95	
	3	124	
61	1	112	115.3
	2	124	
	3	110	
62		Tracheids- no vessels	
65	1	70	64.3
	2	67	
	3	56	
68	1	78	59.3
	2	54	
	3	46	
69	1	54	72
	2	64	
	3	98	
72		Tracheids- no vessels	
75	1	82	73.75
	2	82	
	3	77	
	4	54	
76	1	64	72.6
	2	72	
	3	82	

77	1	58	58
80	1 2 3	116 110 105	110.3
81	1 2	70 46	58
82	1 2	91 66	78.5
84	-	-	-
85	1 2	95 72	83.5
86	1 2 3	58 85 44	62.3
91	1 2 3	162 148 144	151.3
92	1 2	16 12	14
96	1 2 3	16 14 12	14
97	1 2 3	124 106 99	109.66
99	1 2	120 92	106
103	1	82	
105	1 2	114 68	91
106	1 2	12 9	10.5
107	1 2 3	63 56 60	59.6
111	1	250	250
116	1 2	29 34	31.5
118	1	90	90
119	1	66	66
121		Tracheids- no vessels	
122		Tracheids- no vessels	
123	1 2 3	169 106 144	139.6
128		Tracheids- no vessels	
129		Tracheids- no vessels	
140	1 2 3	59 46 44	49.6
142	1 2 3	38 61 44	47.6
143	1 2 3	119 82 76	92.3
148	1	60	60
152	1 2 3	307 329 310	315.3
153	1	94	118

	2 3	140 120	
154	1 2 3	74 78 80	73.3
156	1	96	96
B16: Spit 1			
1	1 2 3	136 138 120	131.3
2	1 2	75 78	76.5
9	1	62	62
10	1 2 3	83 46 42	57
16	1 2 3	36 57 32	41.6
19	1 2 3	139 82 86	102.3
20	1 2 3	54 64 40	52.6
24	1 2 3	102 70 64	78.6
25	1 2 3	44 38 38	40
27	1 2 3	88 84 47	73
28	1 2	18 4	11
29	1	349+	350+
35	1 2	112 64	88
A15: Spit 2			
1	1 2	40? 12	26
3	1 2 3	62 88 84	78
9	1 2	90 70	80
10	1 2	84 108	96
11	1 2 3	160 127 130	139.6
12	1 2 3	113 90 90	97.6
16	1 2	102 82	92
17	1 2 3	75 46 70	63.6

20	1 2 3	108 76 74	86
22	1 2	148 92	120
23	1 2 3	68 84 64	72
26	1 2	70 66	68
28	1 2 3	62 102 76	80
30	1 2 3	138 102 46	95.3
31	1	122	122
38	1	40	40
43	1 2	58 58	58
45	1 2	144 170	157
47	1 2 3	112 100 80	97.3
B15: Spit 2			
1	1 2	300+ 258	279
7	1 2	134 150	142
8	1 2	66 96	81
9	1 2	44 36	40
12	1 2 3	63 64 52	59.6
22	1 2 3	49 33 42	41.3
24	1 2 3	146 121 115	127.3
32	1 2 3	35 35 19	29.6
B16: Spit2			
2	1 2 3	149 129 133	137
5	1 2	71 49	60
6	1 2 3	30 31 33	31.3
8	1 2	98 75	86.5
9	1 2 3	70 84 51	68.3
10	1	60	70

	2	80	
12	1 2 3	94 82 84	86.6
15	1 2 3	277 273 183	244.3
16	1 2 3	120 69 102	97
17	1	120	120
19	1 2	76 53	64.5
22	1 2	98 82	90
26	1 2 3	74 74 82	76.6
29	1 2	106 84	95
31	1 2	115 70	92.5
35	1	70 84	77
37	1 2 3	132 129 114	125
50	1 2 3 4	30 50 44 53	44
54	1 2 3	98 107 106	104
A15: Spit 3			
1	1 2 3 4	91 30 38 39	49.5
2	1 2	48 52	50
3		Tracheids- no vessels	
4	1 2 3 4	66 52 44 54	54
5	1 2 3	123 128 118	123
6	1 2 3	68 107 94	89.6
10	1 2 3	32 38 54	41.3
11		Tracheids- no vessels	
12	1 2 3 4	176 193 183 98	162.5
15	1	124	115.3

	2 3	110 112	
17	1 2 3	140 120 96	118.67
22	1 2 3	100 142 90	110.67
26	1 2 3	103 62 78	81
29	1 2	66 84	75
31	1 2 3	47 49 30	42
32	1 2	82 64	73
34		Tracheids- no vessels	
36	1 2 3	94 66 82	80.67
38	1 2	64 76	70
		B15: Spit 3	
1	1 2 3	122 118 102	114
3	1 2 3	76 48 62	62
4	1 2 3	233 254 138	208.3
5	1 2 3	42 32 26	33.3
6	1 2 3	49 56 32	45.67
7	1 2	42 66	54
8	1 2	44 38	41
9	1 2	96 91	93.5
10	1 2	60 54	57
13	1 2 3	166 94 96	118.67
14	1 2 3	122 106 94	107.3
16	1 2	186 180	183
19	1 2 3	180 130 131	147
20	1 2	23 19	22

	3	24	
21	1 2 3	36 40 59	45
25	1 2	76 98	87
29	1 2	96 82	89
A15: Profile Cleaning			
1	1 2 3	77 86 74	79
2	1 2	78 80	79
A15: Spit 4			
1	1 2	92 50	71
2	1 2 3	84 93 70	82.3
4	1 2 3	92 98 84	91.3
5	1 2 3	147 96 98	113.37
7	1 2	148 213	180.5
9	1 2 3	17 17 18	17.3
11	1 2	58 53	55.5
12	1	14	14
13	1 2 3	82 107 58	82.3
16	1 2	186 148	167
17	1 2	267 269	268
18	1 2 3	89 64 50	67.67
20	1 2 3	50 46 64	53.33
21	1 2 3	93 80 70	81
22	1 2	62 80	71
23	1 2	196 184	190
24	1 2 3	87 76 74	79
25	1 2	138 98	118
29	1 2	62 66	64

31	1 2	133 127	130
32	1 2	94 56	75
33	1 2 3	71 77 59	69.0
34	1 2	128 126	127
36	1 2	64 42	53
38	1 2	32 30	31
39	1 2	126 136	131
40	1 2 3	64 54 56	58
42	1 2 3	77 79 83	79.67
43	1 2	82 46	64
57		Tracheids- no vessels	
65	1 2	98 96	97
71	1 2 3	77 80 96	84.3
72	1 2	88 42	65
76	1 2	68 52	60
77	1 2 3	76 86 72	78
78	1 2 3	129 136 86	117
81	1 2 3	104 136 123	121
83	1	38	38
92	1 2 3	97 85 88	90
94	1 2 3	281 182 196	219
95	1 2 3	105 86 100	97
97	1 2	196 166	181
98	1 2	222 172	197
99	1 2	74 56	65
101	1 2	86 58	72
106	1	52	42

	2 3	38 36	
110	1 2 3	285 212 240	245.67
112	1 2 3	108 118 80	102
119	1 2	9 8	8.5
122	1 2 3	150 156 163	156.3
127	1 2	10 8	9
130	1 2	46 28	37
139	1	173	173
140	1 2	90 86	88
144	1 2 3	86 73 71	76.67
146	1 2 3	46 42 50	46
154	1 2 3	86 88 73	80.6
158	1 2 3	81 77 72	76.6
159	1 2 3	68 62 73	67.67
160	1 2	50 66	58
161	1 2 3	54 66 74	64.67
163	1 2 3	77 73 69	73
164	1 2 3	45 23 48	38.67
166	1 2 3	68 72 66	68.67
170	1 2 3	82 60 88	76.67
172	1 2	70 78	74
175	1 2	229 204	216.5
176	1 2 3	95 99 86	93.33
178	1 2	44 48	46

179	1 2 3	78 132 76	95.33
180	1 2 3	209 162 155	175.33
181	1 2	114 108	111
185	1 2	154 112	133
186	1 2	72 80	76
188	1 2 3	102 88 81	90.33
189	1 2 3	131 96 97	108
195	1 2	78 72	75
197	1	80	80
200	1 2	158 116	137
206	1 2	338 297	317.5
208	1 2	112 156	134
211	1 2	98 122	110
214	1 2 3	69 40 66	58.3
227	1 2	229 186	207.5
228	1 2	218 176	197
229	1 2	28 52	40
244	1 2 3	87 66 52	69.67
257	1 2	122 136	129
271	1 2 3	78 76 64	72.6
285	1 2	216 188	202
295	1 2	60 58	59
303	1 2 3	126 95 91	104
307	1 2 3	194 188 180	187.33
314	1 2 3	216 236 212	221.3
318	1 2	60 52	56

	3	56	
328	1 2 3	259 248 210	239
B15: Spit 4			
1	1 2 3	93 86 68	83.3
2	1 2 3	120 123 99	114
3	1 2	78 88	83
4	1 2 3	31 30 24	28.3
5	1 2	136 78	107
8	1 2 3	116 84 110	103.33
9	1 2	50 48	49
14	1 2 3	76 60 42	59.3
19	1 2	60 80	70
21	1 2 3	8 8 6	7.3
23	1 2	17 8	12.5
26	1 2	92 84	88
30	1 2 3	65 46 42	51
B16: Spit 4			
1	1 2 3	91 89 52	77.3
2	1 2	126 166	146
5	1 2 3	75 64 66	68.3
6	1 2 3	66 54 56	58.6
14	1 2	61 42	51.5
18	1 2	174 128	151
26	1 2	80 58	69
27	1	166	166

APPENDIX 6c Measurements of the ray structures of the archaeological charcoal remains

Fragment#	Cell width (cw)	Cell height (ch)	Cell width measurement (uw) in µm	Cell height measurement (uh) in µm	Freq (per lin. mm)
WB LSA: Surface cleaning					
3	1. 1	8	19.37	228.66	3-4
	2. 1	8	22.7	307.29	
4	1. 1-2	9	38.2	151.75	5
	2. 1-2	6	31.2	168.57	
10					
B15: Surface cleaning					
1	1. 1-2	9	43.14	316.55	6-12
	2. 1-2	8	39	208.76	
	3. 1-2	10	37.22	318.23	
	4. 1-2	10	30.91	278.10	
2	1. 1-2	11	44.26	308.14	4-6
	2. 1-2	8	43.54	276.09	
	3. 1-2	7			
3	1. 1-2-3	13	38	273.32	2-4
	2. 1-2	10	37.38	206.61	
	3. 1-2	8	20.84	204.25	
	4. 1-2	10	26.57	219.26	
B16: Surface cleaning					
1	1. 1-2-3	9	57.4	260.04	8-12
	2. 1-2	10	47.48	196.19	
	3. 1-2-3	22	53.60	581.44	
	4. 1-2-3	15	49.28	380.07	
A15: Spit 1					
1	1. 1-2	12	37.47	271.20	8-12
	2. 1-2	12	30.94	209.39	
	3. 1-2	9	30.57	188.96	
	4. 1-2	14	26.03	302.35	
5	1. 1-2	7	30.71	163.26	8-12
	2. 1-2	9	33.92	202.57	
	3. 1-2	8	35.87	226.76	
	4. 1-2	10	44.01		
6	1. 1-2-3	20+	21.87	>1mm	6-8
	2. 1	12+	13.52	500	
	3. 1-2	20+	32.46	300-500	
7	1. 1-2	11	45.51	350.18	5-6
	2. 1-2	8	43.70	210.52	
	3. 1-2	11	41.66	308.52	
	4. 1-2	9	37.49	194.73	
8	1. 1-2	8	28.96	138.02	4-8
	2. 1-2	12	52.06	518.22	
	3. 1-2	10	45.85	326.59	
	4. 1-2	10	50.27	432.77	
10	1. 1-4	13	80	480	-
	2. 1-3	10	70	200+	
11	1. 1-2	10	48.19	170.12	8-9
	2. 1-2	8	34.14	253.68	
	3. 1-2-3	11	35.91	208.07	
	4. 1-2	6	35.27	160.49	
13	1. 1-2-3	15	39.69	293.51	4-5
	2. 1-2-3	13	44.17	326.88	
	3. 1-2-3	9	47.03	174.26	
17	1. 1-2	17	30	<1mm	-
	2. 1-2	20	35	290	

18	1. 1-2	10	35	300	-
			B15: Spit 1		
1	1. 1-5	20+	60	500?	5-7
2	1. 1-2	20	45.61	300	-
3	1. 1-2	13	35	320	-
	2. 1-2	15	36	300	
4	1. 1-2-3	6	47.26	248	-
	2. 1-2	11	50.32	286	
6	1. 1	8	14.63	156.27	5
	2. 1	6	12.26	111.34	
7	-	-	-	-	-
9	1. 1-2	10	28.81	262.48	-
	2. 1-2	8	31.32	193.94	
	3. 1-2	8	29	231.27	
10	1. 1-2	16	11.59	200+	5-6
	2. 1-2	10	30	324	
	3. 1-2	9	38.09	311	
11	1. 1-2	17	36	400-500	5-6
	2. 1-2	10	32	306.62	
12	1. 1-2	13	25.9	251.92	510
	2. 1-2	16	28.37	287.69	
13	1. 1-2	8	31	217.62	8-9
	2. 1-2	9	38	250	
14	1. 1-2	13	23.04	449.90	-
	2. 1-2	10	35.24	401.29	
	3. 1-2	16	30	440	
15	-	-	-	-	-
16	1. 1-2	13	35.44	285.23	
	2. 1-2	13	30	280	
17	-	-	-	-	-
18	1. 1-2	12	70	170	
	2. 1-2	14	30	200	
	3. 1-2	6	30	110	
19	-	-	-	-	-
21	1. 1	8	11.55	125.29	-
	2. 1	10	10	160	
	3. 1	7	10	100	
	4. 1	9	10	160	
22	1. 1-2	20	40	440	6
	2. 1-2	13	40	360	
	3. 1	13	30	460	
	4. 1-2	10	40	290	
23	1. 1-2	12	25	300	-
	2. 1-2	20	30	500	
	3. 1-2	12	30	280	
	4. 1-2	10	20	240	
24	1. 1-2	10	40	250	6
	2. 1-2	9	30	200	
	3. 1-2	12	40	300	
25	1. 1-2	11	30	250	8
	2. 1-2-3	15	30	270	
	3. 1-2	11	40	350	
26	1. 1-2	11	40	360	-
	2. 1-2	9	35	300	
27	1. 1-2	12	20	300	-
	2. 1-2	12	20	200	
	3. 1-2	14	20	250	
28	1. 1-2	13	15	240	-
	2. 1-2	12	20	210	
	3. 1-2	10	20	200	
29	1. 1-2	12	40	300	-

	2.	1-2	6	35	190	
	3.	1-2	8	35	145	
31	1.	-	-	-	-	-
34	1.	1-2	12	30	370	-
	2.	1-2	11?	30	300	
35	1.	1-2	10	35	310	-
	2.	1-2	9	30	230	
36	1.	1-2	6	25	100	7-12
	2.	1-2	8	28	135	
	3.	1-2	8	20	140	
	4.	1-2	6	20	110	
37	1.	1-2	12	50	300	-
	2.	1-2	15	40	350	
	3.	1-2	11	35	200	
39	1.	1-2	10	30	300	-
	2.	1-2	8	40	250	
	3.	1-2	7	25	210	
42	1.	1-2	7	25	150	16
	2.	1-2	13	22	230	
45	1.	1-2	10	25	250	-
46	1.	1-2	9	30	200	-
	2.	1-2	12	25	300	
47	1.	1-2-3	17	30	300	-
	2.	1-2-3	15	25	260	
	3.	1-2-3	15	20	320	
49	1.	1-2-3-4	13	60	200	-
	2.	1-2-3-4	17	60	240	
	3.	1-2-3-4	23	60	270	
	4.	1-2-3-4	13	55	350	
52	1.	1-2	10	20	300	-
	2.	1-2	8	30	200	
	3.	1-2	7	30	200	
53	1.	1-2	11	25	260	-
	2.	1-2	7	30	190	
	3.	1-2	9	25	210	
54	1.	1-2	8	20	130	-
	2.	1-2	10	20	180	
55	1.	1-2	11	35	290	-
	2.	1-2	10	40	200	
	3.	1-2	16	40	250	
56	1.	1-2	7	25	150	-
	2.	1-2	10	25	240	
	3.	1-2	9?	45	210	
57	1.	1-2	13	25	260	-
	2.	1-2	15	20	310	
58	1.	1-2	14	40	450	8
	2.	1-2	8	30	180	
	3.	1-2	11	30	300	
	4.	1-2	13	35	250	
59	1.	1-2	6	25	110	-
	2.	1-2	9	25	200	
60	1.	1-2	8	25	180	-
61	1.	1-2	9	20	110	-
	2.	1-2	8	25	130	
62	1.	1	7	10	133	6
	2.	1	3	10	45	
65	1.	1-2	9	40	260	-
	2.	1-2	14	30	210	
	3.	1-2	11	20	225	
68	1.	1-2	11	30	180	-
	2.	1-2	10	30	130	

69	1. 1-2 2. 1-2	8 6	30 30	200 120	-
72	softwood	-	-	-	-
75	1. 1-2-3 2. 1-2 3. 1-2	12 7 11	30 20 25	270 230 280	12
76	-	-	-	-	-
77	1. 1-2 2. 1-2-3	11 12	30 40	230 230	-
80	1. 1-2-3 2. 1-2-3	12 9	40 30	300 250	-
81-	-	-	-	-	-
82	1. 1-2-3 2. 1-2-3-4 3. 1-2-3	>30 >35 19	50 60 60	>650 >650 430	-
85	1. 1 2. 1(-2) 3. 1-2	12 6 9	20 20 20	220 140 220	-
86	1. 1-2 2. 1-2	10 12	30 20	230 240	-
91	1. 1-2 2. 1-2 3. 1-2	12 7 12	20 25 20	240 130 220	-
92	1. 1-2 2. 1(-2)	7 7+	20 20	180 240	-
96	1. 1-2 2. 1-2 3. 1-2 4. 1-2	8 10 10 7	40 40 35 30	250 260 250 180	-
97	-	-	-	-	-
99	-	-	-	-	-
103	1. 1 2. 1-2 3. 1-2	9 11+ 8	20 20 30	235 210 145	-
105	1. 1-2 2. 1-2	12 6	40 20	250 190	-
106	-	-	-	-	-
107	-	-	-	-	-
111	-	-	-	-	-
116	1. 1 2. 1 3. 1 4. 1	10 4 4 9	15 15 10 15	140 90 80 170	16
118	1. 1-2 2. 1-2	12 10	30 30	240 210	-
119	1. 1-2	7	35	190	-
121	1. 1 2. 1	2 6	15 18	60 125	4
140	-	-	-	-	-
143	1. 1-2 2. 1-2 3. 1-2 4. 1-2	13 5 9 10	25 25 15 30	240 130 230 200	-
148	1. 1-2	8	20	170	-
153	1. 1-2 2. 1-2 3. 1-2	12 13 10	25 25 30	200 205 180	-
154	1. 1-2 2. 1-2	11 15	25 35	200 230	-
156	1. 1-2	9	20	220	-

	2. 1-2	7	25	140	
B16: Spit 1					
1	1. 1-2	13	50	250	-
	2. 1-2	14	35	>250	
2	1. 1-2	11	25	230	-
	2. 1-2	11	20	240	
	3. 1-2	9	25	140	
9	-	-	-	-	-
10	1. 1	10	-	-	-
16	1. 1-2-3	18	60	400	-
	2. 1-2-3	20	60	520	
	3. 1-2-3	26	40	560	
19	1. 1-2-3	12	45	260	-
20	1. 1	13	10	280	-
	2. 1	11	10	280	
24	1. 1-2	15	30	300	-
	2. 1-2	17	20	320	
	3. 1-2	13	25	220	
25	1. 1	6	20	130	-
	2. 1(-2)	7	30	140	
	3. 1(-2)	10	20	180	
27	1. 1-2-3	9	30	245	-
	2. 1-2(-3)	6	35	130	
28	1. 1-2(-3)	8	40	170	-
	2. 1-2	7	25	120	
29	1. 1	9	20	234	8-12
	2. 1	6	15	179.69	
35	1. 1-2-3-4	30+	35	300	-
	2. 1-2-3	10	25	140	
	3. 1-2(-3)	10	25	170	
A15: Spit 2					
1	1. 1-2-3-4-5	14	120	280	10
	2. 1-2-3	9	80	230	
	3. 1-2-3-4	9	80	240	
	4. 1-2-3	9	80	220	
3	1. 1	5	15	100	12
	2. 1	8	20	180	
	3. 1	6	15	150	
9	1. 1-2	12	25	280	12
	2. 1-2	9	25	180	
	3. 1-2	7	25	180	
10	1. 1-2-3	13+	50	350	-
11	1. 1	5	15	90	20
	2. 1	5	10	120	
	3. 1	9	20	200	
	4. 1	8+	15	170	
12	1. 1-2	9	25	196.6	-
	2. 1-2	9+	35	210	
16	1. 1-2	13	25	240	-
	2. 1-2	8	30	125	
17	1. 1-2-3?	9	70	270	-
	2. 1-2	14	50	325	
	3. 1-2	12	40	333.3	
20	1. 1-2-3	10	35	191.6	-
	2. 1-2	8	25	191.6	
	3. 1-2	9	30	208.3	
22	-	-	-	-	-
23	-	-	-	-	-
26	1. 1	10	20	241.6	8
	2. 1	8	15	150	
	3. 1	11	25	258.3	

28	1. 1-2(-3) 2. 1-2	9 12	30 40	241.6 300	-
30	1. 1-2 2. 1-2 3. 1 4. 1-2	15 8 6 9	35 30 20 35	312 203.12 195.3 195.3	-
31	1. 1-2-3 2. 1-2-3 3. 1-2-3	9 11 10	50 45 40	195.3 203.12 195.3	-
38	1. 1-2 2. 1-2 3. 1-2	8 6 6	30 40 40	187.5 171.9 156.25	8
43	1. 1-2 2. 1-2 3. 1-2 4. 1	7 9 12 6	25 45 30 20	296.87 250 273.44 140	-
45	1. 1-2 2. 1-2 3. 1-2 4. 1-2	5 11 9 10	20 20 25 15	93.75 187.5 187.5 156.25	-
47	1. 1 2. 1 3. 1	9 10 6	15 20 20	187.5 234.3 125	-
B15: Spit 2					
1	1. 1 2. 1 3. 1 4. 1	6 8 9 12	10 10 15 12	117.18 148.43 164.06 203.12	-
7	1. 1	7	15	156.25	-
8	1. 1-2 2. 1(-2)	11 12	25 20	234.37 296.87	-
9	-	-	-	-	-
12	-	-	-	-	-
22	1. 1-2-3 2. 1-2-3-4 3. 1-2 4. 1-2-3	10 12 6 11	60 100 40 60	234.37 250 171.87 265.62	-
24	-	-	-	-	-
32	1. 1-2(1=2) 2. 1-2(-3) 3. 1-2 4. 1-2	8 16 16 17	15 12 20 30	187.5 390.53 390.62 468.75	8
B16: Spit 2					
2	1. 1 2. 1-2 3. 1-2 4. 1	7 8 9 16	15 25 30 20	148.44 164.06 226.56 257.81	4-6
5	1. 1-2 2. 1 3. 1-2 4. 1-2(-3)	13 7 15 11	25 20 30 30	242.19 203.125 257.81 226.56	4-8
6	1. 1-2 2. 1-2 3. 1-2 4. 1-2	9 10 11 10	30 25 35 40	234.37 218.75 242.19 234.37	12
8	1. `1-2 2. 1-2-3	13 17	25 35	257.81 320.31	-
9	1. 1-2 2. 1 3. 1-2 4. 1-2	14 9 10 11	30 20 30 25	281.25 187.5 203.13 210.94	4-8
10	1. 1-2-3	10	50	203.16	4-6

	2. 1-2-3	11	40	203.12	
	3. 1-2	6	30	171.88	
12	1. 1	7	15	125	4-12
	2. 1(-2)	10	15	187.5	
	3. 1-2	9	30	156.35	
	4. 1-2	7	30	117.19	
15	1. 1-2	10	20	125	-
16	1. 1-2-3-4	20	85	609.37	2-4
	2. 1-2-3-4	12	80	515.63	
	3. 1-2-3-4?	13	70	328.13	
17	1. 1-2-3-4?	12	25	203.13	
19	1. 1-2	12	30	257.81	1-4
	2. 1-2	10	25	242.19	
22	1. 1(-2)	11	15	171.88	-
	2. 1	9	15	156.25	
	3. 1	9	12	125	
29	-	-	-	-	-
31	1. 1-2	14	25	289.06	-
	2. 1-2	12	30	320.31	
	3. 1-2	12	20	304.69	
35	1. 1-2	10	30	265.63	-
	2. 1-2	7	25	203.13	
	3. 1-2	11	25	265.63	
37	1. 1-2	13	30	250	-
	2. 1-2	8	20	156.25	
	3. 1-2	11	30	218.75	
50	-	-	-	-	-
54	1. 1-2	9	15	203.12	-
A15: Spit 3					
1	1. 1-7	26	120	560	<4
	2. 1-6	30+	240	1mm	
	3. 1-7	22	120	520	
2	1. 1-2	9	30	218.75	4-8
	2. 1-2	15	30	328.13	
	3. 1-2	11	30	250	
	4. 1-2	14	30	289.06	
3	-	-	-	-	-
4	1. 1-2	11	30	257.81	-
	2. 1-2	11	35	250	
5	1. 1-2	11	20	195.31	4-8
	2. 1-2	13	20	203.125	
	3. 1-2	8	20	112.5	
	4. 1-2	17	25	281.25	
6	1. 1-2	8	25	171.88	-
	2. 1-2	9	15	148.44	
	3. 1-2	14	20	265.63	
10	1. 1(-2)	10	12	203.13	8-12
	2. 1(-2)	9	8	171.88	
	3. 1	7	8	128.13	
	4. 1(-2)	10	10	132.81	
11	1. 1	7	15	81.25	4
	2. 1	7	15	85.94	
12	1. 1-2-3	9	20	132.81	4-6
	2. 1-2-3	13	20	156.25	
	3. 1-2-3	13	20	164.06	
15	1. 1-2	12	30	242.19	2-4
	2. 1-2	10	30	226.56	
17	1. 1-2?	10?	30	281.25	2-4
22	1. 1-2	11	25	226.56	2-4
	2. 1-2	7	30	171.88	

26	1. 1-2-3-4-5 2. 1-2-3 3. 1-2-3	11 8 9	120 40 50	562.5 273.44 242.19	2-4
29	1. 1-2 2. 1-2 3. 1-2	13 8 9	35 25 25	242.19 179.69 164.06	8-12
31	1. 1-2-3-4 2. 1-2-3-4 3. 1-2-3-4 4. 1-2-3	15 16 12 6	30 80 80 30	171.88 359.34 312.5 132.81	2-4
32	1. 1-2 2. 1(-2) 3. 1-2 4. 1-2	8 13 7 12	15 25 30 20	179.69 312.5 187.5 296.88	6-8
34	1. 1 2. 1 3. 1 4. 1	5 5 4 4	15 10 15 12	62.5 50 46.87 46.87	8-12
36	1. 1-2-3 2. 1-2-3 3. 1-2 4. 1-2	14 13 9 11	50 50 35 30	281.25 328.12 257.81 265.62	4-8
38	1. 1-2	9	30	218.75	2-4
			B15: Spit 3		
1	1. 1-2 2. 1-2 3. 1(-2) 4. 1(-2)	10 13 6 13	25 20 15 25	210.94 242.19 156.25 328.13	8-12
3	1. 1-2-3-4- 2. 1-2-3-4-5- 6 3. 1-2-3-4 4. 1-2-3-4	8 20 9 9	60 120 70 50	187.5 343.75 203.13 171.88	4-6
4	1. 1-2 2. 1-2	11 12	20 20	195.31 187.5	4
5	1. 1-2-3-4 2. 1-2-3-4 3. 1-2-3-4	8 8 6	60 50 50	187.5 140.63 164.06	2-4
6	1. 1-2-3 2. 1-2-3 3. 1-2-3 4. 1-2-3	12 18 20 16	35 35 40 35	273.44 320.31 468.75 390.62	8-12
7	1. 1-2-3 2. 1-2 3. 1-2-3 4. 1-2	13 7 12 11	40 20 30 20	281.25 132.81 226.56 203.12	2-6
8	1. 1-2-3-4 2. 1-2-3	20 24	60 70	468.75 500.00	1-2
9	1. 1-2 2. 1-2(-3) 3. 1-2(-3)	10 15 9	30 50 30	195.31 328.13 242.19	2-4
10	1. 1-2 2. 1-2 3. 1-2	11 9 8	30 20 20	234.38 226.56 164.06	8-12
13	1. 1-2 2. 1-2 3. 1-2	15 10 11	20 15 20	281.25 140.63 195.31	8-12
14	1. 1-2 2. 1-2 3. 1-2	8 15 14	20 30 30	164.06 265.63 265.63	4-8
16	-	-	-	-	-
19	1. 1-2	11	20	171.88	8-12

	2. 1-2 3. 1-2	10 12	20 20	164.06 164.06	
20	1. 1-2 2. 1-2 3. 1-2 4. 1-2-3	10 15 17 10	25 20 20 30	203.13 281.25 275.81 234.38	10-15
21	-	-	-	-	-
25	1. 1-2 2. 1-2 3. 1-2	12 18 10	30 20 30	265.63 406.25 218.75	8-12
29	1. 1-2 2. 1-2 3. 1-2 4. 1-2	10 9 15 12	20 25 20 25	218.75 203.13 298.06 242.19	8-12
A15: Profile Cleaning					
1	1. 1-2 2. 1-2 3. 1-2	6 8 12	20 30 30	132.81 156.25 265.63	8-12
2	1. 1-2-3 2. 1-2-3 3. 1-2-3	12 16 10	60 60 60	296.88 328.13 265.63	8-12
A15: Spit 4					
1	1. 1-2 2. 1-2 3. 1-2	9 12 11	40 40 35	250.00 265.63 234.38	6-8
2	1. 1-2 2. 1-2 3. 1-2 4. 1-2	7 7 6 7	30 25 30 35	187.50 195.31 179.69 210.94	8-12
4	1. 1-2(-3) 2. 1-2 3. 1-2(-3) 4. 1-2	11 8 13 12	30 25 30 20	187.50 109.38 203.13 156.25	8-12
5	1. 1 2. 1 3. 1 4. 1	6 6 5 5	15 20 15 20	132.81 117.19 101.56 117.19	16-20
7	1. 1-2-3 2. 1-2-3 3. 1-2	15 13 11	30 20 20	171.88 218.75 195.31	4-8
9	1. 1-2-3-4 2. 1-2-3-4 3. 1-2-3-4 4. 1-2-3-4	17 20 30 21	70 50 60 80	421.88 406.25 625.00 546.88	8-10
11	1. 1-2 2. 1-2(-3) 3. 1-2	8 7 6	50 40 40	203.13 171.88 148.44	8-12
12	1. 1-2-3-4-5 2. 1-2-3-4-5 3. 1-2-3-4	16 15 18	50 35 50	281.25 218.75 296.88	4-8
13	1. 1-(-2) 2. 1-2 (1=2)	10 11	20 20	187.50 281.25	4-8
16	1. 1-2 2. 1-2 3. 1-2	13 7 15	30 30 20	250.00 171.88 328.13	8-12
17	1. 1-2 2. 1-2	10+ 9	40 40	242.19 210.94	2-4
18	1. 1-2	10	30	218.75	2-4
20	-	-	-	-	-
21	1. 1-2-3 2. 1-2	13 9	35 30	265.63 296.88	2-4

22	1. 1-2 2. 1-2	12 14	25 25	304.69 328.16	4-8
23	1. 1-2 2. 1-2	14 9	30 30	304.69 210.94	8-12
24	1. 1-2 2. 1-2 3. 1-2	9 11 7	45 45 45	265.63 289.06 195.31	4-8
25	-	-	-	-	-
29	1. 1-2 2. 1-2(-3)	11 13	30 35	257.81 273.44	4-8
31	1. 1-2	9	30	265.63	2-4
32	1. 1(-2) 2. 1(-2) 3. 1(-2)	14 12 11	25 30 25	257.81 296.88 195.31	4-8
33	1. 1(-2) 2. 1(-2) 3. 1(-2)	5 14 10	20 20 25	132.81 328.13 265.63	12-16
34	1. 1-2 2. 1-2(-3) 3. 1-2	6 7 15	25 20 30	132.81 140.63 281.25	4-8
36	1. 1-2-3 2. 1-2-3	6 6	20 30	117.19 109.38	1-4
38	1. 1-2 2. 1-2 3. 1-2 4. 1-2	18 11 20 13	30 20 15 15	281.25 203.13 312.50 242.19	8-12
39	1. 1-2 2. 1-2	10 7	20 20	164.06 156.25	8-12
40	1. 1-2 2. 1-2 3. 1-2	11 8 13	30 30 40	234.38 187.50 296.88	6-8
42	1. 1-2 2. 1-2(-3) 3. 1-2	10 10 12	50 50 40	265.63 265.63 312.50	8-12
43	1. 1-2-3	17	35	328.13	2-4
57	1. 1-2 2. 1-2	6 8	60 40	250.00 234.38	2-4
65	1. 1-2 2. 1-2	15 12	25 20	257.81 195.31	2-4
71	1. 1-2-3 2. 1-2-3	15 17	30 20	203.13 210.94	2-4
72	-	-	-	-	-
76	-	-	-	-	-
77	1. 1-2-3-4 2. 1-2-3	13 15	55 50	328.13 328.13	2-4
78	1. 1-2-3 2. 1-2-3 3. 1-2-3 4. 1-2-3	10 8 10 8	60 30 45 40	296.87 187.50 304.69 242.19	8-12
81	1. 1(-2) 2. 1-2	12 9	25.65 22.53	217.62 185.77	10
83	1. 1-2 2. 1-2 3. 1-2	12 9 10	26.2 25.61 22.63	216.59 193.40 181.10	5-8
92	1. 1-2 2. 1-2 3. 1-2	11 9 10	45 50 40	281.25 195.31 234.38	8-12
94	1. 1-2 2. 1	11 6	25 20	203.13 132.81	4-8
95	1. 1-2 2. 1-2	9 6	40 40	289.06 242.19	6-8

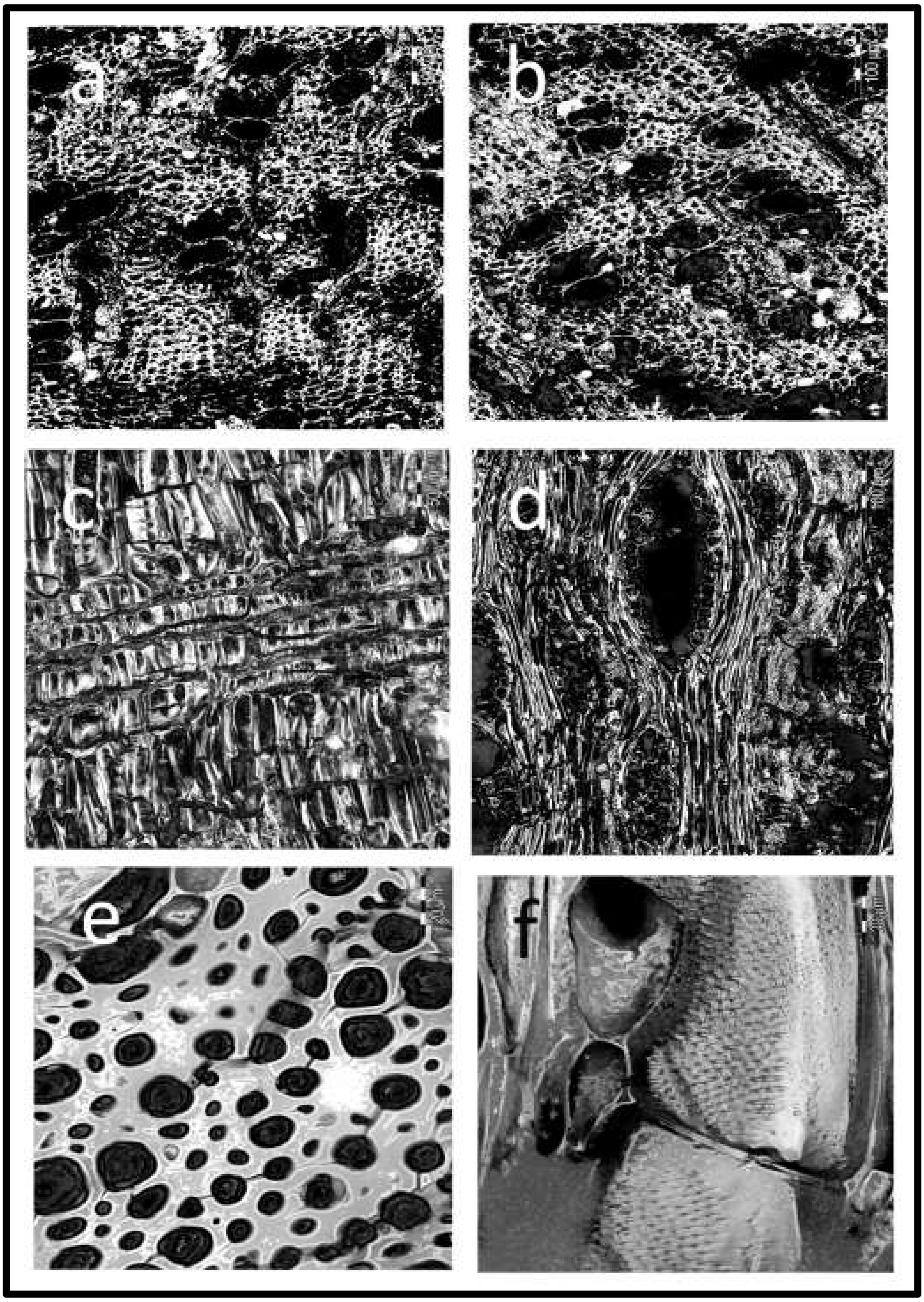
	3. 1-2	8	40	250.00	
	4. 1-2	8	30	226.56	
97	1. 1-2	9	20	132.81	8-12
	2. 1-2	8	20	171.88	
	3. 1-2	9	25	164.06	
98	-	-	-	-	-
99	-	-	-	-	-
101	1. 1-2-3	15	25	289.06	8-12
	2. 1-2-3	9	30	179.69	
	3. 1-2-3	13	35	265.63	
106	1. 1-2-3-4	13	60	375.00	2-4
	2. 1-2-3-4	20	50	390.63	
	3. 1-2-3-4	14+	70	328.13	
110	-	-	-	-	-
112	1. 1-2	16	30	320.31	2-4
119	1. 1-2	14	25	312.50	4-8
	2. 1-2-3	10	40	250.00	
	3. 1-2	11	25	250.00	
122	1. 1(-2)	15	30	265.63	4-8
	2. 1	9	20	218.75	
	3. 1-2	8	25	164.06	
127	1. 1-2-3-4	22	50	289.06	2-4
	2. 1-2-3	21	30	320.31	
	3. 1-2-3	23	30	281.25	
130	1. 1-2	12	35	195.31	4-8
	2. 1-2	14	25	218.75	
	3. 1-2	7	30	132.81	
139	1. 1-2	11	25	195.31	4-8
	2. 1-2	6	20	117.19	
	3. 1-2	11	25	234.37	
140	1. 1-2	12	40	375.00	4-8
	2. 1-2	6	30	203.13	
	3. 1-2	7	40	265.63	
144	1. 1-2-3	6	35	140.63	2-4
	2. 1-2	5	25	109.38	
146	1. 1-2-3	11	60	312.5	2-4
154	1. 1-2	17	20	187.5	12-16
	2. 1-2	12	15	187.5	
	3. 1-2	8	20	148.44	
158	1. 1-2	12	20	218.75	8-12
	2. 1-2	9	25	197.69	
159	1. 1-2-3-4	24	80	406.25	2-4
	2. 1-2-3	18	50	484.38	
160	-	-	-	-	-
161	1. 1-2	9	45	210.93	4-8
	2. 1-2	9	35	156.25	
163	-	-	-	-	-
164	-	-	-	-	-
166	1. 1	10	15	195.31	12-16
	2. 1	9	20	218.75	
	3. 1(-2)	11	20	218.75	
170	1. 1-2	11	25	140.62	8-12
	2. 1-2	12	20	187.50	
172	1. 1-2	11	20	179.69	
175	1. 1-2	9	25	195.31	8-12
	2. 1-2	14	20	218.75	
176	-	-	-	-	-
178	1. 1-2	7	20	109.38	8-12
	2. 1-2	6	15	78.25	
	3. 1-2	5	15	78.25	
179	-	-	-	-	-

180	1. 1-2 2. 1 3. 1 4. 1	8 9 14 7	20 15 15 20	132.81 132.81 218.75 132.81	8-12
181	-	-	-	-	-
185	1. 1-2	8	20	195.31	2-4
186	-	-	-	-	-
188	1. 1-2(-3) 2. 1-2 3. 1-2	16 12 10	20 20 20	320.31 203.13 164.06	8-12
189	1. 1-2 2. 1-2 3. 1-2	10 13 9	30 35 30	218.75 343.75 203.13	2-4
195	1. 1-2(-3)	9	15	234.38	2-4
197	1. 1 2. 1-2	6 18	10 15	101.56 179.69	8-12
200	-	-	-	-	-
206	-	-	-	-	-
208	1. 1-2	14	20	281.25	4-8
211	-	-	-	-	-
214	-	-	-	-	-
227	1. 1-2 2. 1	11 7	25 20	218.75 195.31	8-12
228	-	-	-	-	-
229	-	-	-	-	-
244	-	-	-	-	-
257	1. 1-2 2. 1-2 3. 1-2 4. 1-2	11 11 8 8	20 20 30 20	156.25 171.88 132.81 132.81	8-12
271	1. 1-2	11	30	179.69	4
285	1. 1-2 2. 1-2 3. 1-2	10 6 10	10 15 15	117.19 101.56 125.00	12-16
295	-	-	-	-	-
303	-	-	-	-	-
307	1. 1-2 2. 1-2	12 8	30 20	210.94 148.44	4-8
314	1. 1-2-3 2. 1-2-3 3. 1-2-3	16 8 11	30 30 25	328.13 148.44 210.94	2-4
318	1. 1-2 2. 1-2 3. 1-2	7 8 10	40 35 35	164.06 234.38 273.44	4-8
328	1. 1(-2) 2. 1 3. 1	19 9 20	15 15 15	281.25 125.00 296.88	4-8
B15: Spit 4					
1	1. 1-2 2. 1 3. 1-2	11 10 14	30 25 30	281.25 257.81 304.69	4-8
2	1. 1-2(-3) 2. 1-2(-3) 3. 1-2(-3) 4. 1-2(-3)	9 12 12 10	50 45 40 30	250 281.25 281.25 218.75	6-8
3	1. 1-2-3 2. 1-2 3. 1-2-3 4. 1-2-3	18 15 14 13	40 30 40 35	320.31 265.63 320.31 296.88	6-8
4	1. 1 2. 1	8 13	15 20	195.31 289.06	8-12

	3.	1	7	20	132.81	
5	1.	1-2	11	25	265.63	6-8
	2.	1-2	14	20	250	
	3.	1-2	11	20	226.56	
8	1.	1-2	14	35	257.81	4-6
	2.	1-2	13	25	218.75	
	3.	1-2	11	30	187.5	
9	1.	1-2	11	50	281.25	8-12
	2.	1-2(-3)	6	30	156.25	
	3.	1-2	7	30	140.62	
14	1.	1-2-3-4	25+	60	625	2-4
	2.	1-2-3-4	14+	50	296.88	
	3.	1-2-3-4	13+	50	234.38	
19	1.	1-2	9	30	171.88	8-12
	2.	1-2	11	25	187.5	
	3.	1-2	17	30	273.44	
	4.	1-2	13	30	171.88	
21	1.	1(-2)	8	15	195.31	12-16
	2.	1-2	8	20	171.88	
	3.	1(-2)	10	20	226.56	
23	1.	1(-2)	7	15	156.25	4-8
	2.	1	6	10	148.44	
	3.	1(-2)	8	15	164.06	
	4.	1(-2)	7	20	226.56	
26	1.	1-2-3	16+	25	281.25	4-6
	2.	1-2-3	9	25	195.31	
	3.	1-2-3	13	30	265.63	
	4.	1-2-3	14	30	304.69	
30	1.	1-2(-3)	12	30	242.19	4-6
	2.	1-2(-3)	11	30	218.75	
B16: Spit 4						
1	1.	1-2	20	40	578.12	4-8
	2.	1-2	12	40	421.87	
	3.	1-2	16	50	500	
2	1.	1(-2)	15	15	289.06	8-12
	2.	1	7	15	164.06	
	3.	1-2	10	25	171.88	
5	1.	1-2(-3)	12	30	250	4-8
	2.	1-2	9	30	195.31	
	3.	1-2	10	40	217.5	
	4.	1-2	6	25	140.62	
6	1.	1-2	12	40	304.68	6-8
	2.	1-2	8	35	210.94	
	3.	1-2	7	35	179.69	
14	1.	1-2-3	6	50	187.5	2-4
18	-		-	-	-	-
26	1.	1-2-3	11	30	187.5	2-4
27	1.	1-2-3	9	35	125	2-4

APPENDIX 7 Micrographs and wood descriptions of the species identified from archaeological charcoal.

1. ***Diospyros whyteana***



The microstructure of *D. whyteana* showing: (a), (b) the short vessel arrangement and wide diameter of the vessel lumina, vasicentric paranchyma on the TS; (c) procumbent, square and upright ray cells on the RLS; (d) the 1-4 serriate rays on the TLS; (e) thick fibre walls on the TS and (f) the simple perforation plates as well as alternating intervessel pits of the vessel elements.

Wood diffuse porous, growth ring boundaries are indistinct

Vessels in short radial multiples (2-3)

Simple perforation plates

Intervessel pits alternate, bordered

Intervessel pits are minute 4-8µm

Average diameter of vessel lumina 70 µm

Vessel frequency: 0-20 vessels per mm^2

Fibre pits present in both radial and tangential walls

Fibres very thick-walled

Axial parenchyma is vasicentric

Rays cells of two distinct types on the RLS (heterocellular)

Body ray cells procumbent with over 2 rows of upright and / or square marginal cells

Sheath cells present

Ray frequency: 4-8 / linear mm

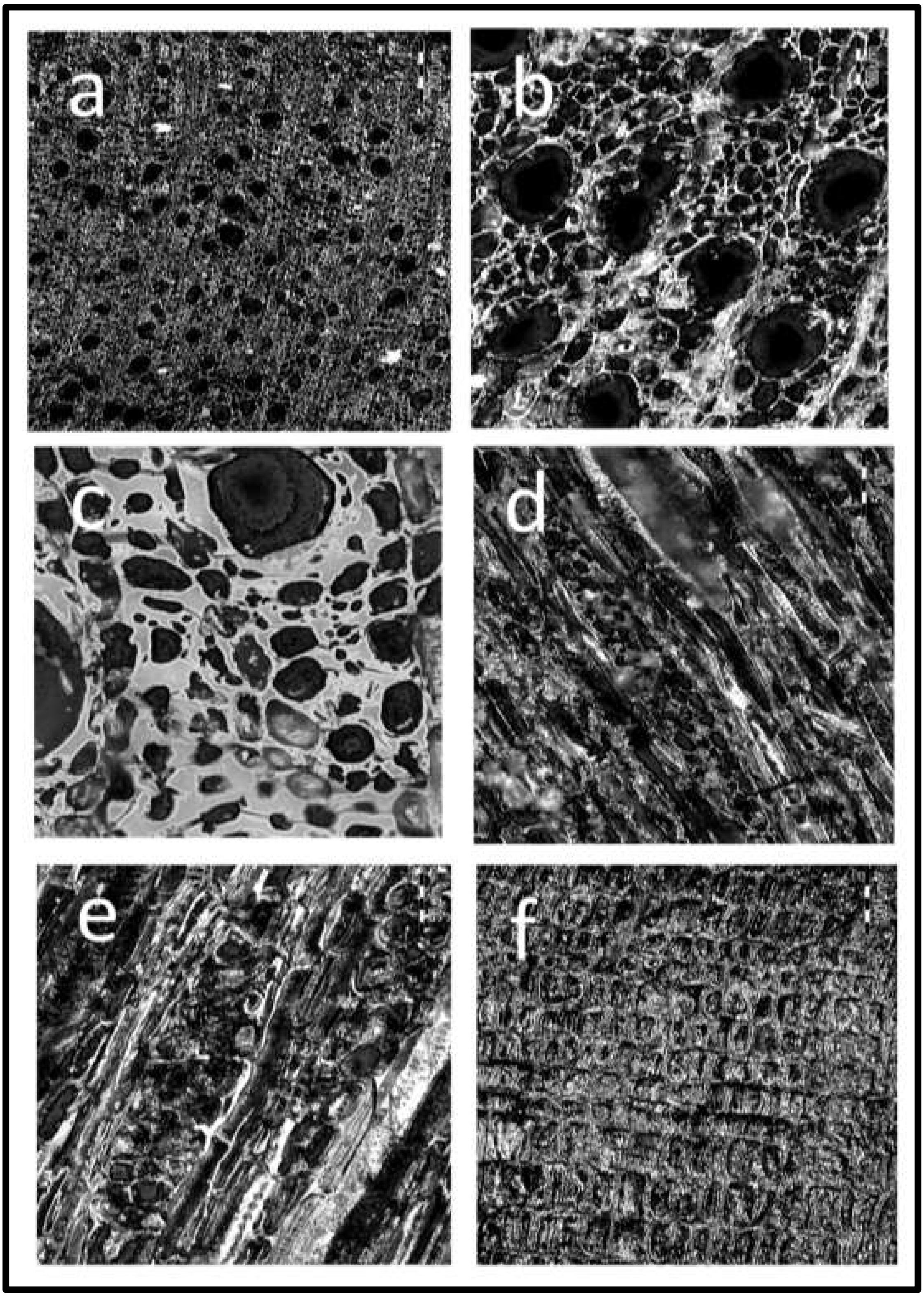
Rays: up to 23 cells long

Rays commonly 1-2-3-4(-5) cells wide

Ray height: <1 mm

Ray width: up to 50 µm

2. *Erica* cf. *glandulosa* subsp. *fourcadei*



The microstructure of *E. glandulosa* subsp. *fourcadei* showing (a) the solitary vessel arrangement; (b) diameter of the vessel lumina; (c) diameter of the fibre lumina; (d) the simple perforation plates, alternating, round intervessel pits; (e) triserriate rays and (f) procumbent, square and upright ray cells.

Growth ring boundaries indistinct

Wood semi-ring-porous

Vessels exclusively solitary

Simple perforation plates

Inter-vessel pits bordered and alternate

Average diameter of vessel lumina: 38 µm

Vessel frequency: 20-40 vessels per mm^2

Fibres thin- to thick-walled on the transverse section

Non-septate fibres present

Axial parenchyma scanty paratracheal

Body ray cells procumbent with up to four rows of upright and / or square marginal cells

Ray frequency: 8-12 / linear mm

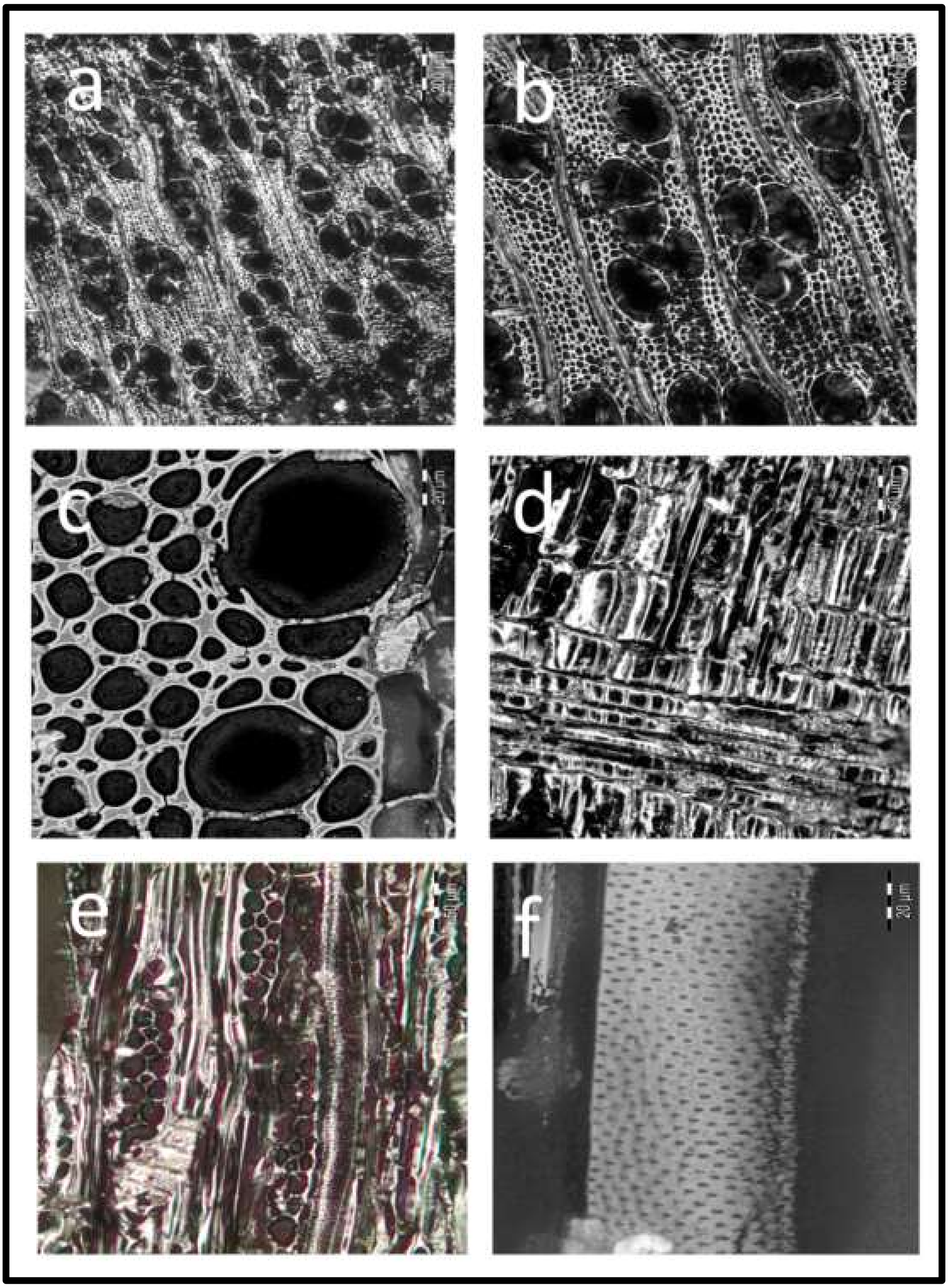
Rays are 1-2(-3) cells wide

Ray are up to 15 cells long

Ray height: <1mm

Ray width: 35 µm

3. *Grewia occidentalis*



The microstructure of *G. occidentalis* showing (a) the short radial multiple vessel arrangement; (b) diameter of the vessel lumina; (c) the diameter of the fibre lumina; (d) procumbent, square and upright ray cells; (e) the triserriate rays and (f) the minute intervessel pits.

Growth ring boundary indistinct

Wood diffuse porous

Vessels in short radial multiples, solitary and sometimes cluster arrangement

Simple perforation plates

Inter-vessel pits alternate, minutely bordered

Average diameter of vessel lumina: ~60 µm

Vessel frequency: 50-100/ linear mm

Fibres thin to thick walled in the transverse section

Septate fibres present

Non-septate fibres common

Axial parenchyma scanty paratracheal; vasicentric

Body ray cells procumbent with 4 rows of upright/square marginal cells

Ray frequency: >12/linear mm

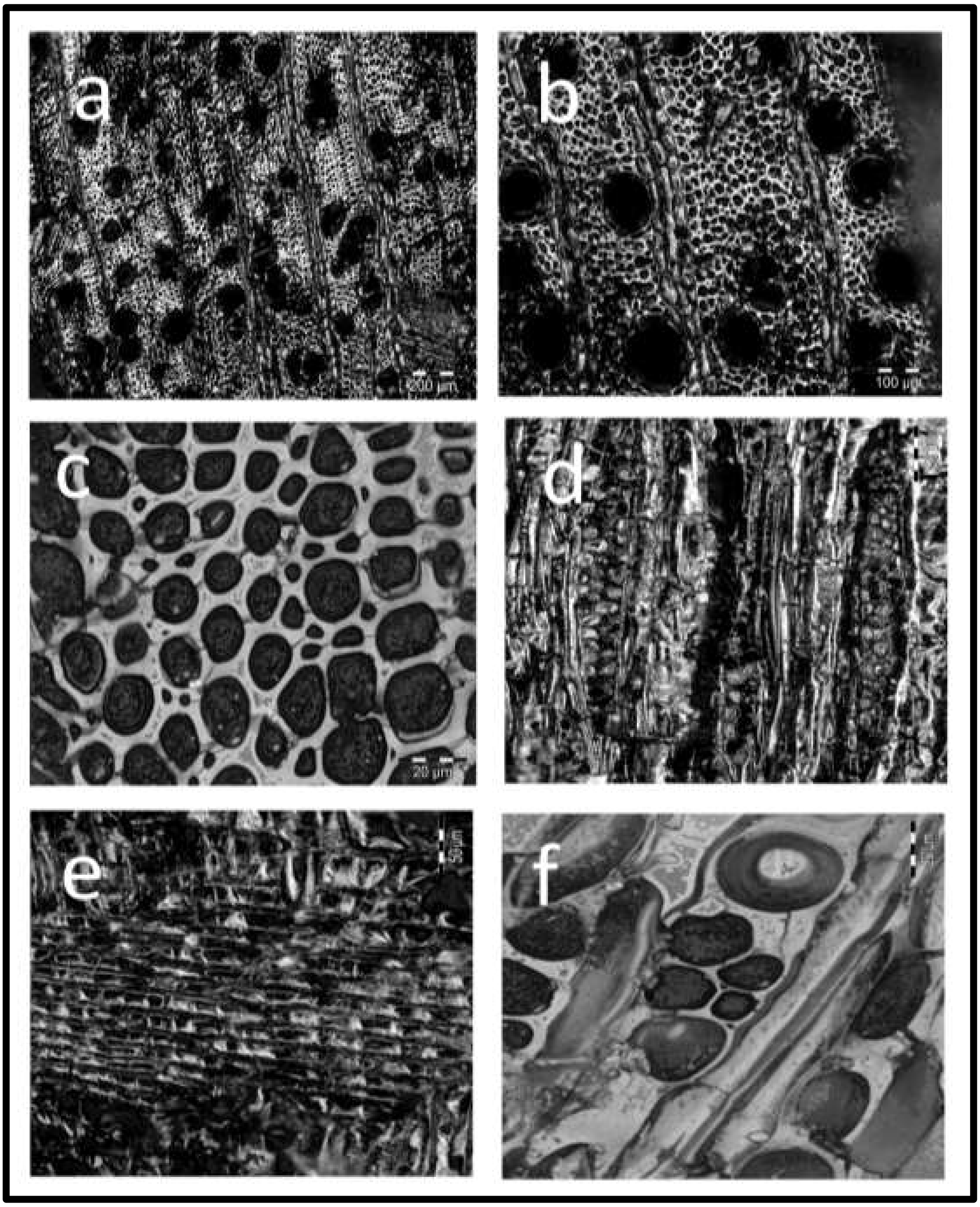
Rays are 1-2-3 cells wide

Rays are up to 20 cells long

Ray height: <1mm

Ray width: up to 40 µm

4. ***Hibiscus* cf. *tiliaceus***



The microstructure of cf. *H. tiliaceus* showing (a) solitary vessel arrangement; (b) the diameter of the vessel lumina; (c) fibre thickness/ lumina of fibre; (d) the triserriate ray cells; (e) the square and procumbent rays and (f) septate fibres.

Growth ring boundaries indistinct or absent

Solitary vessel arrangement

Simple perforation plates

Intervessel pits alternate

Similar intervessel pits throughout the element

Average diameter of vessel lumina: 60 - 103 µm

Vessel frequency: 0- 20; 20-40 per mm^2

Non-septate fibres present

Fibres thin-walled

Axial parenchyma diffuse

Axial parenchyma vasicentric

Ray cell of two types (heterocellular)

Body ray cells procumbent with one row of upright and /or square marginal cells

Rays have sheath cells

Ray frequency: 4-12 / linear mm

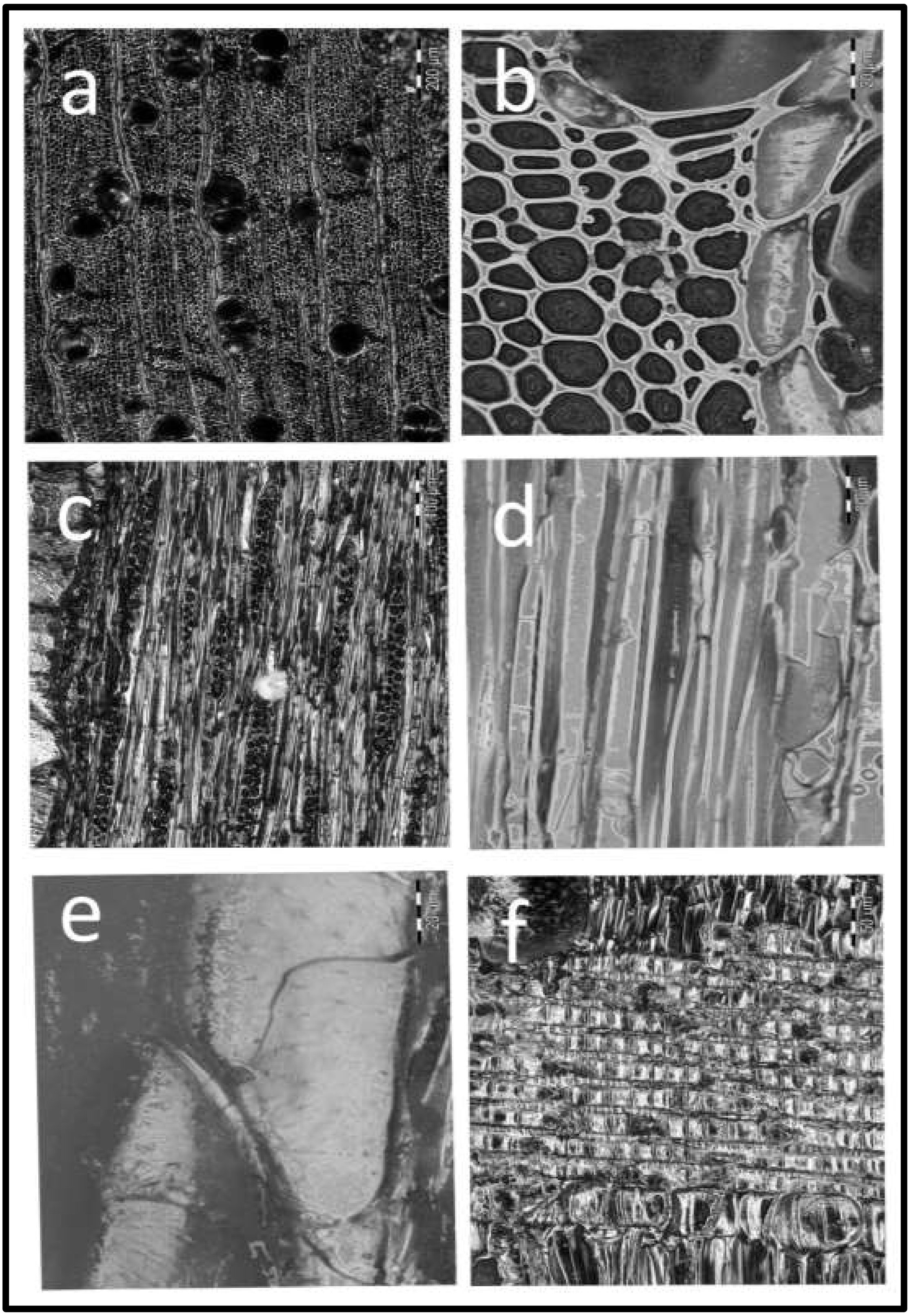
Rays commonly 1-2-3 cells (wide) serriate

Rays up to 28 cells long

Ray height: <1mm

Ray width: up to 60 µm

5. *Loxostylis alata*



The microstructure of *L. alata* showing (a) the vessel arrangement; (b) fibre thickness/fibre lumina; (c) the biserriate rays; (d) the septate and non-septate fibres; (e) the simple perforation plate and alternate intervessel pits and (f) fge procumbent and square ray cells with crystals.

Growth ring boundaries indistinct or absent

Wood diffuse-porous

Simple perforation plates

Intervessel pits alternate

Shape of alternate intervessel pits is polygonal

Intervessel pits are small - 4 - 7 µm

Vessel-ray pits with much reduced borders to apparently simple: pits angular

Average diameter of vessel lumina is 50 - 100 µm

Vessel frequency is 20 - 40 vessels per mm^2

Vessel length is <= 350 µm

Fibres with simple to minutely bordered pits

Septate fibres present

Non-septate fibres present

Fibres thin- to thick-walled

Axial parenchyma is diffuse

Axial parenchyma is scanty paratracheal

Ray width 1 to 3 cells

Body ray cells procumbent with one row of upright and / or square marginal cells

Ray frequency on TLS is 4-12 / linear mm

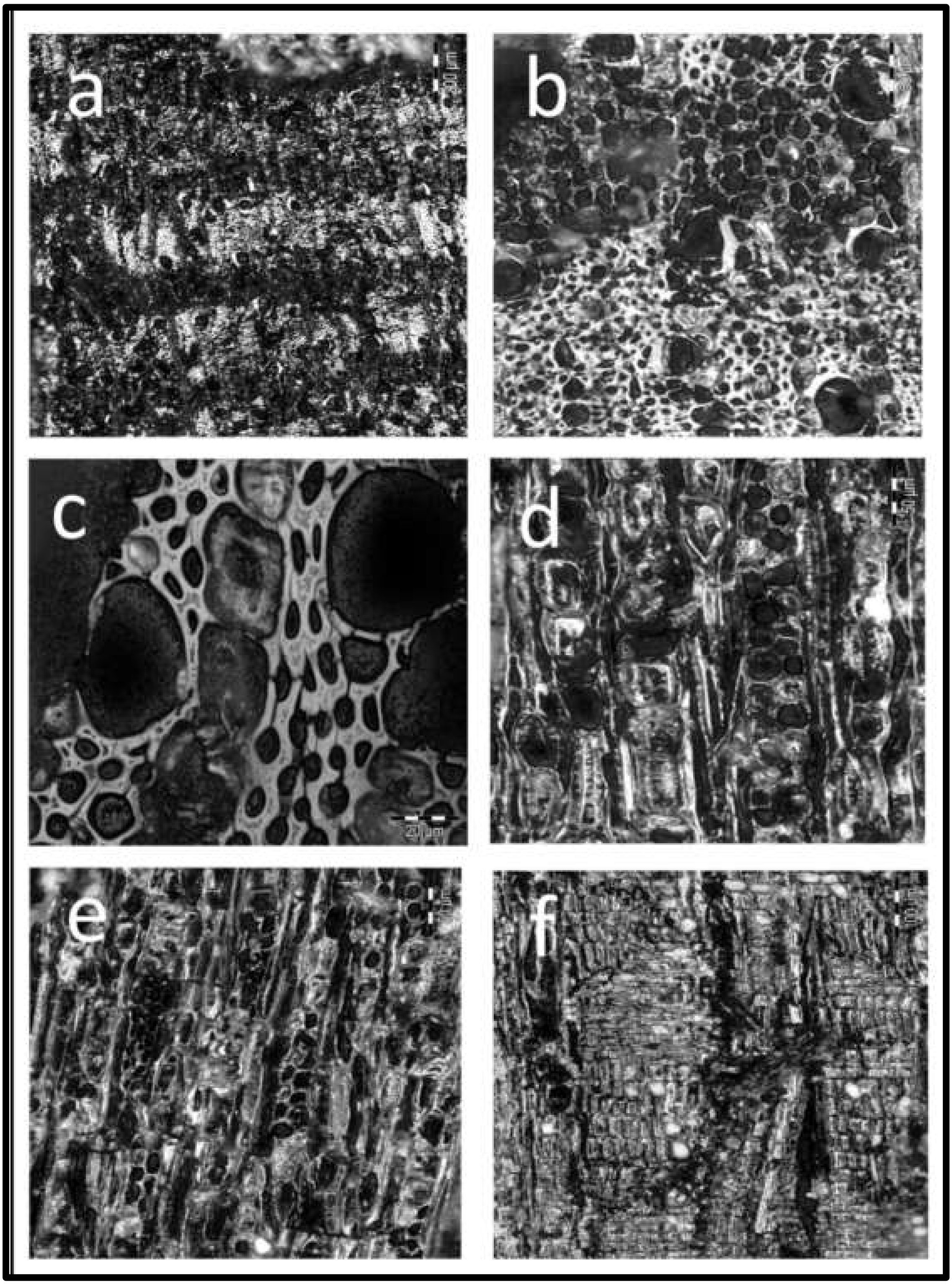
Ray height: <1mm

Ray width: 30 µm

Prismatic crystals are present

Prismatic crystals in upright and / or square ray cells

6. *Mystroxylon aethiopicum*



The microstructure of M. aethiopicum showing (a) the solitary vessel arrangement and banded parenchyma; (b) the parenchyma cells in each strand; (c) fibre thickness/ the lumina of fibre cells; (d) the biserriate rays and parenchyma cells on the TLS; (e) the vessel elements with simple perforation plates and (f) the procumbent, square and upright ray cells.

Growth ring boundaries indistinct or absent

Wood diffuse-porous

Vessels exclusively solitary (90% or more)

Solitary vessel outline angular

Simple perforation plates

Inter-vessel pits alternate

Shape of alternate pits polygonal

Inter-vessel pits minute <= 4 µm

Average diameter of vessel lumina: <= 50 µm (~30 µm)

Vessel frequency: 50 - 100 vessels per mm^2

Fibres with pits

Fibre pits common in both radial and tangential walls

Non-septate fibres present

Fibres very thick-walled (transverse section)

Axial parenchyma in bands; 4-5 bands/ lin. mm; (5-8) cells per parenchyma band

Ray cells have two distinct sizes

Body ray cells procumbent with mostly 2-4 rows of upright and / or square marginal cells

Prismatic crystals present

Prismatic crystals in upright and / or square ray cells

Prismatic crystals in procumbent ray cells

Ray frequency: >= 12 /linear mm

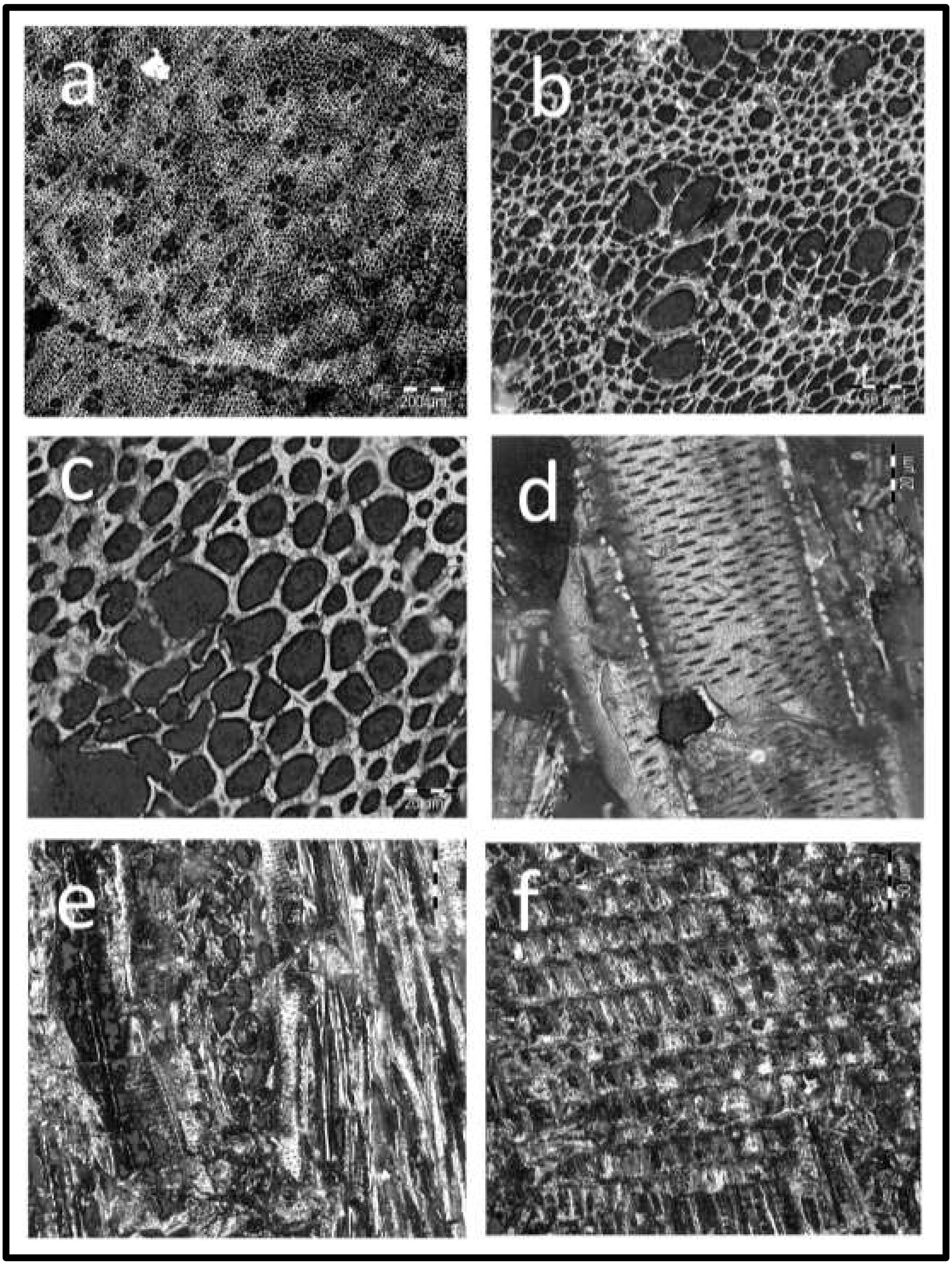
Rays are 1-2-3 cells wide

Rays are up to 15 cells long

Ray height: <1mm

Ray width: up to 40 µm

7. *Metalasia* cf. *muricata*



The microstructure of *M. muricata* showing (a) the clustered vessel arrangement and confluent parenchyma; (b) the diameter of the vessel lumina; (c) fibre thickness/ fobre lumina; (d) alternating inter-vessel pits; (e) the biserriate rays and (f) procumbent, square and upright ray cells.

Growth ring boundaries indistinct or absent

Wood diffuse-porous

Vessel clusters common

Simple perforation plates

Inter-vessel pits alternate

Shape of alternate pits polygonal

Inter-vessel pits minute: 4-8 µm

Average diameter of vessel lumina: <= 33.2 µm (~30 µm)

Vessel frequency: 100-150 vessels per mm^2

Non-septate fibres present

Fibres thin-walled (transverse section)

Axial parenchyma paratracheal

Axial parenchyma is confluent

Ray cells have two distinct types (heterocellular)

Body ray cells procumbent with more than 4 rows of upright and / or square marginal cells

Ray frequency: >=4-8 / linear mm

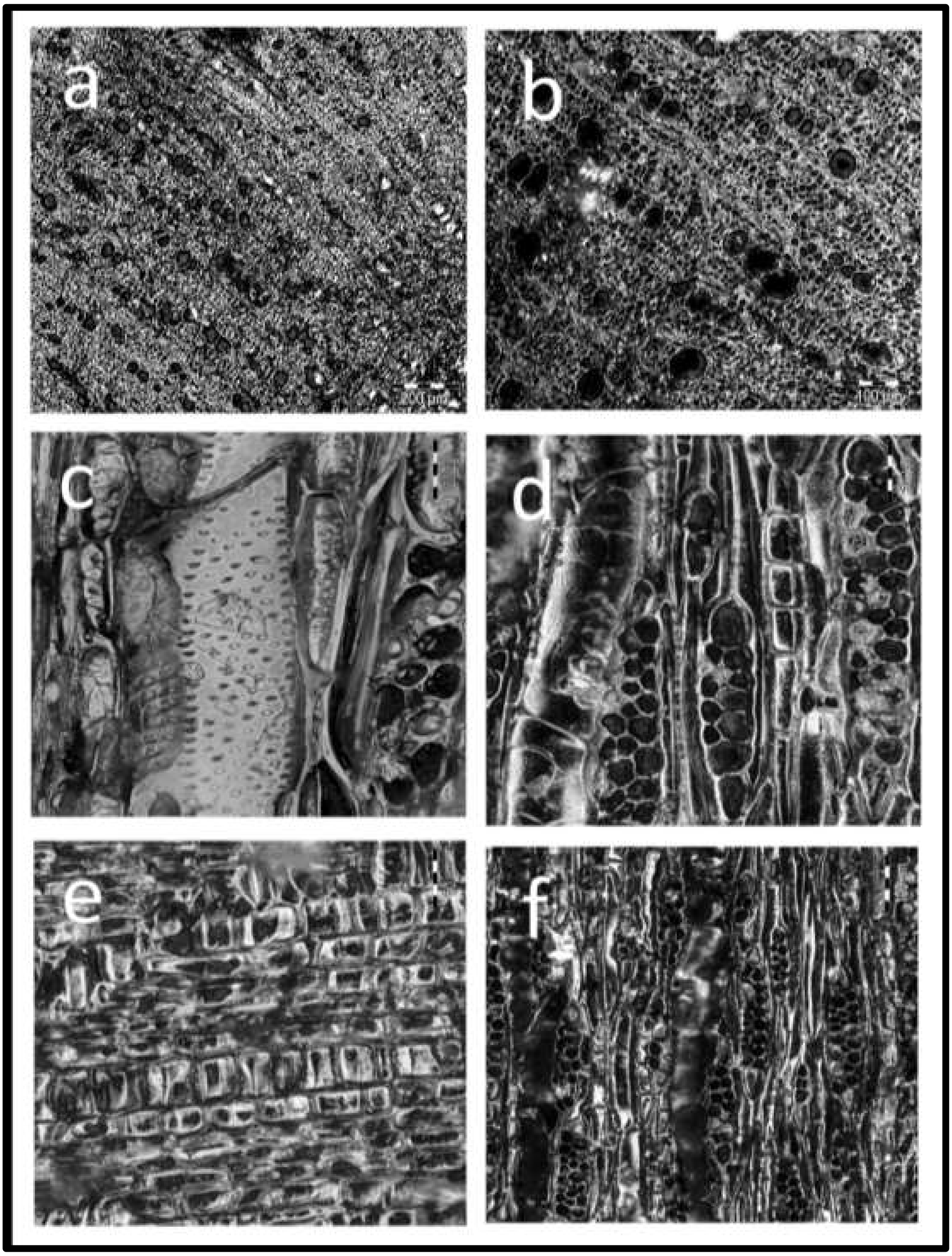
Rays are 1-2 cells wide

Rays are up to 9 cells long

Ray height: <1mm

Ray width: up to 30 µm

8. *Nuxia* cf. *floribunda*



The microstructure of cf. N. floribunda showing (a) solitary and short radial multiple vessel arrangement; (b) vessel diameter; (c) polygonal inter-vessel pits and simple perforation plates; (d) vessel elements, parenchyma cells; (e) procumbent, square and upright ray cells and (f) triserriate rays.

Wood diffuse-porous

Vessels solitary, short radial multiples

Solitary vessel outline angular

Simple perforation plates

Inter-vessel pits alternate

Minute - <= 4 µm

Average diameter of vessel lumina: 40-50 µm

Vessel frequency: 40 - 60 vessels per mm^2

Fibre pits present in both radial and tangential walls

Fibres thin- to thick-walled

Axial parenchyma present but rare; vasicentric (scanty paratracheal)

Rays of two distinct sizes (Heterocellular)

Body ray cells procumbent with over 2 rows of upright and /or square marginal cells

Sheath cells present

Ray frequency: 4-12 /linear mm

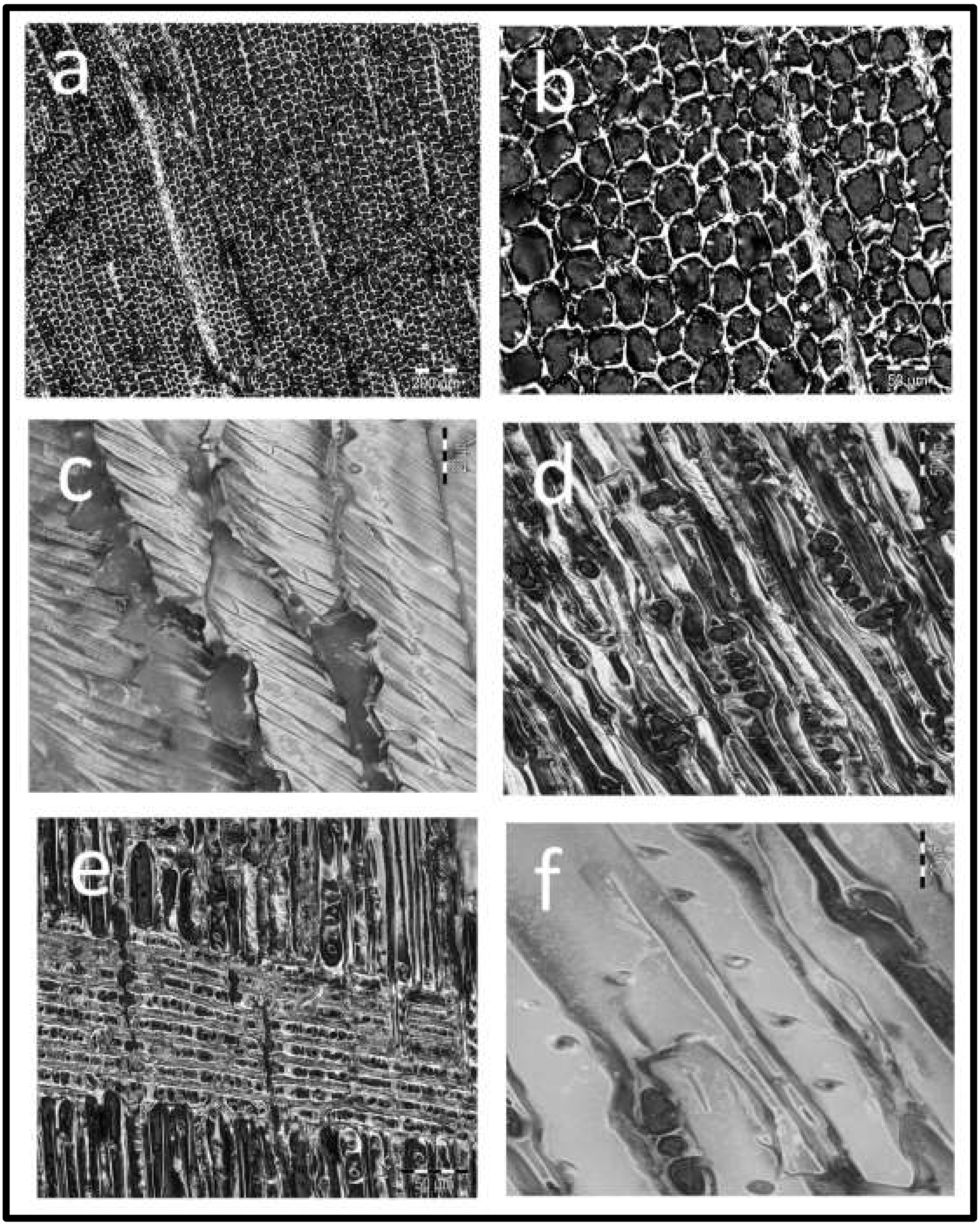
Rays: up to 23 cells long

Rays commonly 1-2-3 cells wide (seriate)

Ray height: <1 mm

Ray width: 30-60 µm

9. *Podocarpus* cf. *latifolius*



The microstructure of P. cf. latifolius showing (a) the tracheids over the TS; (b) lumina of the tracheids on the TS; (c) trecheids on the longitudinal walls; (d) uniserriate rays; e) the procumbent ray cells and (f) fibre with bordered pits.

Wood vessel-less

Growth ring boundaries indistinct

Tracheids present

Fibres are visible along the growth boundaries on the cross/transverse section

Non-septate fibres present on Tangential and Radial longitudinal sections

Parenchyma extremely rare or absent

Ray cells of one size

Ray cells are procumbent on the radial longitudinal section

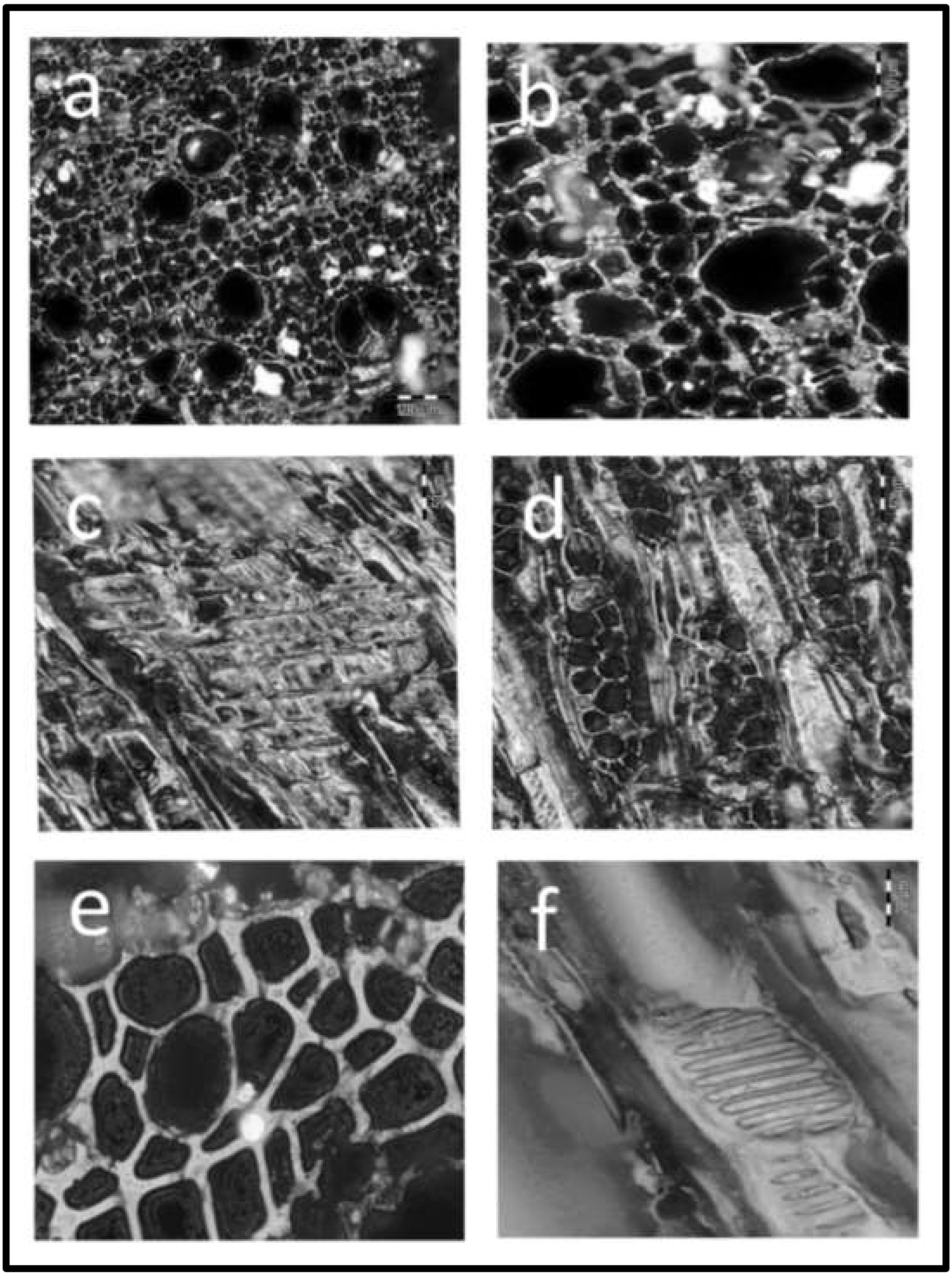
Ray frequency ~8-10/linear mm

Rays are strictly uniseriate

Rays up to 10 cells long

Rays height <1mm

10. *Protorhus longifolia*



The microstructure of P. longifolia showing (a) the vessel arrangement; (b) the diameter of vessel lumina; (c) procumbent and square ray cells; (d) biserriate rays and simple perforation plates; (e) fibre thickness and (f) the scalariform perforation plates with 8-9 bars.

Growth ring boundaries indistinct or absent

Wood diffuse-porous

Vessels have solitary and 1-2 radial multiple arrangement

Scalariform perforation plates with <= 10 bars (8-9 bars)

Intervessel pits medium - 7 - 10 µm

Vessel-ray pits with much reduced borders to apparently simple

Average diameter of vessel lumina: 50 - 100 µm

Vessel frequency: more than 40 vessels per mm^2 (~60 vessels)

Fibres thin- to thick-walled on the transverse section

Fibres with simple to minutely bordered pits on the longitudinal section

Non-septate fibres present

Axial parenchyma scanty paratracheal

Axial parenchyma vasicentric

Body ray cells procumbent with one row of upright and /or square marginal cells

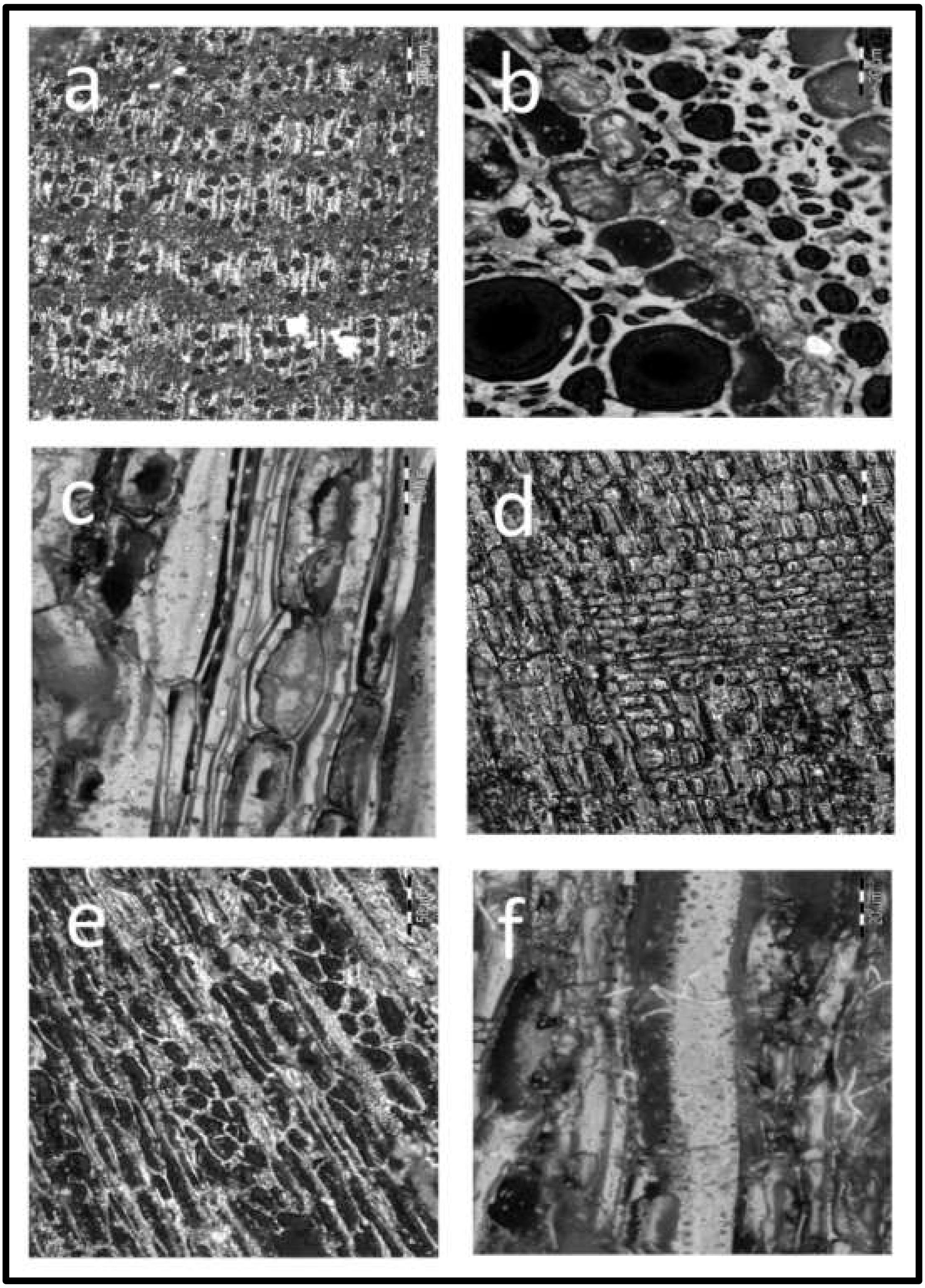
Ray frequency: 4-12 / linear mm

Rays are 1 to 3 cells wide

Ray height: <1mm

Ray width: 36 µm

11. *Pterocelastrus tricuspidatus*



The microstructure of *P. tricuspidatus* showing (a) solitary vessel arrangement and banded parenchyma; (b) thin-thick fibres and ray cells on the TS; (c) fibre pitting on the longitudinal walls; (d) procumbent, square and upright ray cells; (e) biserriate rays and (f) round intervessel pits.

Growth ring boundaries indistinct or absent

Wood diffuse-porous

Vessels exclusively solitary (90% or more)

Simple perforation plates

Inter-vessel pits alternate

Shape of alternate pits polygonal

Inter-vessel pits minute <= 4 µm

Average diameter of vessel lumina: <= 50 µm (~30 µm)

Vessel frequency: 100- 150 vessels per mm^2

Fibres with pits

Fibre pits common in both radial and tangential walls

Non-septate fibres present

Fibres very thick-walled (transverse section)

Axial parenchyma in bands; 4-7 bands/ lin. mm; (4-8) cells per parenchyma band

Ray cells have two distinct sizes

Body ray cells procumbent with mostly 2-4 rows of upright and / or square marginal cells

Ray frequency: >= 12 /linear mm

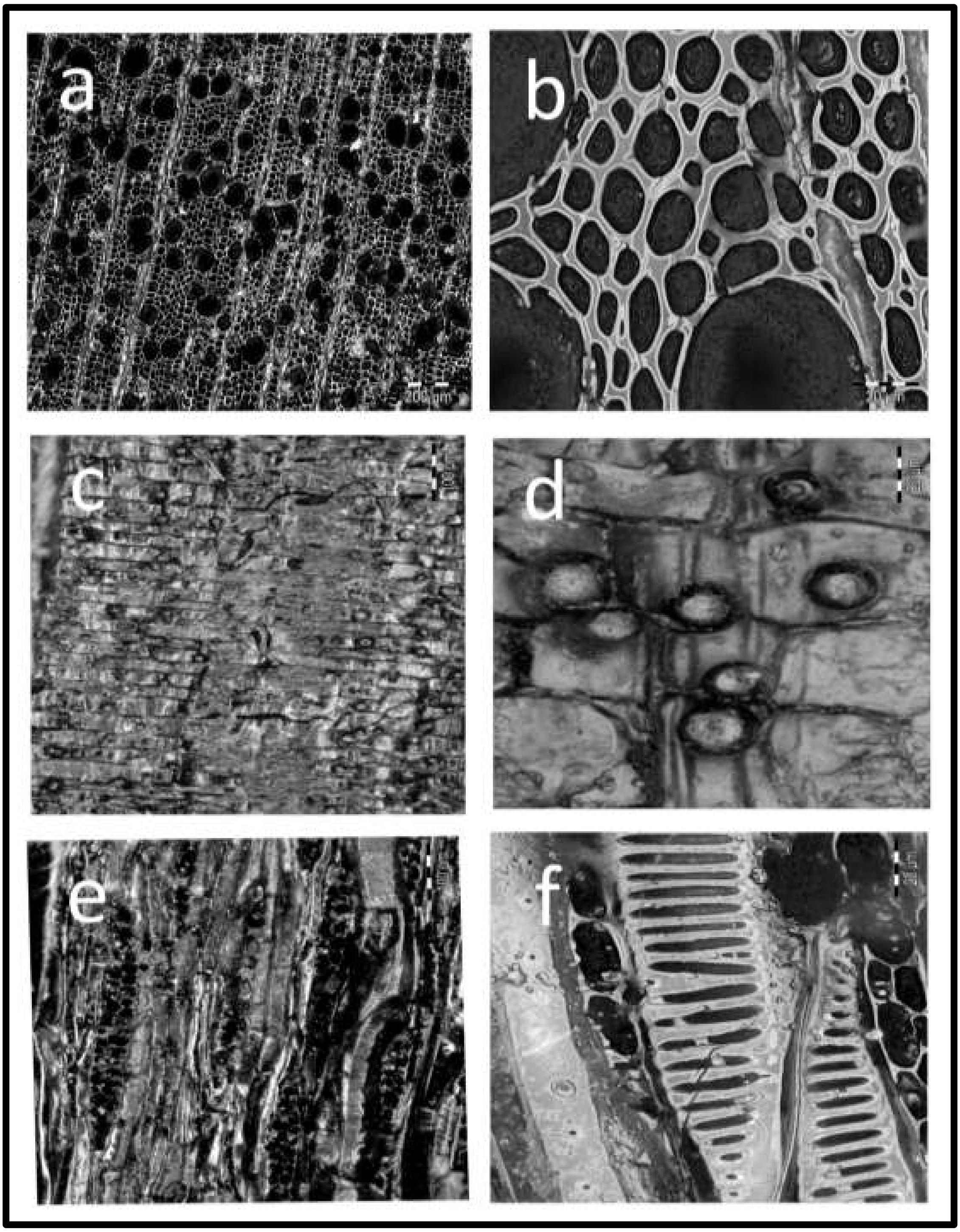
Rays are 1-2-3 cells wide

Rays are up to 20 cells long

Ray height: <1mm

Ray width: up to 30 µm

12. ***Platylophus trifoliatus***



The microstructure of *P. trifoliatus* showing (a) the solitary vessel arrangement; (b) thin fibres; (c)procumbent ray cells with inclusions; (d) silica bodies included in the ray structure; (e) biserriate rays and vessel elements with simple perforation plates and (f) elongated/gash-like (or scalariform) inter-vessel pits along with fibre with bordered pits.

Growth ring boundaries distinct

Wood semi-ring-porous

Vessels in solitary arrangement

Vessel clusters common

Solitary vessel outline angular

Simple perforation plates

Inter-vessel pits scalariform (horizontal gash-like)

Vessel-ray pits restricted to marginal rows

Average diameter of the vessel lumina: = 50 - 100 µm (~60 µm)

Vessel frequency: 40 - 100 vessels per mm^2

Fibres with distinctly bordered pits

Fibre pits common in both radial and tangential walls

Septate fibres present

Non-septate fibres present

Fibres thin- to thick-walled

Axial parenchyma diffuse

Axial parenchyma scanty paratracheal

Rays of two distinct sizes

Body ray cells procumbent with one row of upright and / or square marginal cells

Ray frequency: 4-12 / linear mm

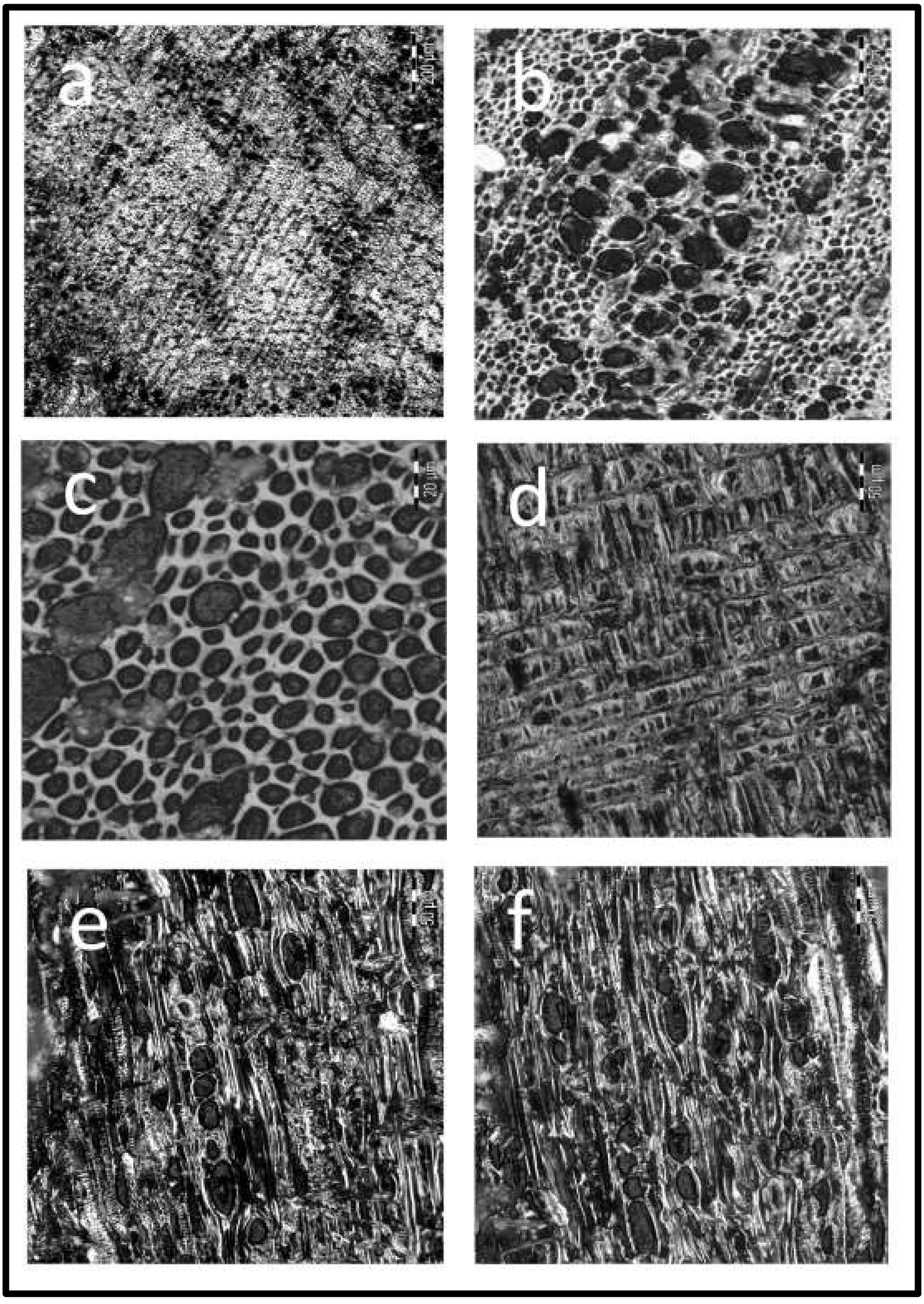
Rays 1-2-3 cells wide

Rays up to 20 cells long

Ray height: < 1 mm

Ray width: up to 40 µm

13. ***Passerina*** **sp.**



The microstructure of Passerina sp. showing (a) the dendritic vessel arrangement; (b) diameter of the vessel lumina; (c) thin – thick fibres; (d) the procumbent and square ray cells and (e), (f) the uniserriate ray cells.

Indistinct growth ring boundaries

Wood semi-ring porous

Vessels in dendritic pattern

Average diameter of vessel lumina: ~15 µm

Vessel frequency: 300+ vessels per mm^2

Thick fibres on the transverse section

Fibres are pitted on the longitudinal section

Axial parenchyma diffuse or scanty paratracheal

Rays of two distinct sizes

Body ray cells mixed: square and procumbent on the radial longitudinal section

Ray frequency: >12/linear mm

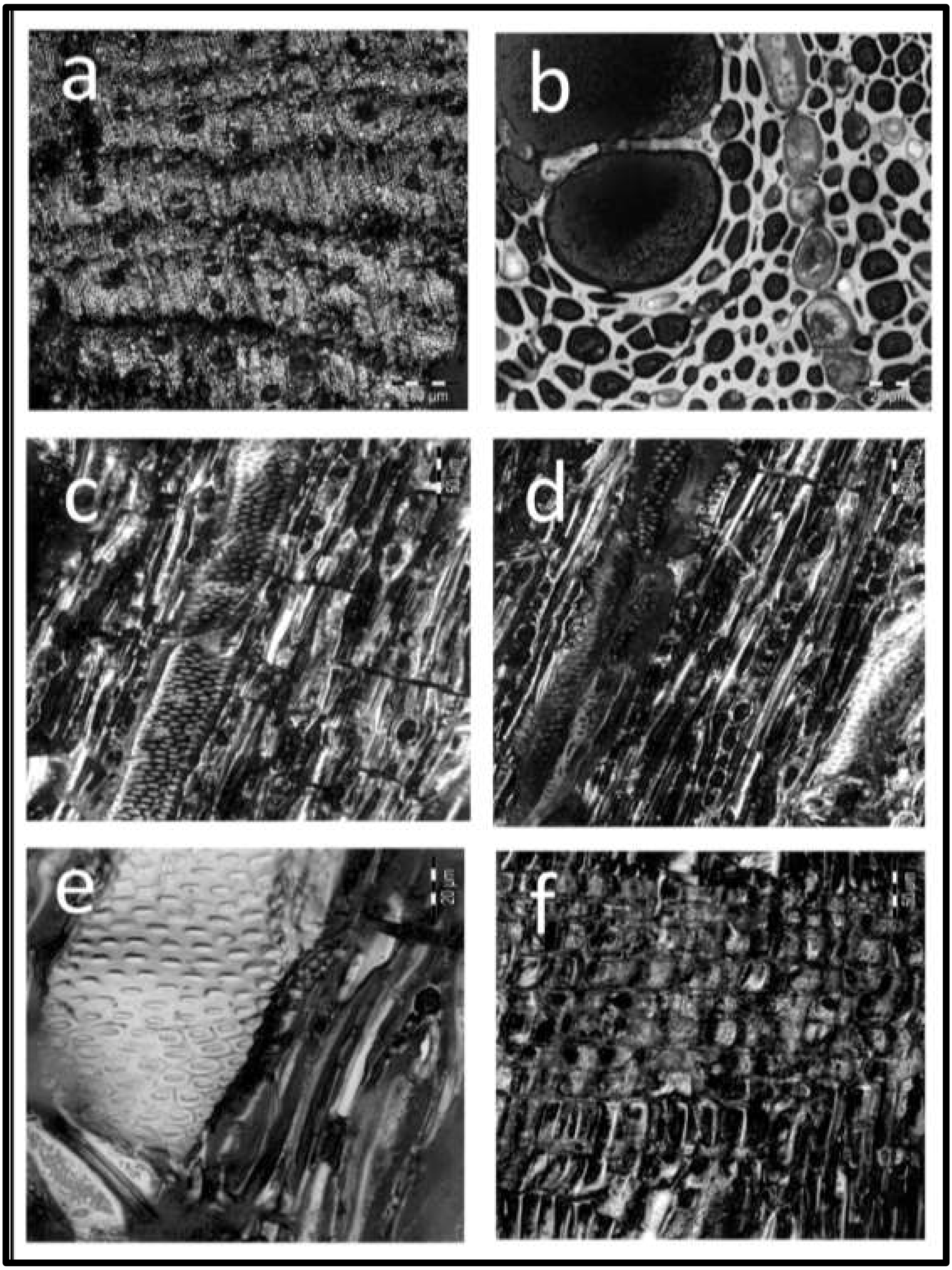
Rays are uniseriate; 1 cell wide

Rays up to 10 cells wide

Ray height: <1mm

Ray width: ~20 µm

14. *Sideroxylon inerme*



The microstructure of *S. inerme* showing (a) the solitary vessel arrangement and irregularly banded parenchyma; (b) the thin -thick fibres; (c) vessel elements and simple perforation plates; (d) uniserriate rays; (e) bordered and alternating inter-vessel pits and (f) procumbent and square ray cells.

Indistinct growth ring boundaries

Wood diffuse porous

Solitary vessels; also 1-2 radial multiple vessels

Simple perforation plates

Alternating and bordered inter-vessel pits

Inter-vessel pits <4 µm

Average diameter of vessel lumina: ~45 µm

Vessel frequency: 50- 100 vessels per mm^2

Thin to thick fibres

Non-septate fibres

Axial parenchyma is apotracheal, irregularly banded; 4-5 bands/mm; 3-7 cells/ band

Body ray cells procumbent, with marginal row of square or upright cells

Ray frequency: 8-12/linear mm

Uniseriate cells common

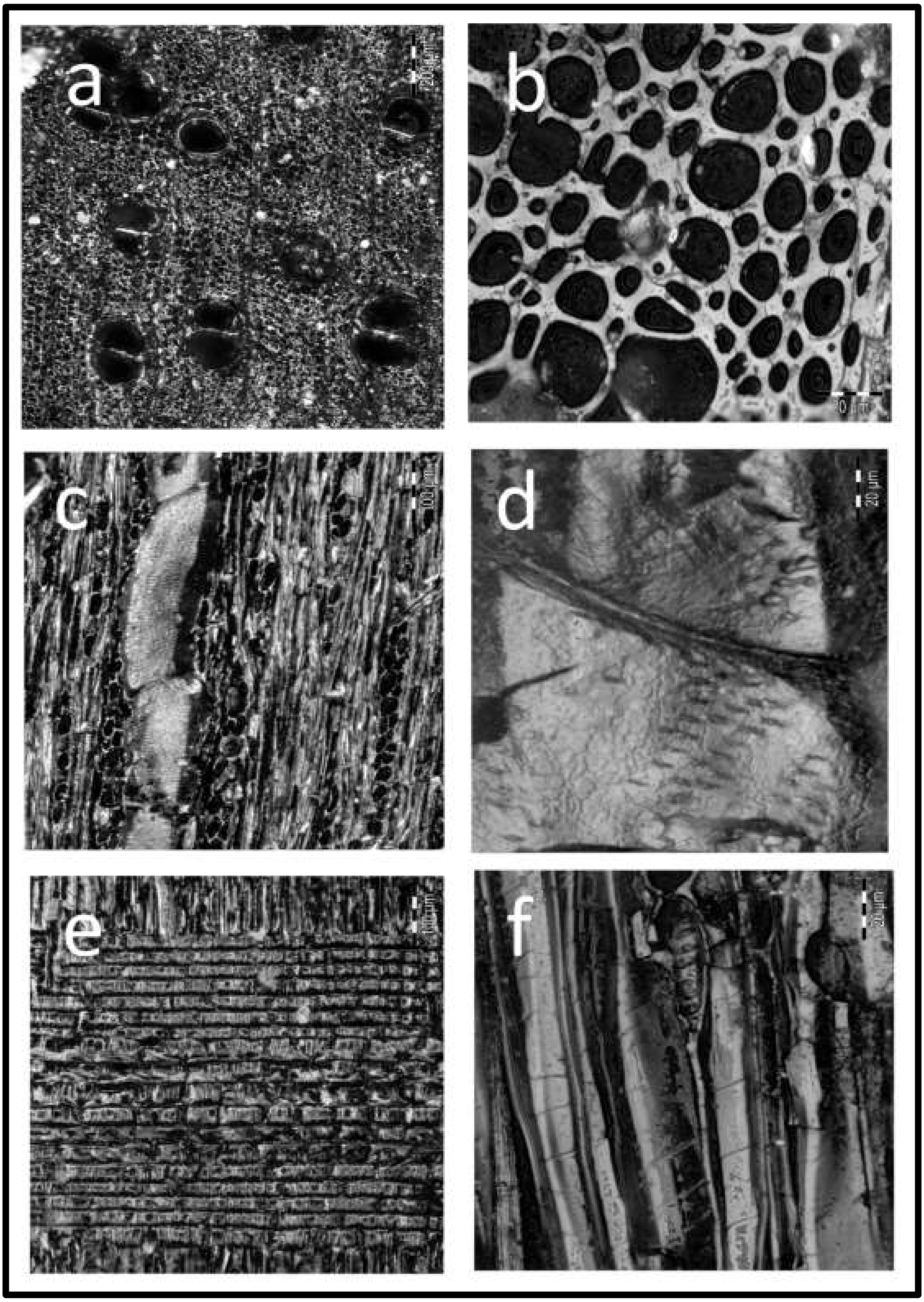
Rays are 1 cell wide, sometimes 1(-2) cells wide

Rays are up to 15 cells long

Ray height: <1mm

Ray width: 13 µm

15. *Searsia lancea*



The microstructure of *S. lancea* showing (a) vessel arrangement and scanty paratracheal parenchyma; (b) fibre thickness; (c) biserriate rays and vessel elements; (d) alternate inter-vessel pits (e) procumbent and square ray cells and (f) septate fibres.

Wood diffuse porous

Vessels: solitary, 1-2 (-3) radial multiple (short radial multiple)

Vessel outline angular

Solitary and short radial multiple vessels common

Simple perforation plates

Inter-vessel pits alternate?

Helical thickenings present on vessel elements

Average diameter of vessel lumina: 60-120 µm

Vessel frequency: <20 or 20-40 vessels per mm^2

Septate fibres present

Fibres thin to thick

Axial parenchyma present, paratracheal vasicentric

Rays of two distinct sizes

Body ray cells procumbent with over 1 row of upright and / or square marginal cells

Sheath cells present

Ray frequency: 4-8 / linear mm

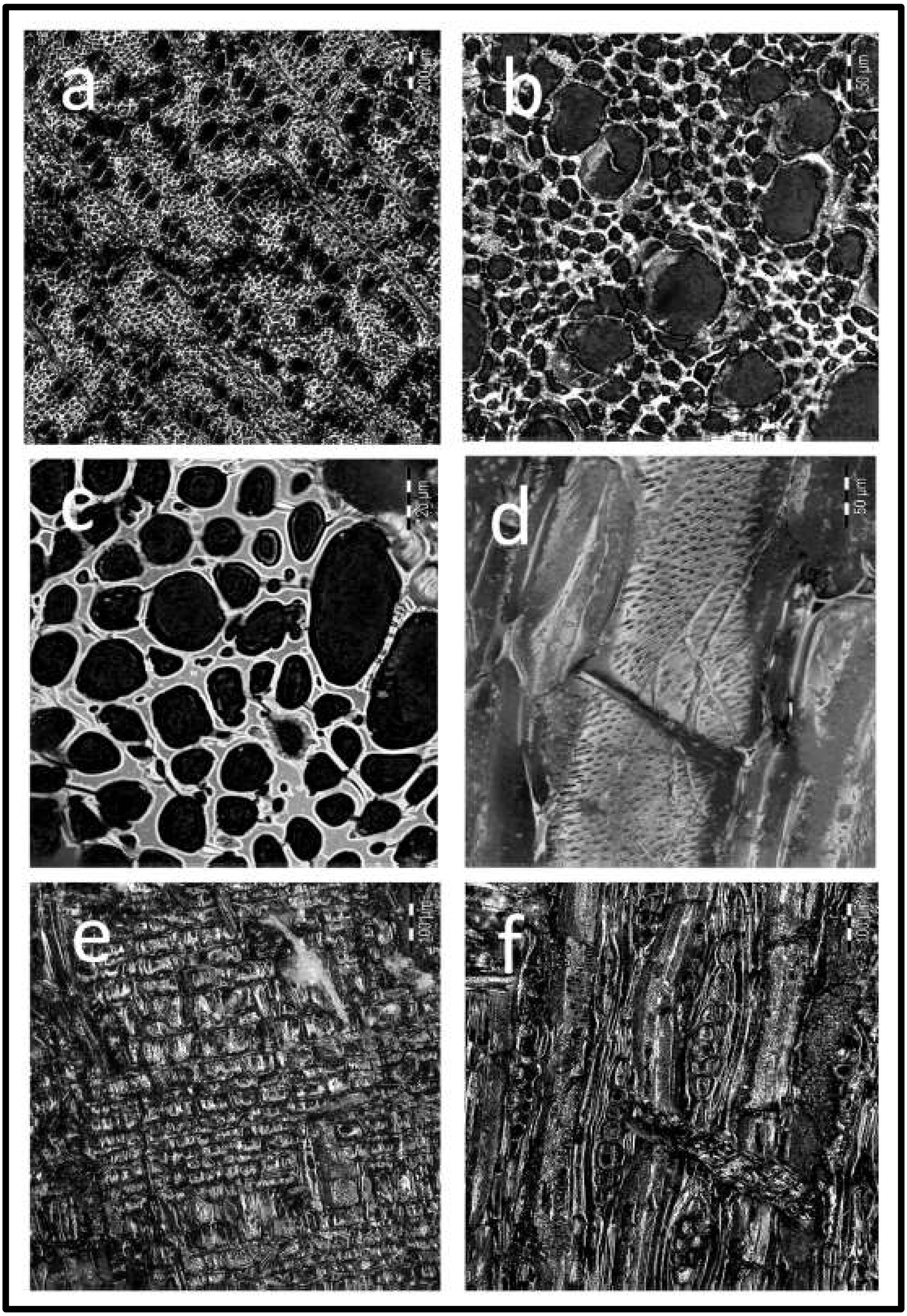
Rays 1-2 cells wide

Rays up to 17 cells long

Ray height: <1mm

Rays width: 30-40 µm

16. *Tarchonanthus* cf. *littoralis*



The microstructure of *T. littoralis* showing (a) long radial multiple vessel arrangement; (b) diameter of the vessel lumina; (c) thin fibres; (d) alternating minute inter-vessel pits and simple perforation plate; (e) square and procumbent ray cells and (f) uniserriate and biserriate rays.

Growth ring boundaries indistinct or absent

Wood diffuse-porous

Vessels in long radial multiples

Simple perforation plates

Inter-vessel pits alternate

Inter-vessel pits minute = 4 to 8 µm

Average diameter of vessel lumina: > 50 µm (~68 µm)

Vessel frequency: 100-150 vessels per mm^2

Fibres with pits

Non-septate fibres present

Fibres thin-walled (transverse section)

Axial parenchyma is rare

Ray cells have two distinct types (heterocellular)

Body ray cells procumbent with mostly 2-4 rows of upright and / or square marginal cells

Ray frequency: 4-12 /linear mm

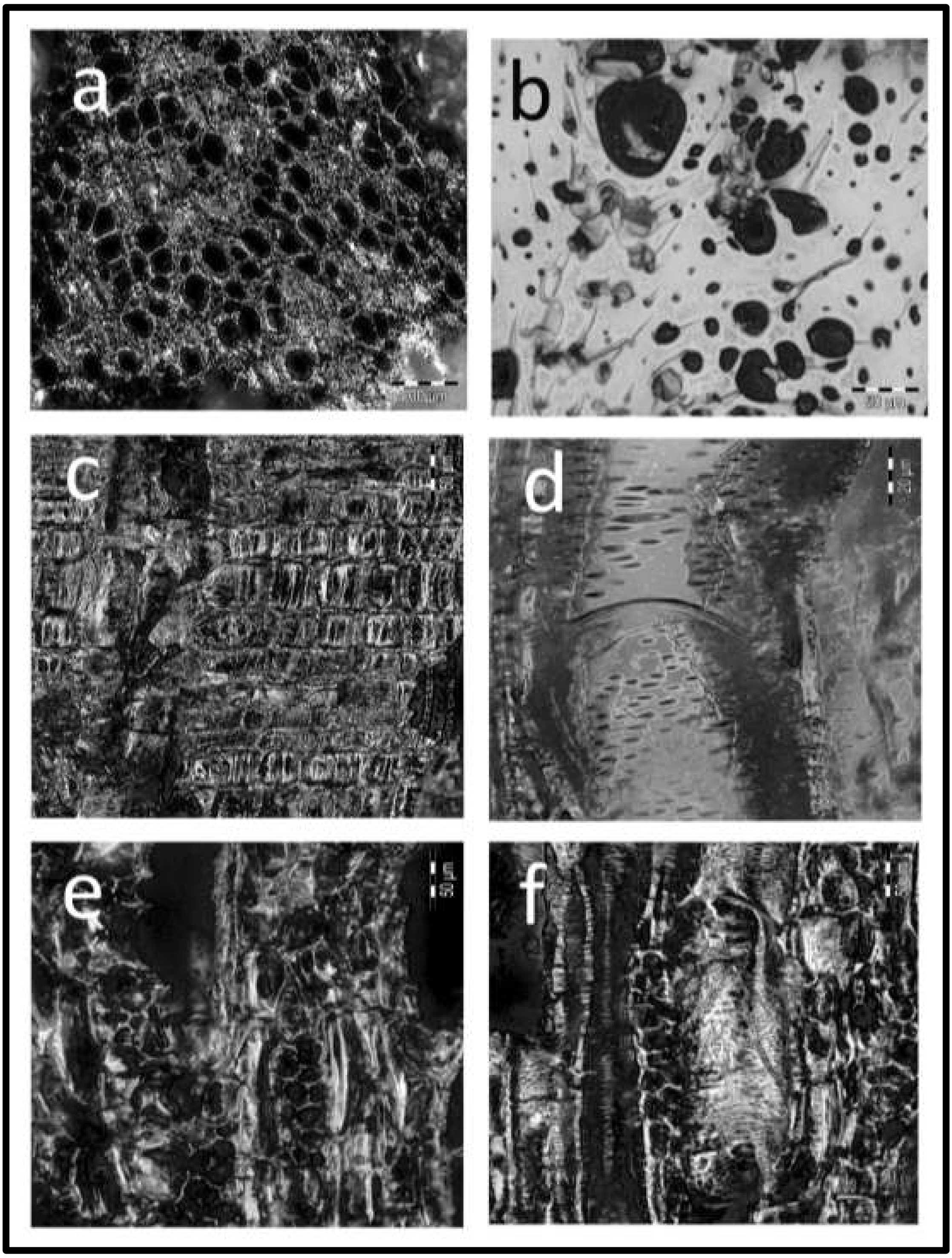
Rays are 1-2 cells wide; also 1 cell wide

Rays are up to 15 cells long

Ray height: <1mm

Ray width: up to 60 µm

17. *Zanthoxylum davyi*



The microstructure of Z. davyi showing (a) the dendritic vessel arrangement and irregular parenchyma bands; (b) very thick fibres; (c) procumbent, square and upright ray cells; (d) alternating intervessel pits and simple perforation plates; (e) and (f) biserriate rays and vessel elements.

Growth ring boundaries indistinct

Wood diffuse porous

Vessels in dendritic arrangement

Simple perforation plates

Inter-vessel pits alternate

Inter-vessel pits: 2-5 µm

Average diameter of vessel lumina: ~30 µm

Vessel frequency: 50-120 per mm^2

Non-septate fibres present

Fibres very thick (transverse section)

Axial parenchyma apotracheal

Axial parenchyma irregularly banded; 4-6 bands/ linear mm; 2-4 cells per band

Rays of two distinct sizes

Sheath cells present

Ray frequency: 4-8/linear mm

Rays are 1-2 cells wide

Rays are up to 10 cells long

Ray height: <1mm

Ray width: ~35 µm

APPENDIX 8 The distribution of the woody species identified in the contemporary Klasies River landscape across three rainfall zones. Species are presented in the alphabetical order of their families. Species highlighted in grey were identified in the archaeological charcoal assemblage. SRZ= Summer Rainfall Zone, YRZ= Year-round Rainfall Zone, WRZ= Winter Rainfall Zone.

B= Botswana, EC= Eastern Cape Province, FS= Free State Province, G= Gauteng Province, KZN= KwaZulu-Natal Province, L= Lesotho, LIM= Limpopo Province, M= Mpumalanga Province, N= Namibia, NC= Northern Cape Province, NW= North West Province, S=Swaziland, WC= Western Cape Province

van Wijk *et al.* (2017) collection	**Distribution of species according to Germistehuizen & Meyer (2003)**		
Genus+ species	**SRZ**	**YRZ**	**WRZ**
Hypoestes aristata	KZN	EC	WC
Justicia leptantha	_	_	_
Isoglossa ciliata	KZN, S	EC	WC
Carpobrotus deliciosus		EC	WC
Ruschia lineolata			WC
Tetragonia fruticosa	N		
Exomis microphylla	N		
Sarcocornia littorea		EC	WC
Searsia (Rhus) chirindensis	KZN, S, N, LIM, M	EC	WC
Searsia (Rhus) crenata	KZN	EC	WC
Searsia (Rhus) glauca		EC	WC
Searsia (Rhus) lucida			WC
Searsia (Rhus) nebulosa	KZN	EC	
Searsia (Rhus) pyroides	N		
Notobubon ferulaceum	_	_	_
Acokanthera oppositifolia	LIM, NW, G, M, S, KZN	EC	WC
Carissa bispinosa	N, B, LIM, NW, G, M, S, KZN	EC, NC	WC
Ilex mitis	LIM, NW, G, M, S, FS, KZN, L	EC	WC
Cussonia thyrsiflora		EC	WC
Asparagus densiflorus	LIM, G, M, S, KZN	EC	
Trachyandra divaricata	NC	EC	WC
Artemisia afra	N, B, LIM, NW, G, M, S, KZN	EC, NC	WC
Felicia echinata		EC	WC
Helichrysum anomalum	N	EC	WC
Helichrysum cymosum	KZN	EC	WC
Helichrysum rosum		EC	WC
Helichrysum teretifolium	KZN	EC	WC
Metalasia muricata		EC	WC
Osteospermum moniliferum		EC	WC
Plecostachys serpyllifolia	KZN	EC	WC
Stoebe plumosa	LIM, NW, G, M, S, FS, KZN, L, N	EC, NC	WC
Syncarpha striata		EC	
Tarchonanthus littoralis	KZN	EC	WC
Cordia caffra	LIM, M, S, KZN	EC	
Cassine peragua		NC	WC
Elaeodendron croceum	LIM, KZN	EC	WC

Gymnosporia nemorosa	M, S, KZN	EC	WC
Lauridia tetragona	LIM, S, M, KZN	EC	WC
Maytenus procumbens	KZN	EC	WC
Mystroxylon aethiopicum		EC	WC
Putterlickia pyracantha		EC	WC
Pterocelastrus tricuspidatus	KZN	EC	WC
Robsonodendron maritimum	LIM, M, S, KZN	EC	WC
Cotyledon orbiculata	NW, G, M, S, FS, KZN, L	EC	WC
Crassula atropurpurea		EC	WC
Crassula cultrata	KZN	EC	
Crassula tetragona		EC	WC
Diospyros dichrophylla	LIM, S, KZN	EC	WC
Euclea racemosa	KZN	EC	WC
Erica glandulosa subsp. *foucardei*			WC
Erica pectinifolia			WC
Erica peltata			WC
Euphorbia erythrina			WC
Erythrina caffra	KZN	EC	
Tephrosia capensis	LIM, NW, G, M, FS, KZN, L	EC	WC
Tephrosia grandiflora	KZN	EC	
Pelargonium capitatum	KZN, L	EC	
Pelargonium odoratissimum	M, S, KZN	EC	WC
Clerodendrum glabrum	N, B, LIM, NW, G, M, S, KZN	EC	
Leonotis leonurus	LIM, M, KZN	EC	WC
Salvia africana-lutea		EC, NC	WC
Grewia occidentalis	LIM, NW, G, M, S, FS, KZN, L	EC	WC
Ekebergia capensis	B, LIM, M, S, KZN	EC	
Ficus burtt-davyi	KZN	EC	WC
Morella cordifolia		EC	WC
Morella serrata	NW, G, M, S, FS, KZN, L	EC, NC	WC
Rapanea gilliana		EC	
Rapanea melanophloeos	M, S, KZN	EC	WC
Chionanthus foveolatus	KZN	EC	WC
Jasminum angulare	M, KZN	EC	
Olea capensis	NW, M, S, KZN	EC	
Penaea cneorum			WC
Pittosporum viridiflorum	LIM, NW, G, M, S, FS, KZN, L	EC	WC
Plantago crassifolia		EC	WC
Limonium scabrum		EC, NC	WC,
Polygala myrtifolia		EC	WC
Muraltia squarrosa		EC	WC
Leucadendron salignum		EC	WC
Leucadendron spissifolium			WC
Leucospermum cuneiforme		EC	WC
Protea coronata			WC
Protea cynaroides		EC	WC
Protea neriifolia		EC	WC
Protea tenax		ECC	WC

Restio eleocharis			
Restio triticeus	KZN	EC	WC
Thamnochortus fruticosus			WC
Phylica litoralis		EC	WC
Phylica purpurea			WC
Rhamnus prinoides	LIM, NW, G, M, S, FS, KZN, L	EC, NC	WC
Scutia myrtina	LIM, M, S, KZN	EC	WC
Cliffortia ilicifolia		EC	WC
Cliffortia linearifolia	LIM, NW, G, M, S, FS, KZN, L,	EC, NC	WC
Burchellia bubalina	LIM, M, S, KZN, L,	EC	WC
Canthium inerme	LIM, NW, G, M, S, KZN	EC	WC
Canthium spinosum	KZN	EC	
Pavetta revoluta	G, KZN,	EC	
Agathosma apiculata		EC	WC
Agathosma ovata	KZN, L	EC	WC
Clausena anisata	LIM, M, S, FS, KZN	EC	WC
Coleonema pulchellum		EC	WC
Zanthoxylum capense	LIM, NW, G, M, S, FS, KZN	EC	WC
Zanthoxylum davyi	LIM, M, S, KZN	EC	WC
Dovyalis caffra	LIM, M, S, KZN	EC	WC
Scolopia zeyheri	N, B, LIM, NW, G, M, S, FS, KZN, L	EC	WC
Colpoon (Osyris) compressum	KZN	EC	WC
Thesidium fragile		EC	WC
Allophylus decipiens	M, S, KZN	EC	WC
Sideroxylon inerme	LIM, M, S, KZN	EC	WC
Jamesbrittenia microphylla		EC	WC
Selago corymbosa		EC	WC
Selago myrtifolia		EC	
Lycium ferocissimum	FS, L	EC	WC
Solunum africanum	KZN	EC	WC
Solunum linnaeanum		EC	WC
Withania somnifera	N, B, LIM, NW, G, M, S, FS, KZN, L	EC, NC	WC
Halleria lucida	N, B, NW, G, M, S, FS, KZN, L	EC, NC	WC
Nuxia floribunda	L, M, S, KZN	EC	WC
Passerina corymbosa	KZN,	EC	WC
Passerina ericoides			WC
Passerina rigida	KZN	EC	WC
Struthiola hirsuta		EC	WC
Rhoicissus tridentata	KZN	EC	WC
Total: 122	**72/122**	**108/122**	**101/122**