Rambler: A Study of South Australian Colonial Ship Construction

By

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TABLE OF CONTENTS

ABSTRACT

This thesis uses the case study of *Rambler* from Victor Harbour to examine colonial shipbuilding practices in nineteenth century South Australia. *Rambler*, to date, is the only South Australian colonial built vessel to be identified, surveyed and recorded. Being constructed in 1875, in Birkenhead, South Australia, *Rambler* was primarily used as a cray fishing vessel around Victor Harbour and Kangaroo Island until its retirement in the 1990s. In the last 20 years the historic fishing vessel has resided in the empty paddock of Waitpinga Dump only a few kilometres from Encounter Bay after the closure of Port Adelaide boat yard.

In 2022, Flinders University students and staff conducted the first recording of the historic vessel. In addition, a combination of archaeological and archival methods were used to establish an understanding of *Rambler.* These methods include; photogrammetry, artefact photography, wood species identification, and metal sampling. These archaeological methods used in combination of historic records and archival materials were used to establish a detailed initial dataset for *Rambler*. To better understand and contextualise the result gathered from *Rambler*'s assessment, 15 comparative vessels were chosen to highlight the similarities and differences between construction techniques, materials used and location of where these vessels were built, to better understand nineteenth century colonial ship construction across Australia. These comparative studies then allowed for a more detailed understanding of the methods and materials used to construct *Rambler* as well as provide future maritime researchers with an initial understanding of the results collected from *Rambler*'s initial assessment.

By assessing comparative vessels alongside data collected from *Rambler*'s initial assessment, further archaeological and historical investigations can be undertaken to understand *Rambler*'s significance and contributions to maritime archaeology and Victor Harbour's local history. This study also discusses the social, economic, environmental, and cultural factors that influenced ship construction and the exchange of materials in the colonies of Australia through the archaeological theories of cultural transmission, colonial adaption and social learning theory. These theories were chosen as they offer insight into the learning and practices of European shipwrights during the early years of colonialization in South Australia in addition to the transmission of cultures and cultural identity. By using a combination of historical and archaeological methods to assess and record *Rambler*, combining comparative studies throughout the nineteenth century, and applying archaeological theories to further understand the methods used during *Rambler*'s construction, this thesis offers insight into South Australian colonial building practices during the nineteenth century and further contribute to the understanding of colonial ship construction and reveals meaningful insight into the material selection, technological changes and cultural adaption of the first settlers in South Australia.

DECLARATION

I certify that this thesis:

1. does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university

2. and the research within will not be submitted for any other future degree or diploma without the permission of Flinders University; and

3. to the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.

Signed....Lilith Somerville.............

Date......29.09.2023......

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LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

1.0 Introduction

Wooden ships of the past collectively represent aspects of human history in terms of exploration, survival, technological advancement, and curiosity (Staniforth and Shefi 2014:335). The study of these vessels provides an insight into the craftsmanship, journeys, battles and daily life of the people who lived, built and worked on them as well as the remaining structures left behind (Staniforth and Shefi 2014:335). It is through these abandoned and often forgotten vessels that new archaeological insights are made even from the scarce materials found. Examples of this can be seen through the archaeological investigations of Barangaroo Boat (*UDHB1*) (Coroneos et al. 2022) and *Barbara* (Burgees 2020; van Duivenvoorde et al. 2021; van Duivenvoorde et al. 2022) just to highlight a few. Data can then be extracted from these examples, through various archaeological practices that in turn, increase our knowledge and understanding of shipbuilding and use. Furthermore, aspects of social, cultural, economic, and geographical influences can be understood in this context. Each vessel is, however, uniquely different and controlled methods must be applied to accurately analyse each vessel. This research project focuses on the nineteenth century fishing vessel, *Rambler* (1875), which is the oldest surviving South Australian fishing vessel. The historic ship is currently located in Victor Harbour, South Australia. The remains of the historic vessel *Rambler* offer the opportunity to record, assesses, and analyse the techniques and materials used to construct a nineteenth century South Australian colonial-built vessel. Furthermore, this thesis will further investigate colonial shipbuilding across Australia, contextualising *Rambler* amongst 15 comparative colonial built vessels. This thesis aims to develop an understanding of nineteenth century colonial shipbuilding practices in South Australia and establish a dataset of *Rambler* for future research and thematic studies within the field.

1.1 Research Question

This study will address the following research question:

How do the remains of the historic fishing vessel *Rambler* inform us about nineteenth century ship construction in South Australia? And, how do the techniques and materials found in *Rambler*'s construction compare to that of the vessels built in other Australian colonies?

1.2 Aims

This thesis aims to:

- Undertake the first recording, archaeological assessment, and survey of *Rambler;*
- Build and establish a primary dataset that will be provided to the National Trust of Victor Harbour and Victor Harbour council for the purpose of conserving and recording local history;
- Conduct metal analysis and wood species identification that will be used in conjunction to confirm the origins of the materials used to construct *Rambler* and to also be cross-examined with other colonial built vessels; and,
- Use material evidence to produce a 3D virtual model of *Rambler* in its current state that can be used for future researchers, academics, and the National Trust to monitor the rate of deterioration.

1.3 Justification

Significant research into pre-1900 colonial shipbuilding in Australia has been conducted for over two decades, however, the colonial shipbuilding industry is overall relatively poorly understood (Staniforth and Shefi 2014:340). Within Australia, previous research into wreck sites, has clearly demonstrated the archaeological significance and answered questions surrounding adaption of early Australian colonists (Staniforth and Shefi 2014:335). Whilst, these questions are significant to understand Australia's early colonial history, this thesis will investigate the significance of the ship building industry in nineteenth century South Australia, as well as the role that other influential states had during this time. In doing so, this research project will use the example of *Rambler*, a South Australian built fishing vessel, to understand the importance of ship construction during this period for the local community of Victor Harbour and South Australia more broadly. Specifically, this research project will record, analyse, sample and digitise *Rambler*, creating a dataset for future researchers and academics to access. This project will examine structural features and components of *Rambler*, to identify tangible evidence relating to archival sources that will allow for further comparisons to be made in correlation to other colonial built vessels in other colonies. Factors that may have impacted the ship building industry such as economy, geography, social, and cultural factors will be explored and further discussed in later chapters. By understanding colonial ship building, this will contribute to our understanding of South Australian built vessels as well as contextualise other significant historic and archaeological factors.

Existing literature relating to colonial ship construction in Australia is extensive. Literature relating to penal colony settlement, colonial identity, ship construction, trade and transport, are heavily documented and explored through countless studies (both historic and archaeological). Literature specifically pertaining to South Australia during the nineteenth century is however more limited. This research will focus on incorporating state colonial history, archival research, and archaeological investigation to explore colonial shipbuilding practices in South Australia more closely. By using the oldest surviving South Australian fishing vessel, this will allow clear insight into building practices, sourcing of materials and local identity.

1.4 Historic Background: Victor Harbour

Victor Harbour is a coastal town of South Australia, located approximately 82 km south of Adelaide. The town is the largest population centre on the peninsula, with an economy still heavily based on agriculture, fisheries and various independent industries. Originally named Port Victor, the name derived from Captain Richard Crozier's ship HMS *Victor* in 1837 (Page 1987:11). The township was surveyed and initially declared a port shortly after in 1865, but would later grow to be known as the city of Victor Harbour by 1921 (Page 1987:11).

Thousands of years before European settlement, the Ramindjeri clan of the Ngarrindjeri people lived in the region of Wirramulla (Kandelaars and Kandelaars 2019:4). This region spread from the lower Murray River, eastern Fleurieu Peninsula and the Coorong of the southern-central area of South Australia (Kandelaars and Kandelaars 2019:4). The area was valued for its rich supply in fresh water, sheltered land, and variety of animals (Kandelaars and Kandelaars 2019:4).

During the early establishment of Victor Harbour, two whaling stations were built and supported the local economy greatly. One at Rosetta Head and the other at Granite Island, whaling soon became South Australia's first export (Hosking 1973:2). These stations are credited as being the most successful and longest lasting whaling stations in South Australia (Hosking 1973:2). In addition to the whaling industry, fisheries, shipping and agriculture were of large importance in the community. Significant families in the area such as the Rumbelow's were widely known and contributed greatly to the fishing and shipping industries of Victor Harbour (National Trust Museum 2022). Immigrating from England in 1854, Malen and Alice Rumbelow arrived at Port Adelaide, South Australia with their eight children (National Trust Museum 2022). In 1855 they settled in Victor Harbour and their family played an important role throughout the district, by establishing a regional fishing and boating industry (National Trust Museum 2022).

1.5 Historic Background: *Rambler* 1875

Rambler is a wooden built vessel, constructed in 1875 by the Weir Brothers of Adelaide (Horn 2023). Historic sources detail wood species selected for the construction of *Rambler* including jarrah and oregon (National Trust Museum 2022). The vessel measures 43 feet long (13.1 m), 10.5 feet beam (3.2 m), and 6 feet (1.8 m) draught (National Trust Museum 2022) and its design resembles a traditional English fishing boat commonly known as a smack (Horn 2023). For the first quarter of its life the Rumbelow family of Victor Harbour used it as a racing yacht before converting it to a cray boat in the early 1900s (National Trust Museum 2022). In addition to its life as a fishing vessel, *Rambler* was also used for running mail between Victor Harbour and Kangaroo Island as well as running ballot boxes during elections (Horn 2023). It was then bought by E. W. Daw of Adelaide in 1910, who used it as a cray-fishing boat around Adelaide, and later around Kangaroo Island (*The Islander* 1995). It finally retired around 1990 and was bought by Kingsely Haskett of Searles Boatyard who saved it from being scrapped and repurposed (*The Islander* 1995). Shortly after in 1993, John McLoughlin purchased it and aimed to restore the vessel and sail it around Port Adelaide for Christmas in 1995 (*The Islander* 1995). McLoughlin repaired parts of *Rambler* that can be identified today and will be highlighted during the fieldwork component of this project.

Currently, the vessel is located at Waitpinga Dump (owned by the National Trust). The dump has not been commercially used in 15 to 20 years and currently sits isolated and exposed to all weather elements year-round (National Trust Museum 2022). *Rambler* is at high risk of further deterioration as each year passes, with particular destruction being caused by local farmers live-stock using the vessel as a scratching post. The ship is not heritage listed, nor protected under any state or Commonwealth legislation. No report of salvage, conservation or recovery of the ship has taken place since its relocation to Waitpinga Dump. In recent years there has been discussions and attempts to have the vessel protected with a tarpaulin, however none have been successful.

1.6 Significance

On a national scale, this research is significant because few nineteenth century Australian-built vessels have been surveyed and recorded. *Rambler* is the oldest surviving fishing vessel in South Australia, and possibly Australia (National Trust 2023). It is therefore of the highest importance that a vessel with such significance is surveyed and recorded before irreversible damage impacts this vessel.

This vessel stands as a primary example of ship construction and building techniques used for the purpose of local fishing and daily life, being the second vessel in South Australia to ever be granted a cray fishing licence (*The Islander* 1995). This vessel is mostly in its original state, with minor restorations made in the 1990s by the previous owner, John McLoughlin (*The Islander* 1995). These restorations have been noted and will be identified and further discussed in Chapter 4.

Furthermore, the social importance of this project extends to the local community of Victor Harbour as well as the descendants of the Rumbelow family today. In April 2017, at the City of Victor Harbour council meeting, elected members donated $2,500 for a tarpaulin to be erected and cover *Rambler*, on the provision that the working committee also offer $2,500 (Simmons 2017). This proposal did not follow through and *Rambler* remains exposed and continues to deteriorate as a result of the harsh weather conditions.

1.7 Methods

Archival material will provide a foundational understanding of ship construction in colonial settlements in South Australia, timber supply around Australia, and the social and economic climate of nineteenth century Australia. Materials were accessed from a variety of online and in-person locations, such as; Victor Harbour National Trust's library, State Library of South Australia, National Archives and Lloyds Ship Registry.

Different recording methods were used for the purpose of this research project, primarily focused on digital recording. Since the vessel is largely still intact and is easily accessible, the opportunity to record all features of *Rambler* was taken. Recording of all relevant structural features of *Rambler* was conducted for this would allow future researchers access to this information. Drone footage and photogrammetry recording were the primary methods used as this allowed for a digital record that can be accessed by the researcher at any point anywhere in the world with a detailed, interactive replica of *Rambler*. This model can be used for future researchers and institutions for monitoring works and analysis, in the event the vessel further deteriorates or becomes no longer accessible. Future monitoring works would greatly benefit the scientific and Victor Harbour communities as this would enable data to be gradually collected over the course of an extended period that would in turn great a more detailed understanding of the vessel. In addition, the community of Victor Harbour is supportive of further understanding their local history particularly surrounding the early colonial period.

Preliminary site visits were conducted on a number of occasions in September 2022, as well as fieldwork taking place on 29th September 2022 with Flinders University Maritime Archaeology Program (FUMAP). Fieldwork included visual survey, the recording of structural components, DSLR and drone recording for photogrammetry. Wood and metal samples were collected in association with FUMAP. The fieldwork team included FUMAP staff and students. Students recorded structural components of the ship and identified any modern additions to the vessel that were not original features or structural changes.

A catalogue was created specifically for the timber samples. This style of cataloguing is suggested by Richard Steffy's 1994 guidelines (Steffy 1994). The following categories were recorded and sampled:

- Keel, keelson, stem, sternpost
- Planking (outer, deck timbers)
- Frames
- Unclassified or discarded timbers

By cataloguing and recording measurements and other information this way it allowed targeted timbers to be discussed in more detail and any additions to the ship to be further discussed and sampled. It will also provide the database with a current and detailed analysis of the ship and its construction.

This research project required a selection of timber samples to be taken for the process of identifying the wood species used for each structural component, then further narrow down the region this timber potentially came from. Timber species identification was analysed by specialist Jugo Illic of 'Know Your Wood'.

By locating the harvested region of these timbers, this will allow for a greater understanding of how the ship construction industry used these specific species of timbers during the nineteenth century. It will also answer questions of 'were local wood species used for the purpose of ship construction ?'. Since no previous archaeological investigations have been conducted on this ship, it is imperative that wood and metal samples are taken to build the contextual information surrounding this ship. The results from this research project will then offer opportunities for colonial shipbuilding researchers to gain insight into wooden vessels around Australia.

1.8 Permissions and Consultations

For this research project site access approval was needed from Victor Harbour council and the local National Trust branch. Approval from Flinders University was also required in preparation for the fieldwork component of this research project.

1.9 Chapter Outlines

Chapter Two: Literature Review

Chapter two focusses on the theoretical approach of colonial identity and cultural adaption through the maritime landscape. These will be discussed through the theoretical understanding of social learning and behavioural approaches, using shipbuilding to explore this theme. By building on pre-existing research, this chapter will discuss how colonists adapted to the landscape and how this is transcribed through ship construction and colonial ship building practices.

Chapter Three: Methodology

Chapter three details the methods used over the course of this research project, along with the techniques applied during the surveying and recording of *Rambler* at Victor Harbour, South Australia. The survey methods include drone mapping, photogrammetry, and the collection of timber and metal samples. This chapter further outlines the techniques used throughout these methods and how they have been applied in this case study.

Chapter Four: Results

This chapter will present the results collected during the 2022 fieldwork. These results will include the site survey conducted during the 2022 fieldwork, wooden samples collected, timber species identification conducted by Jugo Illic, and Scanning Electronic Microscope (SEM) metal analysis.

Chapter Five: Discussion

Chapter Five will contextualise the results gathered from the 2022 fieldwork. This chapter will provide the explanation of timber species identification and metal sampling, contextualise the vessel in the historic record, and highlight similarities and differences between 15 comparative vessels. Using comparative research will allow *Rambler* to be examined alongside similar vessels and therefore will increase the overall knowledge of ship construction in nineteenth century Australia.

Chapter Six: Conclusion

Chapter Six will conclude this thesis by answering the research question and addresses the aims and significance of this project. This chapter also discusses the limitations identified during this project, suggesting areas for further research into colonial ship construction in the nineteenth century.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Previous research surrounding Australia's maritime history has focused on adaptation of early colonists and wooden vessels in Australia (Staniforth and Shefi 2014; Coroneos et al. 2022; Bullers 2006; Bullers 2007; Orme 1988; O'Reilly 2006). Such studies have highlighted the cultural transmission of shipbuilding knowledge, skills, and adaptation that early colonists made when adjusting to the Australian landscape. What this chapter highlights, however, is how archaeological theory of colonial identity can be explored through ship-building practices in early colonial Australia. This will be discussed in combination with social learning theory as well as cultural transmission and cultural adaption, all used to highlight the process of colonial identity in Australia. These theories were chosen as they can be applied to the case study of *Rambler*, and clearly identify the transmission of knowledge and information from one individual to the other through the use of adaption, experience and knowledge. Through the transmission of information, colonial shipbuilding methods have gradually advanced and adapted to the surrounding landscape and can be identified in the example of *Rambler.* By exploring *Rambler*'s individuality through archaeological assessment and applying archaeological theories of social learning, cultural transmission and cultural adaption, colonial ship construction can be better understood. This chapter will directly apply archaeological theory to the case study of *Rambler* and explore wooden ship construction and design during nineteenth century colonial Australia.

Furthermore, this literature review will discuss previous archaeological studies conducted on Australian colonial-built vessels as well as highlight the clear gap in South Australian built vessels. Finally, theories of social learning, cultural transmission and adaption will be discussed in detail in relation to colonial ship building practices.

2.1 Previous Archaeological Studies

Between the late eighteenth century and early nineteenth century, colonial merchants are seen purchasing vessels over 100 tons, with very few less than 100 tons arriving in Australia (Staniforth and Shefi 2014:336). This was because the Australian colonies were too remote to dispatch vessels smaller than 100 tons, and as a result the need for smaller vessels used for trade and transport between the colonies began to grow (Staniforth and Shefi 2014:336). These smaller vessels would soon become increasingly important to support the maritime industries for whaling, sealing and local trade that would eventually become significant industries within the colonies (Staniforth and Shefi 2014:336). Though, small coastal traders were often not registered and therefore unrecorded despite their critical role in the establishment and expansion of the newly founded colonies (Broxham 1996; Gillespie 1994; Graeme-Evans and Wilson 1996; Kerr 1974).

Previous research of Australia's maritime history has clearly demonstrated that the wreck sites of Australian built vessels hold significant archaeological potential when answering questions surrounding early colonial adaption to the unfamiliar Australian landscape (Bullers 2006, 2007; Nash 2004; O'Reilly 2006; Orme 1988). More specifically, the research surrounding these vessels has often concentrated on the historic accounts of their voyages and wreckage, or surveying to establish protection and preservation. According to Rick Bullers (2006:62), 2,786 Australian built vessels are recorded as having been wrecked along Australia's coastlines, with the available database indicating only 271 of those vessels have been located officially. A more recent search of the Australian Underwater Cultural Heritage Database (AUCHD) revealed the number of shipwrecks along the Australian costliness is now at 5,936 (AUCHD 2023). Whilst it is not officially know how many of these vessels have been surveyed, it can be assumed that all of those with published results have at some point been surveyed or recorded. To understand the significance of *Rambler* and contextualise the results, 15 comparative vessel have been chosen to facilitate a greater understanding of colonial built vessels across Australia. These comparative studies range in materials identified, vessel type, and use and therefore hope to provide insight into the variety of methods, materials and techniques used during colonial ship construction in the nineteenth century. Additionally, majority of these selected vessels have undergone metal sampling and species identification, and have their results published.

These vessels are:

1. The cutter *Water Witch*, built in Tasmania 1835, lost in South Australia 1842 (Jeffrey 1987, 1992).
2. The schooner *Clarence*, built in NSW 1841, lost in Victoria 1850 (Harvey 1989).
3. The schooner *Robert Burns*, built in Tasmania 1857, lost in South Australia 1908 (O'Reilly 1999).
4. The ketch *Adonis*, built in Tasmania 1864, lost in South Australia, 1962 (O'Reilly 1999).
5. The schooner *Dorothy S*, built in Victoria 1868, abandoned in South Australia, 1935 (O'Reilly 1999).
6. The ketch *Annie Watt*, built in Tasmania, 1870, stored in South Australia, 1970 (O'Reilly 1999).

7. The schooner *Dianella*, built in Tasmania, 1872, lost in South Australia, 1909 (O'Reilly 1999).
8. The ketch *Alert*, built in Tasmania, 1872, broken up South Australia, 1959 (O'Reilly 1999).
9. The ketch *Thomas and Annie*, built in Tasmania, 1874, abandoned in South Australia, 1945 (O'Reilly 1999).
10. The schooner *Lady Daly*, built in Victoria, 1876, lost in South Australia, 1926 (O'Reilly 1999).
11. The schooner *Alert*, built in NSW, 1846, lost in Tasmania, 1854 (Nash 2004).
12. The ketch *Three Sisters*, built in Tasmania, 1874, wrecked in South Australia, 1899 (Jacobs and Myers 2022; van Duivenvoorde et al. 2023; van Duivenvoorde and Polzer 2023).
13. The schooner *Barbara*, built in Tasmania, 1841, wrecked 1852 in Victoria (Burgees 2020; van Duivenvoorde et al. 2021; van Duivenvoorde et al. 2022).
14. The clinker boat UDHB1 otherwise known as Barangaroo Boat, presumably built in New South Wales in the 1800s, wrecked as early as the 1830s in New South Wales (Coroneos et al. 2022).
15. The schooner *Heroine*, built in New South Wales, 1894, wrecked in the Gold Coast, Queensland in 1897(van Duivenvoorde et al. 2023).

The gap in the data highlights the lack of diversity of these vessels, with majority of them originating from New South Wales, Tasmania, and Victoria. There has previously never been a South Australian colonial-built vessel to be surveyed and recorded that dates back to the nineteenth century. The case study of *Rambler* will serve as the foundation for understanding colonial ship construction, cultural adaption, and colonial lifestyles in South Australia during the nineteenth century, as well as timber and metal production and sourcing. Whilst tracing *Rambler*'s origins, there was no official registry used to register small coastal traders due to their often-short working lives (Coroneos 1991; Richards 2006:49). *Rambler* was traced through various owners, both private and State, who collected its history, photographs, and documents (National Trust 2022). Whilst studies of these vessels have established the historical significance of understanding Australia's colonial maritime history, *Rambler* will contribute to the understanding of South Australian colonial-built vessels.

2.2 Social Learning Theory

Jamshid Tehrani and Felix Reide describe social learning theory through different human strategies of copying one another, specifically through the distinction of imitation and emulation (Tehrani and Reide 2008:316). Imitation is defined as when an observer copies the specific set of actions enacted by a role model to accomplish some task, and emulation, in which an observer focuses only on the outcomes of those actions (i.e. the goals that motivated them or the qualities that made them efficacious) (Tehrani and Reide 2008:316). Therefore, emulation allows the individual or group to borrow or manipulate the behaviours observed, whereas imitation allows for the reproduction of intricate and complex designs without necessarily understanding how they work (Whiten et al 2006). In the case of shipbuilding, shipwrights would have learnt their trade through either one of these strategies: imitation or emulation. By applying social learning theory to the investigating of ship construction techniques, the models of change combined with the social and cultural factors become incredibly significant when observing colonial shipbuilding in Australia.

In the case of complex shipbuilding, to ensure that these skills and techniques were accurately transferred to the next generation, shipwrights must have actively guided their apprentices, a form of transmission referred to as ‘pedagogy’. Pedagogy in the context of craft apprenticeships can be understood as involving the gradual scaffolding of skill in a novice through demonstration, intervention, and collaboration (Tehrani and Reide 2008:316). This transmission when applied to the discipline of archaeology suggests that pedagogy has played an essential role in securing the transmission of skills across generations and should be regarded as the central mechanism through which long-term and stable material culture traditions are propagated and maintained (Tehrani and Reide 2008:316).

Knowledge and skills that accumulate within a collective group and are handed down over generations can be defined as ‘tradition’. Traditions can be identified across a wide range of surviving cultural materials. These forms of material culture, when recognised, display a distinct pattern among the remaining artefacts (Tehrani and Reide 2008:316). In the context of shipbuilding, these replicated practices are apparent through the repeated techniques of ship construction and eventually the modification of these techniques in the Australian landscape (Orme 1988:31). This can be seen through early colonial ship construction where the use of European techniques and methods were applied initially in the colonies (Orme 1988:31). Traditional European shipbuilding techniques would have initially been applied when constructing vessels in the colonies. Through trial and error these traditional techniques would have gradually adapted and been modified to better suit the Australian landscape and available materials. In addition to adapting to materials available, early colonists had to modify their ship building designs to better suit the Australian coastal landscape. Unlike the European coasts, the Australian maritime landscape presented obstacles of reefs and shallow sand banks, not allowing vessels with deeper hulls through these terrains. As a result, small coastal traders were built, enabling travel around the maritime landscape. Additionally, higher demand of smaller vessels, trade, and transport of these colonial built vessels began to take place and eventually resulted in significant production of smaller vessels (especially from Tasmania) (Staniforth and Shefi 2014:336).

Social learning theory is further argued in Michael O'Brien and Alexander Bentley's 2011 paper 'Simulated Variations and Cascade'. O'Brien and Bentley argue that variation within individual learning is controlled and modified by existing behaviours through trial and error (O'Brien and Bentley 2011:317). This is also referred to as 'guided variation', meaning; having two important or equal components, unbiased transmission and environmental (individual) learning (O'Brien and Bentley 2011:317). These two varying types of learning can be understood as follows. In one circumstance, the individual can copy the behaviour from a master, having no influence on the behaviour before passing this same learnt trait/skill/task onto the next person. In another circumstance, environmental learning is a process that can occur multiple times within the same generation (O'Brien and Bentley 2011:317). Therefore, when applying guided variation processes to ship building practices, it is highly likely that unbiased transmission and environmental factors are applicable in ship building yards. Environmental learning and unbiased transmission would have influenced not only the individual designing of the vessel, but the formation and shipbuilding process itself (O'Brien and Bentley 2011:317).

Individuals that allow their behaviours to be influenced by others, are benefiting from receiving added information and therefore improve their knowledge and skill set. Thus, by acquiring information from others, populations adapt, respond, and grow (O'Brien and Bentley 2011:316). It can therefore be supported through these theoretical approaches, as well as the material record, that ship construction methods and applications are directly connected to the impacts and changes of the surrounding environment and can be clearly applied in the case of *Rambler* as well as other colonial built vessels in the nineteenth century.

2.3 Cultural Transmission and Colonial Adaption

Cultural transmission (CT) is implicated through explanations of cultural change (Eerkens and Lipo 2007:239). In doing so, CT can be understood through the technological changes over time, along with the explanation of rates of change (Eerkens and Lipo 2007:239). Eerkens and Lipo further argue that CT processes are affected by the content, context, and mode of transmission and fundamentally structure variation in material culture (2007:239). For example, complex instructions being delivered to an individual in the form of written instructions statistically have a higher rate of success than that of verbal or visual demonstrations (Eerkens and Lipo 2007:247). The more complex the content or information is for an individual to absorb, the greater chance of that the information is copied incorrectly (Eerkens and Lipo 2007:247). Through the archaeological analysis and design variability, ship construction can be researched thoroughly and understood in the context of early colonial adaption in Australia. By studying these cultural traits of shipbuilding, this information encodes behaviour and environmental insight into the related group or individuals (O’Brien et al. 2015:692).

Researchers studying artefacts and their design, can identify the stages of modification through the transmission of information (Eerkens and Lipo 2007:261). Through the study of historical vessels alongside archival records and associated material remains, researchers are able to better contextualise the past and begin to identify the social, political, economic, and physical influences that have contributed to the ship’s construction (Eerkens and Lipo 2007:261). Applying this to colonial shipbuilding practices allows researchers to move beyond a typology assessment and begin to answer questions of ‘*why’* this change has taken place and ‘*where*’ these influences have come from (Eerkens and Lipo 2007:240).

Cultural transmission in its simplest form is defined as the transfer of information between two groups (Eerkens and Lipo 2007:246). Eerkens and Lipo (2007) go on to further outline the contributing factors of cultural transmission theory: invention or innovation, the removal or selection, and lastly the differential transmission of behaviours or artefacts (cultural variants) (Eerkens and Lipo 2007:246). Invention is understood as something that can occur at any point in time, whereas innovation is the process in which knowledge and skills must be passed down through the populous.

Taking this one step further, to understand the evolution of this process, it is essential to understand the transmission process as well as the role human decision making contributes to this theory. To understand the human decision making it is imperative to avoid the misconception that shipbuilding is autonomous (Bennett 2021:20). By incorporating a variety of other disciplines when analysing shipbuilding techniques this begins to contextualise the artefact, acknowledging the various influences it may have. Understanding the pattern of change and cultural adaption allows the researcher to raise questions such as ‘*did these colonies develop their own culture?*’ (Bennett 2021:20).

Cultural transmission, as highlighted by Bentley and O’Brian, is formed on the basis that genes and culture are linked through systems of inheritance, variation, and evolutionary change (O'Brien and Bentley 2011:311). Therefore, cultural transmission produces traits that cannot be identified genetically or through the individuals’ environmental surroundings. Adding to this theory, Schiffer (2005) explains how information is transferred across the social landscape and applied by the individual or group to better adapt to their surroundings. Humans, through their individual learning processes, have the ability to continually learn, modify, and pass on information though experimentation and social learning (Eerkens and Lipo 2007:242). An example of this could be a young adolescent assisting a grandparent with the computer. The young adolescent (expert) guides the grandparent (the novice) through the process of functioning a computer. In this example there is a reverse age hierarchy highlighting that the expert is not always older than the novice (Schlegal 2011:459). However, through the guided learning of how to use the computer the novice is able to continually learn through reciprocal exchanges of knowledge (Schlegal 2011:459).

Therefore, allowing the individual to process and respond to their environmental changes more effectively. Thus, through this theory, the study of ship construction and cultural adaption of early colonial settlers in Australia can be explored more effectively when understanding how they would have adapted to their surrounding environment, both in a cultural and environmental capacity. By understanding these external factors, evidence of the shipbuilders social learning behaviours can be highlighted in the ship construction processes and identified through the remaining material culture.

2.4 Conclusion

By applying the discussed application of these archaeological theories in this chapter, colonial adaption in nineteenth century Australia can be more clearly understood. By highlighting the transformation of ship building methods and design in colonial-built vessels, through the social changes and cultural adaption of early European settlers, the development of early Australian shipbuilding practices can be identified. Applying this archaeological framework to real world ship designs allows for more insight into colonial building practices. Understanding how behaviour and environment influence a vessels construction can be understood in examples such as how early seafaring utilised streamline cutters on the bow of ships to then streamline sailing. This example highlights both the influences of behaviour versus environmental influences in the adaption and modification of shipbuilding practices.

Using archaeological and historic sources to contribute to this understanding of cultural adaption in the nineteenth century, allows for an understanding of societies and technologies to be observed and contextualised. In terms of human behaviour, this research considers the social, political, economic, and environmental factors that would have contributed to the ship construction process. By employing social learning theory and cultural transmission to maritime archaeology, this enhances our understanding of colonial adaption and how these choices would have been made concerning shipbuilding and the development of nineteenth century ship construction methods and design. These archaeological theories were chosen as they explore how early seafaring utilised particular ship designs depending on their environmental surroundings, learnt skills and materials available. Over time the adaption and modification of these vessels gradually transformed and can be identified over an extended period of time. However, the analysis of these nineteenth century vessels and their construction techniques can be closely examined through social learning theory and cultural transmission and cultural adaption theory.

CHAPTER THREE: METHODOLOGY

3.0 Methodology

For this study a variety of archaeological methods were applied to the research project of *Rambler*. These included: archival research, timber and artefact recording, metal analysis, timber species identification, artefact photography and cataloguing, were all used in combination to extract physical and written information concerning Australian colonial shipbuilding. *Rambler* is a vessel that has previously never been surveyed or recorded, and has minimal archival documentation detailing its previous owners, construction materials or history. This research project therefore focused on the first surveying and recording of *Rambler*, using a variety of methods to document the vessel. The 2022 fieldwork represents the start of research and documentation of South Australian vessels that will aid in the understanding of colonial shipbuilding practices across Australia. This chapter will outline the methodological approaches used during archaeological fieldwork, historic archives and 3D documentation and recording of the vessel.

3.1 Historic and Archival Research

Archival records were sought to trace the origins of *Ram*bler. Research began at the National Trust branch in Victor Harbour, also known as the National Trust Museum, Victor Harbour South Australia, 5211. The museum holds an archive that assisted with research pertaining to the general history, local knowledge, and maritime industries of the region. The facility also holds a collection of artefacts and historic material related to *Rambler*. Artefacts included multiple ship fastenings, ballast, ship masts, and small fragments of timbers. Three metal fastenings were taken from the National Trust Museum for metal analyses.

Although some documents were provided for this research project, there is limited documentation on *Rambler*. No record of *Rambler* was found in Lloyds Ship Registry, or any local historic ship building registry within the Victor Harbour region. This may have been due to small coastal traders typically not being registered (Broxham 1996; Gillespie 1994; Graeme-Evans and Wilson 1996; Kerr 1974). Photographic and written records of *Rambler* were however found in Gifford Chapman *Wooden Fishing Boats* (1998), a publication from *The Island* (1995) and previous owners: Dave Jamieson. These sources combined confirmed the origin story of *Rambler*. Additionally, extensive archival research was conducted concerning the Rumbelow family. This allowed for an understanding of the fishing culture in Victor Harbour to be better understood as well as highlight the creation and importance that *Rambler* would have served during the nineteenth and into the twentieth century.

In addition to the archival research process, previous studies of Australian colonial-built vessels were also found to discuss the quality of materials and techniques used to construct these vessels. A study from Rick Bullers (2006), highlighted the quality of materials and ship construction methods of eleven colonial built vessels originating from New South Wales and Tasmania during the nineteenth century. Whilst previous research on shipbuilding practices in the colonies is extensive, research tends to focus on the quality of these techniques and materials. Additionally, due to the lack of South Australian built vessels and furthermore the lack of surviving South Australian built vessels, there is minimal archaeological evidence available in this colony's construction practices. Therefore, this research project will explore the materials and methods used to construct colonial built vessels in Australia, during the nineteenth century with specific focus on South Australian built vessels.

3.2 Archaeological Fieldwork

In September 2022, a small team of students and a variety of academics from Flinders University visited Victor Harbour for the first archaeological investigation of *Rambler*. This survey was a part of the Flinders University Maritime Archaeology Program (FUMAP) and a fieldwork component for a ship recording class (Figure 1). Initial surveying activities comprised of: visual surveying and recording, photogrammetry, drone mapping, and timber and metal collection for samplings at a later date. During this fieldwork a small collection of artefacts were taken from the site for sampling, of which were small ship fastenings that were used for metal analysis. The timber sampling was conducted by extracting small amounts of timber from a variety of locations across the vessel (Table 1), that would be used to establish a timber profile and wood identification of the vessel. The overall aim of fieldwork was to establish a clear and detailed recording and dataset of *Rambler* through the use of visual and digital recording methods.

Figure 1: FUMAP students conducting fieldwork at *Rambler*, September 2022 (Photographed by Wendy van Duivenvoorde).

3.2.1 Photogrammetry

Photogrammetry is a recording method in which photographs of a subject are taken from a variety of angles and orientations allowing for overlapping coverage to generate a three-dimensional model of the subject (McCarthy and Benjamin 2014:96). Photogrammetry was selected for this project as it allowed for a detailed recording of *Rambler* to be established, analysed, and interpreted. A total of 2264 photographs and videos were taken to create a digital model of *Rambler*. Photographs and videos were recorded using Olympus digital cameras and a Mavic 2 Pro drone. General overview photographs were also taken of artefacts, exposed interior and general site conditions. Close up photographs of significant features or artefacts were also taken using a scale card. Photogrammetry was conducted twice on this site. Initially it was conducted by Philippe Kermeen using the Mavic 2 Pro. Several datasets were created due to multiple missed sections that had not been correctly captured during the photogrammetry process. Once these datasets were combined the final model was successfully developed and depicted a more accurate model of *Rambler.* The days in which photography and photogrammetry were taken were overcast, allowing for minimal shadows in the images and videos. During one of the visits to *Rambler*, it was raining with occasional strong winds, this didn't affect the final dataset collected or the equipment used. 3D models were then created using Agisoft Metashape 2022 (Version 1.8.4), enabling an interactive and detailed model to be created of *Rambler* in its current state that would allow future researchers to reference (Figs 2-6.).

Figure 2: ***Rambler*** **(Oblique view) (portside) 3D model (Model by author).**

Figure 3: ***Rambler*** **(Oblique view) (starboard) 3D model (Model by author).**

Figure 4: *Rambler* (Oblique view) (stern) 3D model (Model by author).

Figure 5: *Rambler* (Oblique view) (stem) 3D model (Model by author).

Figure 6: *Rambler* (Plan- view) 3D model (Model by author).

3.2.2 Artefact Photography

In addition to the 3D modelling of *Rambler*, artefact recording by photography was conducted to record individual artefact characteristics that had been collected during fieldwork (see Figures 7-12.). A total of thirteen artefacts were collected, recorded, documented and photographed. The artefacts were divided into three material categories consisting of timber, metal, and corking (Figs. 7-12.). Of this collection, eight metal fastenings (Fig. 7.) were then taken from the collection, alongside one other fastening provided by the National Trust of Victor Harbour to undergo metal analysis. Results will be outlined in Chapter 4: Results.

Figure 7: Eight metal fastenings collected from *Rambler* during 2022 fieldwork.

Figure 8: Metal fastening collected from starboard side of *Rambler* during 2022 fieldwork.

Figure 9: Wooden trunnel collected from *Rambler* 2022 fieldwork.

Figure 10: Corking collected from starboard stem strake 13 from *Rambler* 2022 fieldwork.

Figure 11: Corking collected from starboard stem strake 15 from *Rambler* 2022 fieldwork.

Figure 12: Corking collected from starboard stem strake 14 from Rambler 2022 fieldwork.

3.2.3 Timber Sampling and Identification

Timber identification is an important method used to identify vessels, timber species, timber origins and in some instances the potential construction location. Wood sampling was conducted in November 2022 at the location of *Rambler* to confirm and identify the timber species used to construct this historic vessel. A collection of samples were taken using a small hand saw to remove a small portion of the timber profile. A total of twenty-five samples were taken from a variety of places across the vessel to build an extensive dataset (Table 1). The sample locations were determined by visual inspection with significant deterioration and damage able to be observed across various points on the vessel. Each strake on the portside of the bow was sampled as this area showed significantly less deterioration than that of the starboard. The starboard side of the stem is significantly more damaged due to livestock rubbing against this section of the vessel as a scratching post. As a result, this has caused the stem to detach from the vessel along with portions of the starboard strakes. Samples were stored in zip-lock bags to transport between the site and their analysis destination, detailed with the information pertaining to the location, collector and date taken.

Jugo Illic from ‘Know Your Wood’ laboratory conducted the timber identification on all twenty-five samples (Table 1). The timber identification process is conducted by examining the cross sections of the sample through microscopic analysis, this determines the species and potentially the origin of the tree in which the sample came from (Abe 2016:240). For the purpose of this research project, wood sampling has been conducted to ensure that the archival documents correlate with the physical material. In addition, micrographs were also provided allowing for other wood specialists to have access to the data collected from the 2022 samples (see Appendix 3 for *Rambler* timber sample micrographs). Documents provided by the National Trust stated that oregon and jarrah wood were used for the construction of *Rambler*. Neither of these wood species could have been sourced in South Australia, let alone Victor Harbour. Jarrah is sourced exclusively from Western Australia (south-west region) and oregon was an introduced species originating from eastern America, Mexico and British Columbia, but can be found in Victoria and New Zealand (Good Wood 2020). This highlights the likelihood that the timber used to construct *Rambler* was sourced from timber that had been either traded or exchanged amongst the colonies, a form of exchange that was not uncommon during this period. Nash (2003) discusses that during this time, Tasmania grew to service the ship building industry with their high quality timber and their shipbuilders exclusively (2003:83). If *Rambler* is constructed from jarrah and oregon timber material, it would confirm that it had been built from materials sourced or exchanged amongst the colonies before or during the nineteenth century. Moreover, if results indicate that the vessel was constructed from other timbers, this may suggest that certain timbers were selected specifically to construct the vessel and a certain level of quality was important to achieve. Results will be discussed in the following chapter alongside a discussion in Chapter Five

Table 1: Timber samples collected from Rambler.

Sample Number	Description	Details
0001	Planking	Planking strake 1 (garboard strake), portside bow. Sample from hood end of plank.
0002	Planking	Planking strake 2, portside bow. Sample from hood end of plank.
0003	Planking	Planking strake 3, portside bow. Sample from hood end of plank.
0004	Planking	Planking strake 4, portside bow. Sample from hood end of plank.
0005	Planking	Planking strake 5, portside bow. Sample from forward area of plank, top side.
0006	Planking	Planking strake 6, portside bow. Sample from hood end of plank.
0007	Planking	Planking strake 7, portside bow. Sample from hood end of plank.
0008	Planking	Planking strake 8, portside bow. Sample from hood end of plank.
0009	Planking	Planking strake 9, portside bow. Sample from hood end of plank.
0010	Planking	Planking strake 10, portside bow. Sample from hood end of plank.
0011	Planking	Planking strake 11, portside bow. Sample from hood

		end of plank.
0012	Planking	Planking strake 12, portside bow. Sample from hood end of plank.
0013	Planking	Planking strake 13, portside bow. Sample from hood end of plank.
0014	Planking	Planking strake 14, portside bow. Sample from hood end of plank.
0015	Planking	Planking strake 15, portside bow. Sample from hood end of plank.
0016	Planking	Planking strake 16, portside bow. Sample from hood end of plank.
0017	Stem timber	Stem, lower stem timber, starboard side on top
0018	Keel	Keel, front end
0019	Stem timber	Stem, top stem timber (fallen off bow), samples from starboard rabbet
0020	Rib	Rib, portside bow, foremost frame timber
0021	Planking	Planking strake 10, starboard stern transom. Sample from aftermost hood end of plank.
0022	Stern timber	Sternpost, portside
0023	Stern timber	Sternpost, rudder area
0024	Stringer	Stringer, portside, bow, foremost hood end.
0025	Rib	Rib, starboard bow, foremost frame timber

3.2.4 Scanning Electronic Microscope Analysis

Metal samples were taken from a total of nine artefacts, eight of which were collected during the September 2022 and one that was provided on the behalf of the National Trust (Table 2). The samples consisted of ship fastenings, fittings, and sheathing tacks that were collected and then stored in zip-lock bags and labelled with date, location and collector. Artefacts were then photographed and categorised before sampling. Sampling was conducted by Wendy van Duivenvoorde. The composition of these samples were analysed using Scanning Electronic Microscope (SEM) and element chemical analysis and a report was produced by van Duivenvoorde (2023) discussing the results.

Table 2: Metal samples of *Rambler*.

Sample Number	Registration	Description
1	National Trust Museum, Victor Harbour	Fastening, head
2	002	Fastening, head, starboard side
3	003	Small staple
4	003	Small staple
5	Loose finds	Screw head, starboard side, on ground near ship
6	Loose finds	Sheathing tack head, starboard side, on ground near ship
7	Loose finds	Sheathing tack shaft, starboard side, on ground near ship
8	Loose finds	Sheathing tack shaft, starboard side, on ground near ship
9	Loose finds	Sheathing tack shaft, starboard side, on ground near ship

Sample preparation for all artefacts consisted of embedding a small fragment of each sample in phenolic hot mounting resin (brand: Struers MultiFast). The resin was then added and set in a Struers CitoPress-10 hot mounting machine (Fig. 13.). The mounted samples were then polished using Struers TegraPol-11 diamond polisher to get clean, uncorroded surfaces for analysis (Fig. 14.).

Scanning Electronic Microscope (SEM) is a non-destructive method used to identify elements in the sample (Zapor 2020:29). Knowing the metal composition that may be present in the artefact prior to analysis, this may provide data on the manufacturing time period or technique once further analysed. SEM is comprised of three major sections: the electron column, the specimen chamber and the computer/electron controls (Ul-Hamid 2018:4). Electrons beamed from an electron gun are focused into a small diameter probe by electromagnetic lenses located in the electron column (Ul-Hamid 2018:4). This beam is then swept across the sample where the electrons in the beam penetrate a few microns into the surface (Ul-Hamid 2018:4). ‘This then allows the electrons to interact with the samples atoms and generate signals of backscattered electrons and characteristic x-rays that are then collected and processed to obtain images and chemistry of the specimen surface’ (Ul-Hamid 2018:4). The following report produced by van Duivenvoorde will discuss the results and analysis of metal samples taken from *Rambler.*

Figure 14: Struers CitoPress-10 hot mounting press (Wendy van Duivenvoorde, Flinders University, 2020).

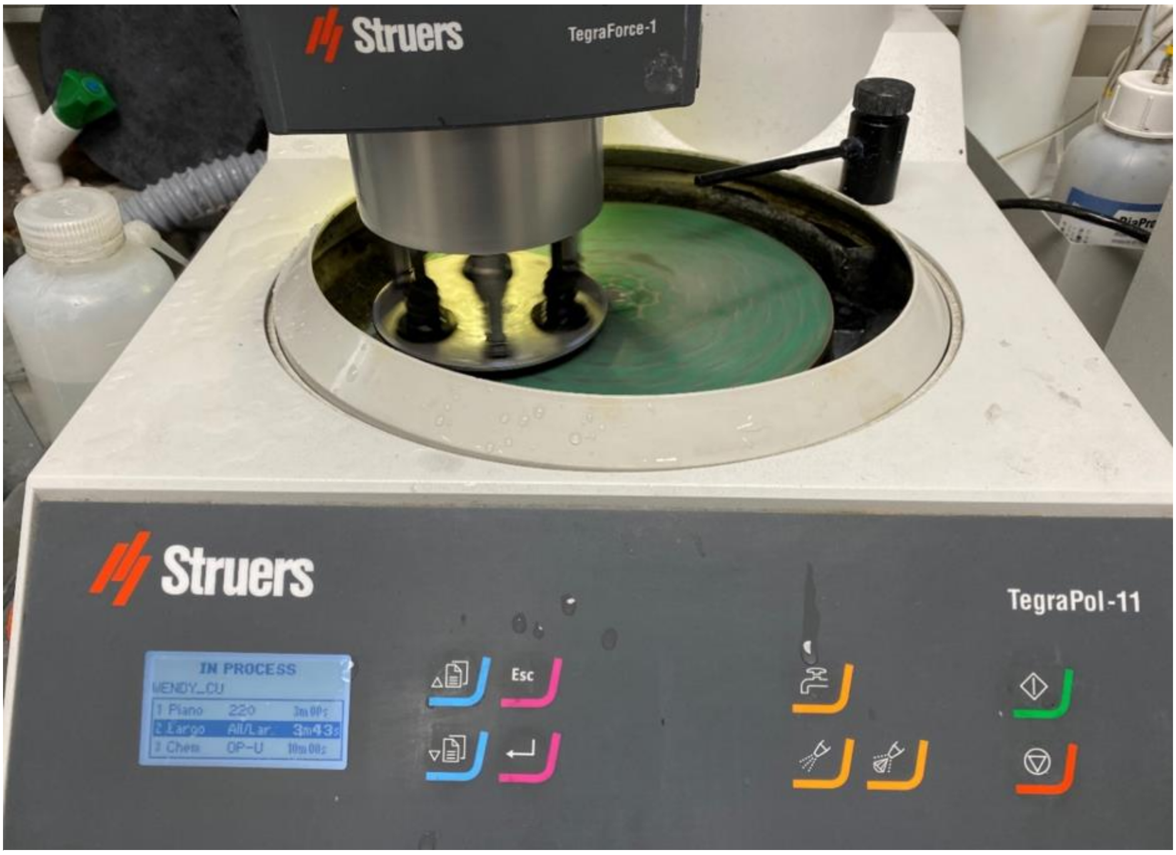

Figure 13: Struers TegraPol-11 polisher (Wendy van Duivenvoorde, Flinders University, 2020).

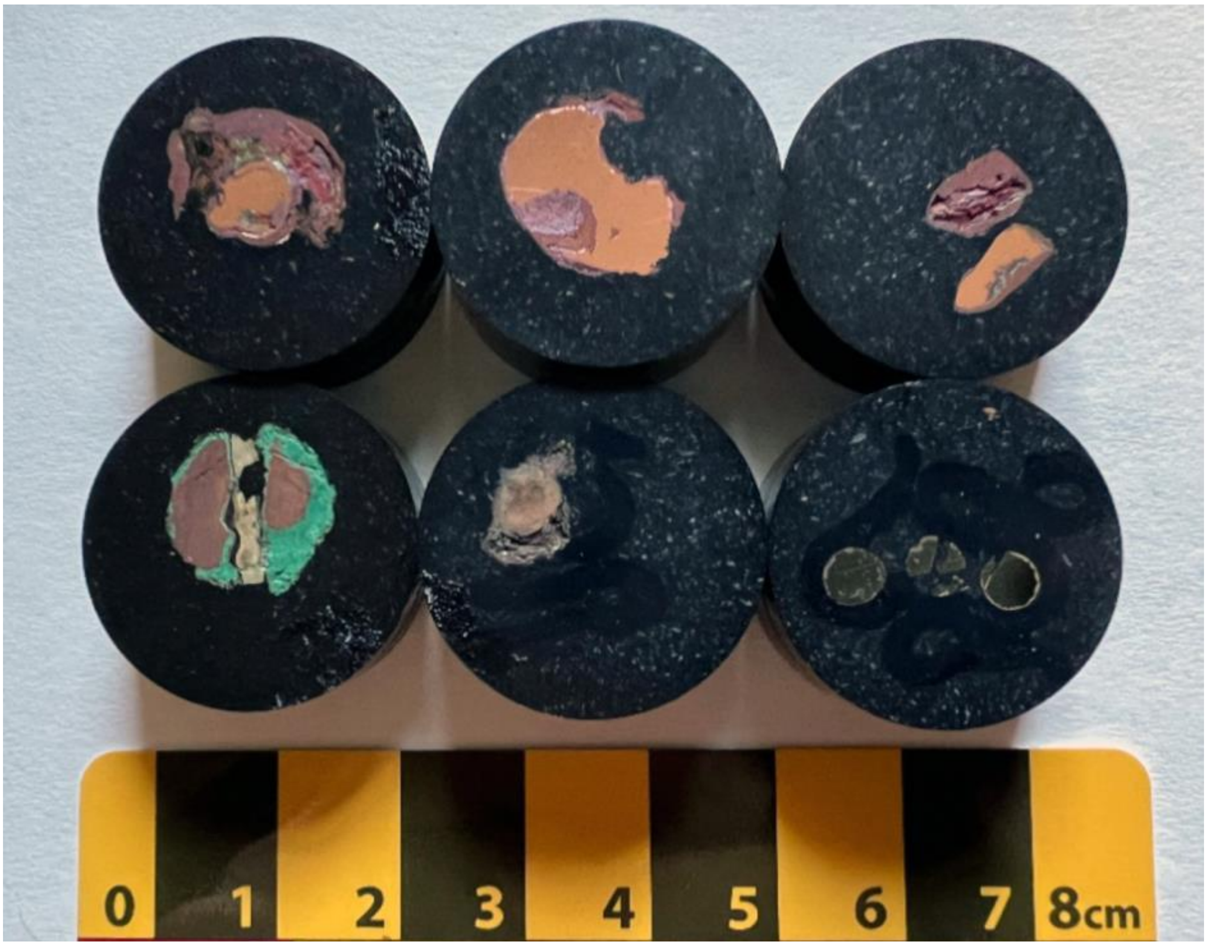

Figure 15: Samples embedded in resin after polishing. From left to right on top: Samples number 1, 2 and 3-4; bottom: Samples number 5, 6 and 7-9 (Wendy van Duivenvoorde, Flinders University, 2023)*.*

Figure 15 displays the metal samples from *Rambler* that were analysed at Adelaide Microscopy, South Australia, using a FEI Quanta 450 FEG Environmental Scanning Electron Microscope (ESEM) (Fig. 16.) (van Duivenvoorde 2023:4). The FEI Quanta 450 is a High-Resolution Field Emission Scanning Electron and is used to image and analyse surface topography, collect backscattered electron images and characterise and determine a sample's elemental composition through x-ray detection with an SDD EDS detector (van Duivenvoorde 2023:4).

Figure 16: FEI Quanta 450 FEG Environmental Scanning Electron Microscope, Adelaide Microscopy, University of Adelaide (Wendy van Duivenvoorde, Flinders University, 2020).

The FEI Quanta 450 with SDD EDS detector allows for a semi-quantitative analytical method of elemental composition by area or spot (van Duivenvoorde 2023:4). The areas chosen for elemental determination are those that display solid metal and are free of obvious surface corrosion or unevenness (van Duivenvoorde 2023:4).

The following SEM settings were used during data acquisition: High-Vacuum, Kilovoltage: kV 20, Element Normalized, SEC table: default, standardless. The time per sample analysis was automated (van Duivenvoorde 2023:4).

For all samples, carbon (C) was deliberately omitted from the automated results as carbon is a known corrosion product that can occur as isolated inclusions in the actual metal a few millimetres below the surface (pers. comm. Animesh Bashak, Adelaide Microscopy) (van Duivenvoorde 2023:4). It is however known from nineteenth century records that charcoal was sometimes added purposely to copper (Bennett 2021:293–294). For the purpose of this study carbon is simply omitted to focus primarily on the metal composition and ratio of metals in alloys (van Duivenvoorde 2023:4).

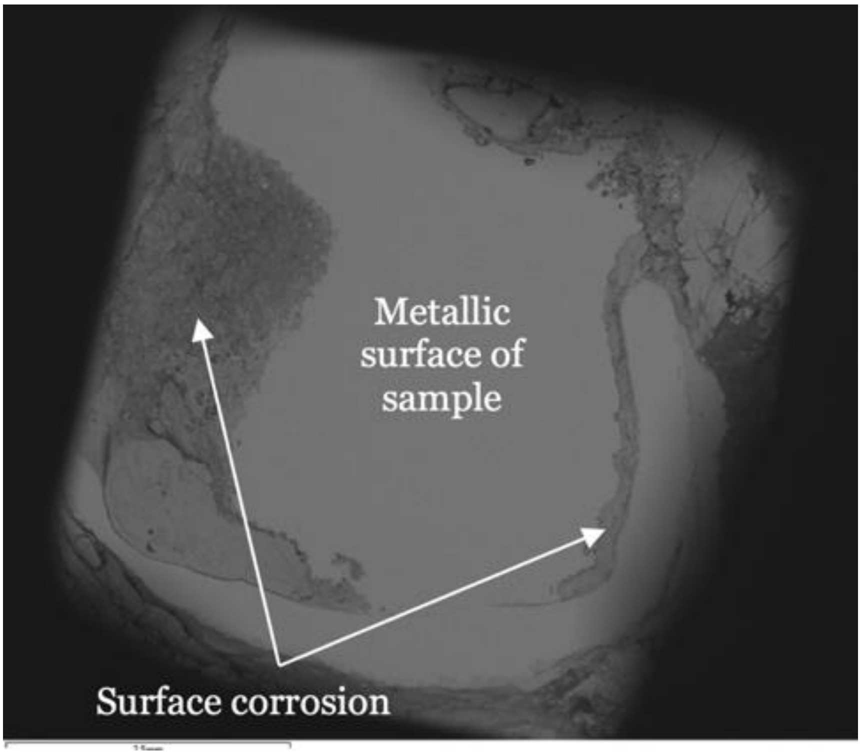

Figure 17: Cross section of Rambler fastener. Sample number 1, showing surface corrosion on the edges and metallic surface in centre of the mounted sample. The black area around the sample is the resin of the mount in which it is embedded (Micrograph by Wendy van Duivenvoorde, Flinders University, 2022)*.*

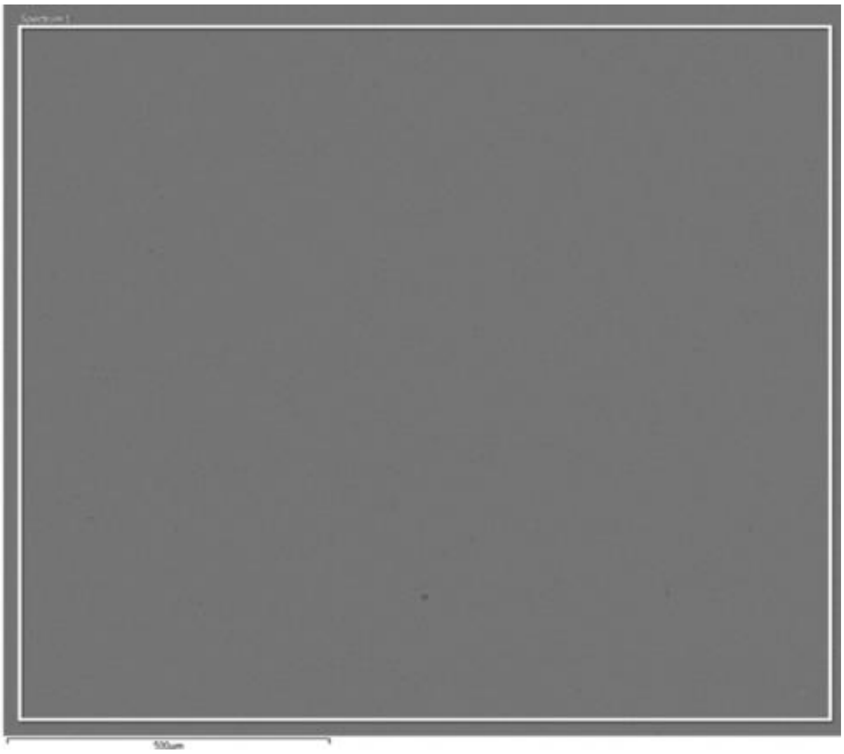

Figure 18: Testing area in the metallic surface of Sample number 1 (Micrograph by Wendy van Duivenvoorde, Flinders University, 2022)*.*

3.3 Conclusion

Without any previous archaeological data from *Rambler*, the fieldwork primarily focused on surveying and recording the current state of the vessel. Photography and photogrammetry, sampling of timber, and metal were all methods that were utilised for this research project. Additionally, will aid in the digital reconstruction of *Rambler*, and provide a foundational understanding of the vessel structure and construction method. Secondary sources such as newspaper articles, historic photographs, and archival resources provided a cross reference for an additional understanding of the period and the vessel. The following chapter will discuss the results obtained from the timber and metal sampling and identification.

CHAPTER FOUR: RESULTS

4.0 Introduction

This chapter presents the collected data from the archaeological fieldwork, historical records, and archives. The archaeological fieldwork will be discussed in three sections, site survey, timber species identification, and metal sampling analysis. The first section will discuss the site visits conducted in 2022, discussing the archaeological survey of the site and the condition of the vessel alongside historical records. The following section will discuss the timber species identification and the process. The last section will discuss the chemical analysis of the metal samples, conducted by Wendy van Duivenvoorde.

4.1 Historic Record and Site Survey

Historic records provided by the National Trust branch in Victor Harbour, show that *Rambler* was constructed in 1875 in Birkenhead, South Australia (Simmons 2016). Records note that Peter Sharp built the vessel using a combination of jarrah and oregon timber. The first owner of *Rambler* was Malin Rumbelow (1878), who had a noteworthy influence over the maritime culture of Victor Harbour. Following Rumbelow, a list of other private owners were noted with the most recent being John McLoughlan (1990s) before being donated to the National Trust on behalf of current living relatives of the Rumbelow family (Horn 2023). Due to the lack of historical records, details surrounding *Rambler*'s working life and restorations were unable to be confirmed.

Based on site inspections conducted in 2022, majority of the vessel remains intact. The vessel being widely exposed lent itself to a detailed analysis, focusing on the deterioration and damage, and was recorded thoroughly to observe any modern additions to the vessel. Considerable damage can be identified at the bow that over time has gradually led to the exposure of the inner planking of the hull. On the deck, the vessel has partial coverage at the bow leading to two small bunkers below. However, due to the exposed interior of the vessel rubbish and debris from the surrounding dumping ground has accumulated in the hull. The keel remains intact with copper tacks and sheeting still partially attached, metal samples were taken from this. Large portions of the hull show wooden plugs used to fill the holes from previous tacks that would have secured copper sheeting to the hull. Sheathing tacks and fastenings are still identified across the vessel in some places, such as the keel, yet, there were none observed on the hull.

Photogrammetry use has been a significant component of this fieldwork project. The purpose of creating a 3D model of *Rambler* is to enable a digital copy of the vessel to be rendered for the purpose of open access for any potential future researchers. Elemental exposure of the vessel and damage caused by livestock has resulted in a significant portion of the present damage.

4.2 Timber Species Identification

Shipbuilding historically, uses a variety of soft and hardwood timbers for different purposes. Materials that are highly sort after in ship construction include; durability, strength, flexibility, and grain (Steffy 1994:256–259). A total of twenty-five timber samples were taken and sent to Jugo Illic of 'Know Your Wood' laboratory for species identification. Table 3 outlines each sample, description and date taken. Table 4 outlines the species identified by Jugo Illic. Appendix 2 present the species identification report by Jugo Illic.

The timbers that were sampled, were treated with caution due to the condition and because of the limited contextual information available surrounding the construction material of *Rambler*. Each sample was chosen to develop a detailed dataset that would become available for future researchers. In doing so, the author chose to sample each strake on the port side bow, as it showed significantly less deterioration than the starboard. In addition, a variety of other timbers across the vessel's hull were sampled and can be seen in Table 3. Each timber was then assessed for their diagnostic features. These features would be used to identify the species of wood, which would then be compared along the historic archives detailing *Rambler*'s construction materials. Archival records were provided by the National Trust of Victor Harbour. The archival records stated that a combination of jarrah and oregon timbers were used to construct *Rambler.* No record of the materials used for the restoration in the 1990s could be found.

Table 3: Wood samples collected from *Rambler*.

Sample Number	Timber Description	Details	Date
0001	Planking	Planking strake 1 (garboard strake), portside bow. Sample from hood end of plank.	19.12.2022
0002	Planking	Planking strake 2, portside bow. Sample from hood end of plank.	19.12.2022
0003	Planking	Planking strake 3, portside bow. Sample from hood end of plank.	19.12.2022
0004	Planking	Planking strake 4, portside bow. Sample from hood end of plank.	19.12.2022
0005	Planking	Planking strake 5, portside bow. Sample from forward area of plank, top side.	19.12.2022
0006	Planking	Planking strake 6, portside bow. Sample from hood end of plank.	19.12.2022
0007	Planking	Planking strake 7, portside bow. Sample from hood end of plank.	19.12.2022
0008	Planking	Planking strake 8, portside bow. Sample from hood end of plank.	19.12.2022

0009	Planking	Planking strake 9, portside bow. Sample from hood end of plank.	19.12.2022
0010	Planking	Planking strake 10, portside bow. Sample from hood end of plank.	19.12.2022
0011	Planking	Planking strake 11, portside bow. Sample from hood end of plank.	19.12.2022
0012	Planking	Planking strake 12, portside bow. Sample from hood end of plank.	19.12.2022
0013	Planking	Planking strake 13, portside bow. Sample from hood end of plank.	19.12.2022
0014	Planking	Planking strake 14, portside bow. Sample from hood end of plank.	19.12.2022
0015	Planking	Planking strake 15, portside bow. Sample from hood end of plank.	19.12.2022
0016	Planking	Planking strake 16, portside bow. Sample from hood end of plank.	19.12.2022
0017	Stem timber	Stem, lower stem timber, starboard side on top	19.12.2022

0018	Keel	Keel, bow	19.12.2022
0019	Stem timber	Stem, top stem timber (fallen off bow), samples from starboard rabbet	19.12.2022
0020	Rib	Rib, portside bow, foremost frame timber	19.12.2022
0021	Planking	Planking strake 10, starboard stern transom. Sample from aftermost hood end of plank.	19.12.2022
0022	Stern timber	Sternpost, portside	19.12.2022
0023	Stern timber	Sternpost, rudder area	19.12.2022
0024	Stringer	Stringer, portside, bow, foremost hood end.	19.12.2022
0025	Rib	Rib, starboard bow, foremost frame timber	19.12.2022

Table 4: Timber species identified by Jugo Illic (January 2nd 2023).

Sample Number	Timber Description	Scientific Name	Common Name
0001	Planking	*Eucalyptus marginata*	Jarrah
0002	Planking	*Eucalyptus marginata*	Jarrah
0003	Planking	*Eucalyptus marginate*	Jarrah
0004	Planking	*Eucalyptus marginate*	Jarrah
0005	Planking	*Eucalyptus marginate*	Jarrah
0006	Planking	*Eucalyptus marginate*	Jarrah
0007	Planking	*Eucalyptus marginata*	Jarrah
0007χ	Transverse plug	*Pseudotsuga menziesii*	Douglas Fir
0008	Planking	*Eucalyptus marginata*	Jarrah
0009	Planking	*Eucalyptus marginata*	Jarrah
0010	Planking	*Agathis* sp.	Kauri
0011	Planking	*Agathis* sp.	Kauri
0012	Planking	*Agathis* sp.	Kauri
0013	Planking	*Agathis* sp.	Kauri
0014	Planking	*Agathis* sp.	Kauri
0015	Planking	*Agathis* sp.	Kauri
0016	Planking	*Agathis* sp.	Kauri
0017	Stem timber	*Eucalyptus camaldulensis*[1]	Red Gum
0018	Keel	*Eucalyptus marginata*	Jarrah

[1] River red gum and forest red gum have similar structure and cannot be separated through wood anatomy from this material.

0019	Stem timber	*Pinus sylvestris*	Baltic Pine
0020	Rib (frame)	*Ulmus* sp.	Elm
0021	Planking	*Agathis* sp.	Kauri
0022	Stern timber	*Eucalyptus camaldulensis*[2]	Red Gum
0023	Stern timber	*Eucalyptus camaldulensis*	Red Gum
0024	Stringer	*Eucalyptus* sp.	Stringybark or Blackbutt
0025	Rib (frame)	*Ulmus* sp. *(thomasi*[3]*)*	Rock Elm

[2] The species of Eucalyptus is difficult to determine form the small-sized and weathered material. Material appears to be red gum.
[3] Other species in the rock elm have the same wood structure, originally from North America.

4.3 Metal Analysis

Metal analysis using SEM was undertaken on nine ship fastenings. The results from the SEM analysis show the estimated breakdown of elements identified in each sample, represented as a percentage in Table 5 and Table 6. These tables display the elemental compositions of samples taken from fastenings collected. Results show that each sample was identified as pure copper. Appendix 1 present the metal SEM report by Wendy van Duivenvoorde along with cross section images of each sample.

Table 5: Elemental composition of the samples from fastenings taken from *Rambler's* hull (Group 1). Automated collection (W. van Duivenvoorde, Flinders University, 2023).

	Wt%			**Atomic%**	
Description	**Cu**	**Total**		**Cu**	**Total**
Sample 1: spectrum 1	100.00	100		100.00	100
Sample 2: spectrum 1	100.00	100		100.00	100
Sample 3: spectrum 1	100.00	100		100.00	100
Sample 4: spectrum 2	100.00	100		100.00	100
Sample 5: spectrum 1	100.00	100		100.00	100
Sample 6: spectrum 1	100.00	100		100.00	100

Table 6: Elemental composition of the samples from fastenings from *Rambler*'s hull (Group 2). Automated collection (W. van Duivenvoorde, Flinders University, 2023).

	Wt%							**Atomic%**					
Description	**Fe**	**Cu**	**Zn**	**Sn**	**Pb**	**Total**		**Fe**	**Cu**	**Zn**	**Sn**	**Pb**	**Total**
Sample 7: spectrum 1	0.76	73.02	21.81	2.78	1.62	100		0.89	75.22	21.84	1.54	0.51	100
Sample 8: spectrum 1	0.61	72.92	22.24	2.86	1.36	100		0.72	75.03	22.24	1.58	0.43	100
Sample 9: spectrum 1	0.81	76.53	18.71	2.44	1.51	100		0.95	78.56	18.67	1.34	0.47	100

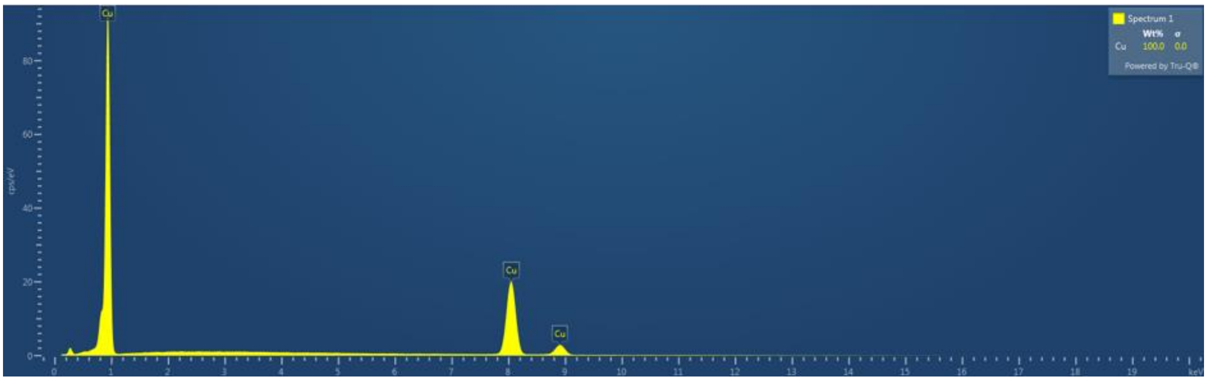

Figure 19: SEM spectrum results from *Rambler* fastening Sample 1 (Illustrated by Wendy van Duivenvoorde).

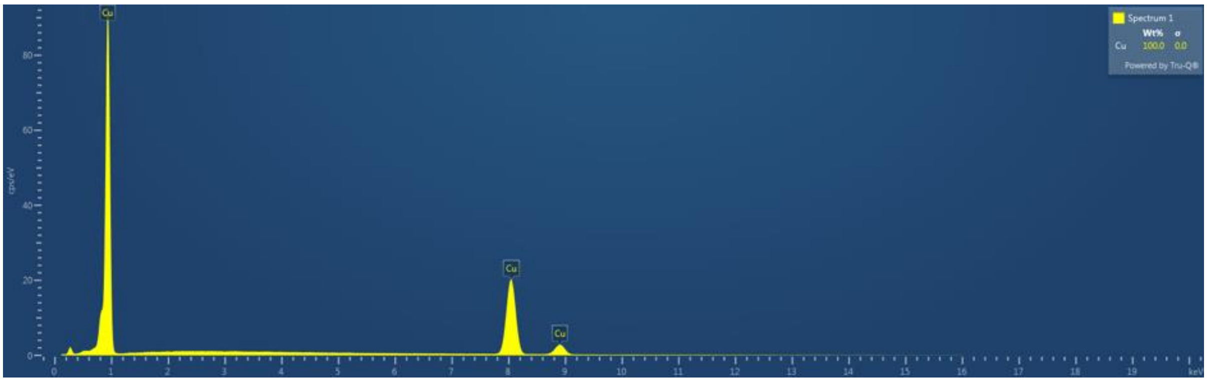

Figure 20: SEM spectrum results from *Rambler* staple Sample 2 (Illustrated by Wendy van Duivenvoorde).

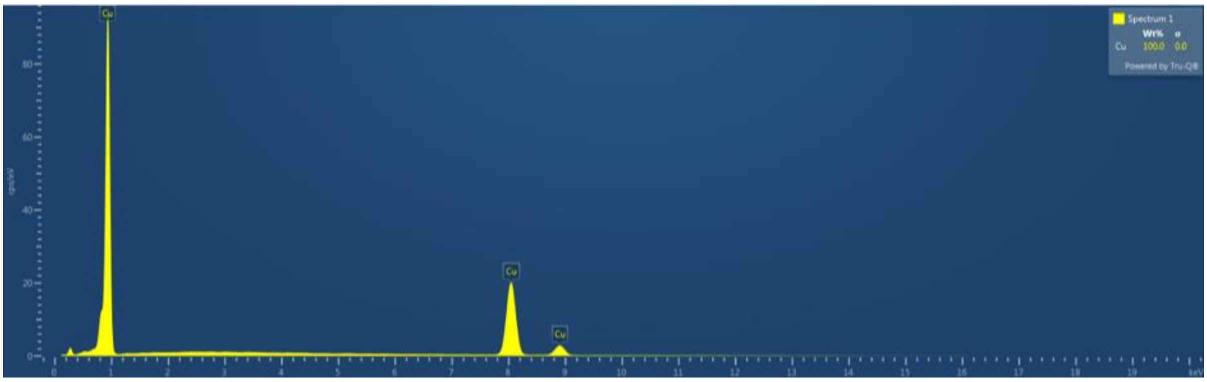

Figure 21: SEM spectrum results from *Rambler* staple Sample 3 (Illustrated by Wendy van Duivenvoorde).

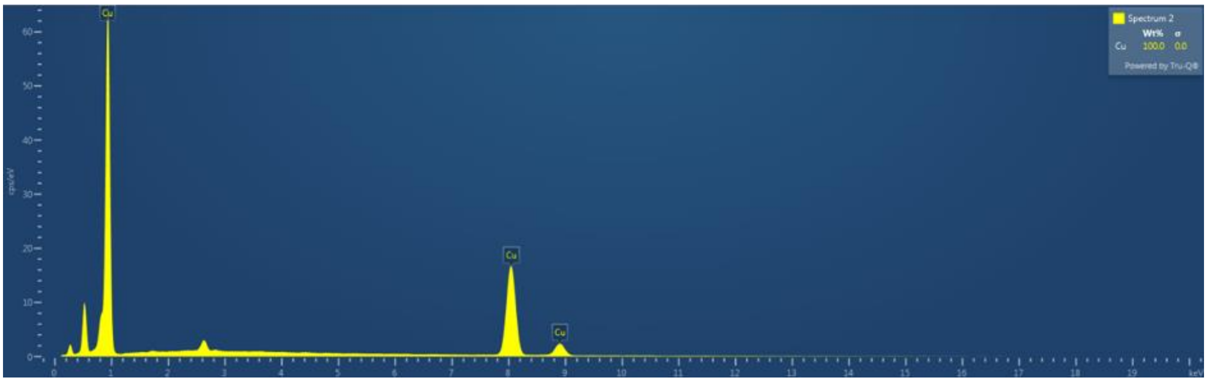

Figure 22: SEM spectrum results from *Rambler* screwhead Sample 4 (Illustrated by Wendy van Duivenvoorde).

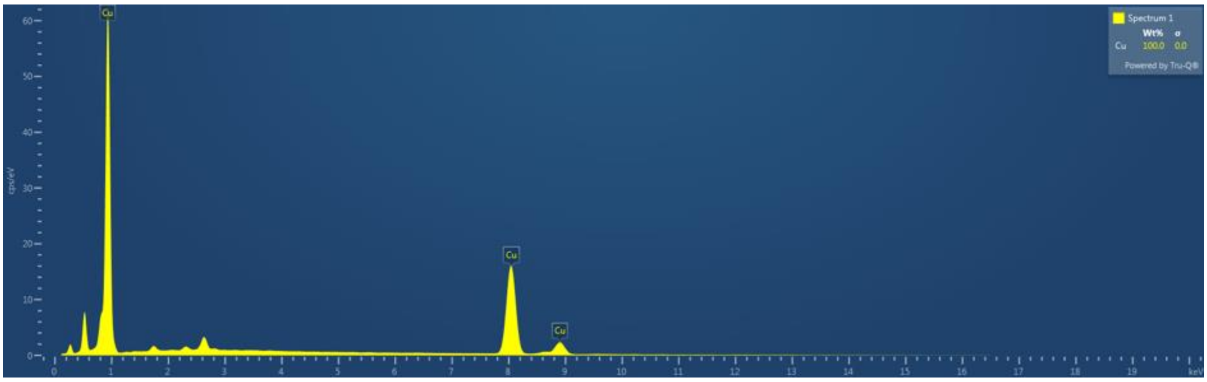

Figure 23: SEM spectrum results from *Rambler* sheathing tack Sample 5 (Illustrated by Wendy van Duivenvoorde).

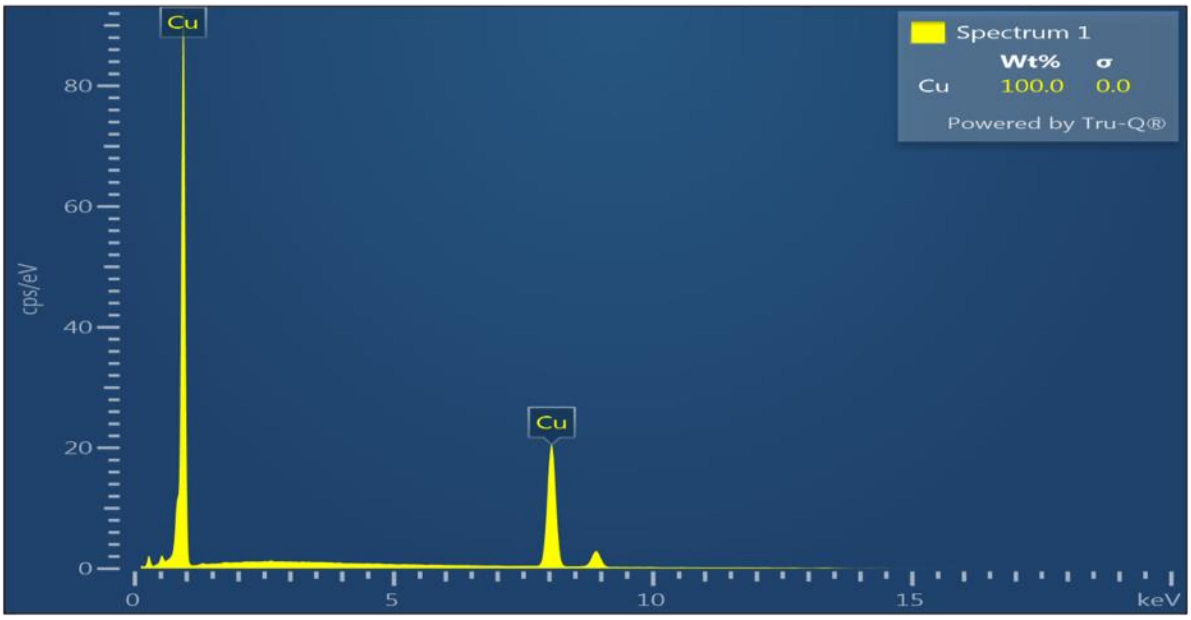

Figure 24: SEM spectrum results from *Rambler* sheathing tack Sample 6 (Illustrated by Wendy van Duivenvoorde)

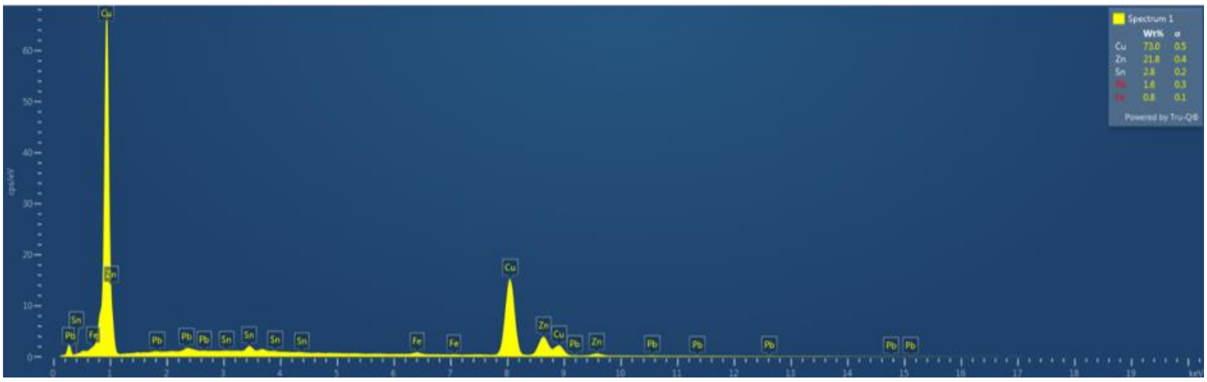

Figure 25: SEM spectrum results from *Rambler* sheathing tack Sample 7 (Illustrated by Wendy van Duivenvoorde).

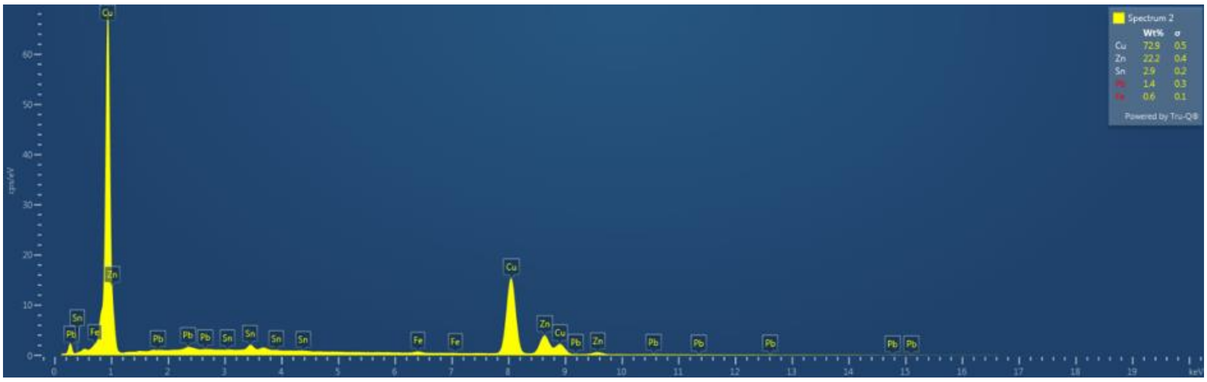

Figure 26: SEM spectrum results from *Rambler* sheathing tack Sample 8 (Illustrated by Wendy van Duivenvoorde).

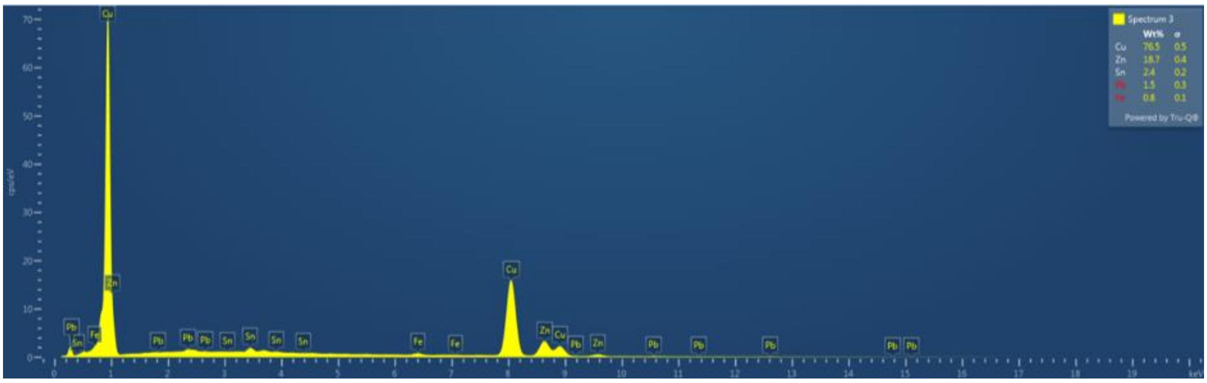

Figure 27: SEM spectrum results from *Rambler* sheathing tack Sample 9 (Illustrated by Wendy van Duivenvoorde).

The SEM results displayed in Figures 19-27 show the estimated breakdown of identified elements by percentage for each ship fastening sample. The preparation of each sample discussed in the previous chapter, allows for the most accurate identification of composition, eliminating surface corrosion (van Duivenvoorde 2023).

4.4 Conclusion

The timber species identification combined with the metal analysis offer details about the materials used to construct *Rambler*. This data along with historical records and archives has allowed for a more thorough and detailed investigation into the shipbuilding practices and materials used for *Rambler*. Additionally, this data cross referenced with comparative Australian built vessels will allow for a contextual understanding of early colonial ship construction in South Australia. The following chapter will discuss in detail these results along with the 15 comparative vessels and contextualise *Rambler* in the colonial shipbuilding narrative.

CHAPTER FIVE: DISCUSSION

5.0 Introduction

Using *Rambler* as a case study, different methods of scientific and archaeological investigation were applied in attempt to understand this vessel. Historical archival research, timber species identification and metal analysis were all used in combination to understand the material selection, and cultural influences that contributed to the construction of *Rambler*. In addition, 15 comparative vessels will be discussed in correlation to *Rambler*, to contextualise this vessel in Australian colonial ship construction. These comparative vessels allow for similarities and differences in *Rambler*'s data to be addressed and together identify the change of in colonial ship construction and technologies during the nineteenth century.

This chapter will begin by firstly discussing the data collected during the 2022 archaeological fieldwork, along with the results gathered from the sampled materials. Following this, comparative case studies will then be discussed using the datasets from the 2022 fieldwork. Combined, this analysis contributes to the understanding of colonial built vessels and the transfer of knowledge and technology during the cultural adaption process.

5.1 Timber Species Identification

In the case of *Rambler*, majority of the vessel remained intact but showed significant signs of deterioration and elemental exposure. It was determined that timber identification would aid in the understanding of colonial ship construction as the identification of timber species would support the theory of locally sourced materials for colonial built vessels. Since the location of *Rambler*'s construction is known, timber species identification along with metal analysis would provide valuable data that reinforces the historical significance of this vessel. A total of twenty-five samples were taken across the entire vessel that would then be examined by Jugo Illic from Know Your Wood. See Table 3 and 4 in the previous chapter for timber description, location, scientific name and common name.

Timber species identification was conducted for two purposes. The first purpose was to confirm the wood species used to construct *Rambler* and whether or not this aligns with the historic archives. The second purpose was to use the timber species identification to compare *Rambler*'s materials to that of other colonial built vessels in the nineteenth century as well as offer an accessible and extensive dataset for future analysis.

Timbers sampled returned primarily a mix of species identified as jarrah (*Eucalyptus marginata*) kauri (*Agathis* sp.) and red gum (*Eucalyptus camaldulensis*). These woods are native Australian species however, none would have been sourced from South Australia. South Australia has virtually no natural timbers suitable for ship construction so often vessels built in this state relied heavily on the import or trading of materials from other states like Western Australia and New South Wales (O'Reilly 1999). Jarrah is a species that exclusively grows in the south-west region of Western Australia therefore supporting this theory of materials being traded or imported for the construction of *Rambler*. Kauri, is a common timber that has been identified in colonial built vessels but is a species that is found in New Zealand (Lake 2019:115). Additionally, the historic records detailing *Rambler*'s construction materials stated that oregon was used, this was not supported by the species identification results. However, it is possible that oregon was believed to be used to construct *Rambler* as oregon was used in instances when New Zealand kauri became too expensive (Kerr 1974:55). Lastly, red gum is a species that is typically found in Victoria, New South Wales and Queensland, again supporting the theory that these timbers were specifically sourced because of their characteristics and high quality to build *Rambler*. It should also be noted that this sample (sample number 17) could not be distinguished from river red gum or forest red gum due these species having similar structures and could not be separated from this sample. Micrographs of each sample have been included in Appendix 3 to allow other timber species specialists access to the data collected from the 2022 fieldwork.

Other species that were identified were baltic pine (*Pinus sylvestris*), stringybark or blackbutt (*Eucalyptus* sp.), rock elm (*Ulmus* sp. *(thomasi)*), douglas fir (*Pseudotsuga menziesii*) and elm (*Ulmus* sp). It should be noted that none of these samples identified made up the planking of the vessel. Baltic pine was identified from sample number 19 taken from the stem indicating that this timber may have been chosen for its strength as it a hard wood. In addition, timbers such as elm and rock elm being identified in the samples taken from the framing of the vessel, suggest that again a hard wood was chosen to reinforce the structure of *Rambler*. Timbers such as douglas fir and stringyback or blackbutt are commonly used for structural applications because of their hard wood characteristics. The sample that was identified as stringybark or blackbutt was sample number 24 and was taken from the stringer, again highlighting the need for a structurally strong and hard timber. Douglas fir was identified in the transverse plug sample number. 7x.

Australian timbers were a critical resource for colonial built vessels during the nineteenth century. It was intended that by conducting timber analysis, *Rambler* would provide a unique insight into nineteenth century timber ship construction as well as the resources sought out to build it. The results collected from the timber species identification highlight that native Australian timbers were sourced for the majority of the vessel however, unique species such as Baltic pine, were also incorporated in the construction of *Rambler* and were perhaps sourced exclusively for their characteristics and quality, thus reinforcing the historical and cultural significance of this vessel. To further support the conclusions drawn from timber species identification, metal analysis was conducted from samples taken from ship fastenings and sheathing.

5.2 Metal Analysis

Historically shipwrights have tried various methods to protect wooden hulls of ships (Bingeman et al. 2000:218–220). These methods have included sacrificial planking, antifouling compounds, filing nails and metal sheathing (lead, copper and mixed metals) (Bingeman et al. 2000:218–220). Sacrificial planking has been identified in VOC or Dutch East India Company ships from the seventeenth and eighteenth centuries (van Duivenvoorde 2012:241). This methods was used to create a teredo worm (*Teredo navalis*) repellent iron-oxide layer (van Duivenvoorde 2015:1). For almost two centuries this method was widely used by European shipbuilders to protect their vessels against marine-borers until the introduction of copper sheathing (van Duivenvoorde 2012:241).

The use of copper sheathing is a technique that appears in Europe in the eighteenth century but has also reported to have appeared on early seventeenth century Chinese vessels (Bingeman et al. 2000:220; Kemp 1976:777; McCarthy 2005:102). Copper sheathing became a popularised technique that allowed the hull of the vessel to be protected from marine growth such as ship worms (*Teredo navalis*) but also provided a strategic advantage of achieving greater speed and manoeuvrability (McCarthy 2005:107; Rodgers 1993:296). In addition, it became more ideal for sheathing ships as it oxidised enough to deter marine growth but it corroded more slowly than copper so it would last longer (McCarthy 2005:116).

Pure copper sheathing was used until 1832 when George Fredrick Muntz developed what was referred to as yellow metal, a 60 percent copper and 40 percent zinc alloy, also known as Muntz metal (Flick 1975:74). There are multiple reasons for why this metal mixture became superior; the two primary reasons being its affordability and durability.

By knowing the composition of the metal used to construct a vessel, archaeologists can distinguish a general time period that the sheathing was created; pre or post 1832. In the case of *Rambler*, a total of nine samples were taken from the ship fastenings and sheathing and results revealed each sample was pure copper. As displayed in the previous chapter, results from the semi-quantitative metal analysis using SEM, concluded each sample presented a high percentage of copper (minimum percentage identified was 72.4% indicated in sample 8). Furthermore, analysis of metal sampling conducted on other colonial built vessels is limited. Whilst examples of copper sheathing have been identified in some of the selected comparative examples, few have undergone semi-quantitative metal analysis.

Copper sheets were identified on Barangaroo Boat along the portside garboard shelf board and was held in place with sheathing tacks (van Duivenvoorde 2022:194). Similarly, *Rambler* was also at one point copper sheathed however, no remains of this sheathing was identified during the fieldwork component and therefore could not be sampled. It is suspected that the copper sheathing that would have covered *Rambler* would have also been pure copper with small trace elements of other metals similar to the sheathing tacks identified during the metal analysis.

However, whilst Barangaroo Boat was identified as mostly being fastened with iron nails and spikes, no examples survived well enough to document (Coroneos et al. 2022:194). Whilst no examples survived it could be established through the holes that remain that ferrous nails were square shanked 5-7 mm at the throat and tapered down on four sides to a point (van Duivenvoorde 2022:194). In addition to iron nails and spikes being identified, various copper alloy nails were recovered from the vessel during the conservation and cleaning phase (van Duivenvoorde 2022:194). The composition of the copper alloy nails and sheathing from the rider keel were both analysed. The samples tested had no solid matter remaining and mainly consisted of corrosion products, though it was still possible to obtain results (van Duivenvoorde 2022:194). Two tacks were examined, and results comprised of 80.14 – 85.58% copper, up to 4.55% zinc, 14.30% tin and 3.04 – 4.7% lead (van Duivenvoorde 2022:194). These results in comparisons to *Rambler*, indicate that while small traces of other elements can be identified the majority of these results indicated a high percentage of copper.

In addition, SEM analysis was also undertaken on *Heroine* to further aid in the investigation of confirming the vessels identity. Fragments of copper alloy remained on the exterior surface of hull planking along with nail holes in areas where sheathing was no longer present (van Duivenvoorde et al. 2023). Nine samples underwent semi-quantitative analysis to determine their elemental composition. The analysis was conducted on seven sheathing samples and two fastenings and identified copper and zinc (van Duivenvoorde et al. 2023).

The sheathing samples analysed returned all similar spectrum results, however the fastenings differed (van Duivenvoorde et al. 2023). The sheathing sampled identified a composition of approximately 62-63% copper, 37-38% zinc. (van Duivenvoorde et al. 2023). Copper and zinc were the main elements identified along with arsenic (As), silver (Au), bismuth (Bi), iron (Fe), lead (Pb), nickel (Ni), antimony (Sb), and tin (Sn) were added manually to all the spectra, as they are known trace elements in copper (van Duivenvoorde et al. 2023). However, these elements were all identified in low amounts therefore they cannot be anything besides trace elements (van Duivenvoorde et al. 2023).

The concentration of copper and zinc is slightly higher in the tacks sampled opposed to the sheathing, making the tacks a harder metal (van Duivenvoorde et al. 2023). This is expected as fastenings are expected to be stronger than the sheathing they hold in place (van Duivenvoorde et al. 2023). This was also identified in the fastenings sampled for *Rambler*. However, there due to no copper sheathing identified on the hull of the vessel a comparative analysis could not be conducted.

No other comparative vessels conducted metal analysis or did not have their results published. Due to the lack of comparative studies focusing on metal analysis, comparative results are limited. However, results collected from Barangaroo Boat, *Heroine* and *Rambler* suggest that high percentages of copper were still being used during nineteenth century in Australia right until the latter half of the century.

5.3 Comparative Studies

In this section a total of 15, nineteenth century colonial built vessels will be discussed in comparison to *Rambler*. The aim of this is to highlight the similarities and differences in construction techniques and materials to in-turn identify the changes of in colonial ship construction and technologies during the nineteenth century. The vessels that will be discussed include:

1. The cutter *Water Witch*, built in Tasmania 1835, lost in South Australia 1842 (Jeffrey 1987, 1992).
2. The schooner *Clarence*, built in NSW 1841, lost in Victoria 1850 (Harvey 1989).
3. The schooner *Robert Burns*, built in Tasmania 1857, lost in South Australia 1908 (O'Reilly 1999).
4. The ketch *Adonis*, built in Tasmania 1864, lost in South Australia 1962 (O'Reilly 1999).
5. The schooner *Dorothy S*, built in Victoria 1868, abandoned in South Australia 1935 (O'Reilly 1999).
6. The ketch *Annie Watt*, built in Tasmania 1870, stored in South Australia 1970 (O'Reilly 1999).
7. The schooner *Dianella*, built in Tasmania 1872, lost in South Australia 1909 (O'Reilly 1999).
8. The ketch *Alert*, built in Tasmania 1872, broken up South Australia 1959 (O'Reilly 1999).

9. The ketch *Thomas and Annie*, built in Tasmania 1874, abandoned in South Australia 1945 (O'Reilly 1999).
10. The schooner *Lady Daly*, built in Victoria 1876, lost in South Australia 1926 (O'Reilly 1999).
11. The schooner *Alert*, built in NSW 1846, lost in Tasmania 1854 (Nash 2004).
12. The ketch *Three Sisters*, built in Tasmania 1874, wrecked in South Australia 1899 (Jacobs and Myers 2022; van Duivenvoorde et al. 2023; van Duivenvoorde and Polzer 2023).
13. The schooner *Barbara*, built in Tasmania (1840s), wrecked in 1852 in Victoria (Burgees 2020; van Duivenvoorde et al. 2021; van Duivenvoorde et al. 2022)
14. The clinker UDHB1 otherwise known as Barangaroo Boat, built most likely in NSW in the 1800s, wrecked as early as the 1830s in NSW (Coroneos et al. 2022)
15. The schooner *Heroine*, built in New South Wales, 1894, wrecked in the Gold Coast, Queensland in 1897(van Duivenvoorde et al. 2023).

Water Witch (1835)

Water Witch was a cutter constructed by John Gray in Hobart Town, Tasmania 1835 (Bullers 2006:11). *Water Witch* was the seventh of eight vessels built by Gray between 1825 and 1840 in his shipyard (Bullers 2006:11). It was a clinker built, cutter rigged vessel measuring 35 feet 6 inches in length (10.85 m), 13 feet 6.5 inches in breadth (4.1 m) and had a 6 feet 7 inch depth (2.04 m), endowing it with a carrying capacity of 25 tons (Bullers 2006:11). By 1841, the vessel had developed a 'leaky condition', as a result of lack of maintenance (Bullers 2006:11). *Water Witch* was then transferred to Moorundie on the River Murray where she lay idle. The *Water Witch* sank at its moorings at Moorundie on 5 December 1842 (Jeffery 1987:20).

O'Reilly (1999:19) theorised that the use of clinker style construction may have led to the development of the leak thus resulting in *Water Witch* sinking, as it was a relatively new technique employed by early Australian shipbuilders (Bullers 2006:12). However, this technique was not unfamiliar to British shipwright, a more likely explanation would be the

Clarence (1841)

Clarence was a 67 ton schooner built in Williams River, New South Wales in 1841 (Bullers 2006:12). During its working life it was primarily used on inter-colonial trading routes between Sydney, the Manning River, Hobart and Port Albert until it ran aground at Coles Channel, Port Phillip Bay in September 1850 (Bullers 2006:12). Efforts to afloat it were all unsuccessful (Bullers 2006:12).

Harvey (1989) conducted a multi-phase survey of the wreck including excavation (Bullers 2006:12). Harvey identified that *Clarence* was not constructed with its original plans but in fact had been modified due to the difficulty of working with hard wood timbers (Bullers 2006:12). Timbers used in *Clarence*'s construction were locally sourced in its colony of construction (Bullers 2006:12). The quality of *Clarence*'s construction also suggests it was built at the lowest possible cost (Bullers 2006:12).

Robert Burns (1857)

Robert Burns was built in 1857 by Alexander Bruce Smith at Long Bay, Hobart Tasmania (Bullers 2006:12). Originally built as a schooner the vessel measured 54.3 feet in length (16.55 m), 17 feet breadth (5.18 m) and 6.7 feet depth (2.04 m) but was later enlarged to 66 feet length (20.11 m) (Bullers 2006:12). *Robert Burns* was a square-sterned, carvel built, with a billet head and standing bow spirit (Bullers 2006:12). The square stern was later modified to a round stern and O'Reilly (1999) theorises was used to structurally support the length of the hull (O'Reilly 1999).

Robert Burns was primarily used for Tasmanian coastal trading and was later transferred to South Australia in 1897 (Bullers 2006:12). It later ran aground in Kangaroo Island in December 1908 (Bullers 2006:12). A survey showed it was double framed, with narrow spaces and large scantlings for a vessel of its size (Bullers 2006:12). No timber samples were taken.

Adonis (1864)

Adonis was built in Franklin River, Tasmania in 1864 by Robert Daniel Cuthburt (Bullers 2006:12). The vessel was a square stern carvel built measuring 65.5 feet length (19.96 m), 19.3 feet breadth (5.88 m) and 5.7 feet depth (1.73 m) (Bullers 2006:12). *Adonis* was transferred to South Australia in 1866 and operated in the Gulf trade for many years until it capsized and sank off Outer Harbour, Port Adelaide (Bullers 2006:13).

Adonis was known as one of the fastest ketches of its time in South Australia (Bullers 2006:13). The quality of Adonis' construction is inconclusive. It is not known whether Adonis was double framed, or what frame spacings it had (Bullers 2006:13). No timber samples were taken during the survey, leaving the timber species used for its construction unknown.

Dorothy S (1868)

Dorothy S was a schooner built in 1868 Sandridge, Victoria by Henery A. Wernecke (Bullers 2006:13). It was a square stern, carvel-built vessel that measured 72.7 feet in width (22.15 m), 19.6 feet in breadth (5.9 m) and it had a 7.4 feet depth (2.25 m) (Bullers 2006:13). *Dorothy S* was employed as a Victorian interstate coastal trader until 1922 when it was then transferred to South Australia where it was later that year broken up and used as a hulk at Penrice (Bullers 2006:13). The size of the scantlings, particularly the frames suggest that Dorothy S was very heavily constructed for a vessel of its size (Bullers 2006:13). O'Reilly (1999) notes that the vessel was double-framed and that the frame spacings were narrow, though she did not give spacing measurements. Timber samples were taken from several scantlings and revealed that *Dorothy S* was built using endemic Victorian timbers (Bullers 2006:13).

Annie Watt (1870)

Annie Watt was a ketch constructed in 1870 by John Wilson in his shipyard in Port Cygnet, Tasmania (Bullers 2006:13). It was a double framed, square stern, carvel-built vessel measuring 63.7 feet in length (19.41 m) and 18 feet in breadth (5.4 m), and it had a 5.4 feet depth (1.64 m) (Bullers 2006:13). After launching at Port Cygnet, *Annie Watt* was employed in the 'Mosquito Fleet' and had a century long working life (Bullers 2006:13). By 1970 it was purchased by the South Australian Ketch Preservation Society and was removed from the water (Bullers 2006:13). Since its removal from the water its timbers have deteriorated significantly (Bullers 2006:13).

Dianella (1872)

Dianella is a schooner built in Recherche Bay, Tasmania by Thomas Williams in 1872 (Bullers 2006:14). It was square-sterned and carvel-built, measuring 90 feet in length (27.43 m), 19.2 feet in breadth (5.85 m) and 8.1 feet in draft (2.46 m) (Bullers 2006:14).

Dianella was then transferred to Victoria in 1873 and then to South Australia in 1877 (Bullers 2006:14). The vessel serviced the coastal trade in South Australian until it sprang a leak, grounded and broke up in Moonta Bay, South Australia, in 1909 (Bullers 2006:14). Little remains of the wreck, and the quality of its construction is inconclusive. In addition, only a few timber samples were taken across the entire vessel with only the outer planking could be identified to species level (Bullers 2006:14).

Alert (1872)

Alert was a ketch built in Battery Point, Hobart, Tasmania by James and David Mackay in 1872 (Bullers 2006: 14). It was carvel-built and had a round-stern, totaling 65.6 feet in length (19.99 m) 17.9 feet in breadth (5.45 m) and a 6.6 feet depth (2.01 m) (Bullers 2006: 14). It was later extended to a total length of 70.0 feet in length (21.3 m) 18 feet in breadth (5.48 m) with a 6.2 feet depth of hold (1.88 m) in 1898 (Bullers 2006:14). *Alert* later arrived in South Australian waters in 1873 and traded around the gulf ports until it was beached and condemned in 1959 (Bullers 2006:14).

Alert was a double-framed, and relatively lightly constructed (Bullers 2006:14). Timber samples were collected, showing that a variety of species were used in the construction (Bullers 2006:14). Majority of timber identified were from mainland species not available in Tasmania (Bullers 2006:14). The treenails were identified as blackwood (*Acacia melanoxylon*), the only species identified in the survey that grows in Tasmania, although the sternpost may have been Tasmanian blue gum (*Eucalyptus globulus*) (Bullers 2006:14).

Thomas and Annie (1874)

Thomas and Annie was a ketch built at Port Cygnet, Tasmania by Colin Walker, in 1874 (Bullers 2006:14). The vessel was carvel-built, double framed vessel and had square-stern, measuring 52.8 feet in length (16.09 m), 16.1 feet in breadth (4.90 m) and 4.8 feet depth (1.46 m) (Bullers 2006:14).

Thomas and Annie was employed around southern ports of Tasmania until it was later transferred to South Australia in 1876 (Bullers 2006:14). It then became a regular gulf trader until it was abandoned in the North Arm of Port River, South Australia, between 1933 and 1945 (Bullers 2006:14). The timbers used in the construction were largely species that were available in Tasmania during the time the vessel was built (Bullers 2006:15).

Lady Daly (1876)

Lady Daly was built by the White Brothers at Williamstown, Victoria, in 1876 (Bullers 2006:15). It was carvel-built, double framed and had a round-stern and measured 90.8 feet in length (27.67 m), 19.6 feet in width (5.97 m) and 6.3 feet deep (1.92 m) (Bullers 2006:15). *Lady Daly* traded the ports of South Australia gulf until it was dismantled in 1926, then hulked and scuttled in the North Arm of Port River in 1929 (Bullers 2006:15).

Little remains of the vessel today due to extensive salvaging (Bullers 2006:15). Timbers were all available species grown endemically in Victoria (Bullers 2006:15). The floors are the only exception being made of native teak (*Flindersia australis*), a rainforest species only found in northern NSW and southern Queensland (Bullers 2006:15).

Alert (1846)

Alert was a schooner built in 1846 by William Brown at the Bellinger River, New South Wales (Bullers 2006:15). It was square-sterned, carvel-built, measuring 67.7 feet in length (20.63 m), 19.2 feet in breadth (5.85 m), and 8.2 feet deep (2.49 m) (Bullers 2006:15). *Alert* was employed in the Hobart to Victoria interstate trade until 1854 when it was driven ashore (Bullers 2006:15).

In 2003, following a heavy storm, Mike Nash conducted a survey of the exposed remains of *Alert* (Nash 2004a). The survey conclude that *Alert* was a well-built vessel with relatively large scantlings using strong locally-sourced timbers and suitable fasteners (Bullers 2006:15). Timber samples were taken from several scantlings and revealed that *Alert* was built from timbers locally available (Bullers 2006:15).

Three Sisters (1874)

Three Sisters was constructed in 1874 by Thomas Horne, in Hobart Town, Tasmania (Jacobs and Myers 2022:12; van Duivenvoorde et al. 2023; van Duivenvoorde and Polzer 2023). It was a ketch that when completed measured a total of 48.8 feet in length (14.9 m). *Three Sisters* served moving grain from Lipson Cove to Kangaroo Island, South Australia until its wrecking in in May 1899 when heavy winds forced a collision with Lipson Cove Jetty (Jacobs and Myers 2022:12; van Duivenvoorde et al. 2023; van Duivenvoorde and Polzer 2023). An attempt to refloat the vessel was made but ultimately was unsuccessful therefore leaving it to remain empty and abandoned (Jacobs and Myers 2022:12; van Duivenvoorde et al. 2023; van Duivenvoorde and Polzer 2023). Wood sampling was conducted and was taken from the keelson and stern timbers however, results have not been published. *Three Sisters* was studied as a part of the Flinders University Maritime Archaeology Program in conjunction with Heritage South Australia and Tumby Bay National Trust Museum. A report is in preparation however, was unavailable for this study.

Barbara (1840s)

Barbra was a 16.26 tonne schooner with 2 masts reaching a total length of 39.3 feet (11.99 m) and was built along the Tamar River, Tasmania by Joseph Hind (Burgees 2020; van Duivenvoorde et al. 2021; van Duivenvoorde et al. 2022). The construction of *Barbara* is estimated to be within the

1840s. *Barbara* was a coastal trader used for the lime trade within Port Phillip Bay, Victoria up until its loss in August 1852. It is reported that its anchor dragged along the seafloor in a northern gale until finally reaching White Cliffs (Rye). No wood species identification data has been published however, species of jarrah, tea tree and eucalypti are believed to be used for the construction of planking and frames (Burgees 2020; van Duivenvoorde et al. 2021; van Duivenvoorde et al. 2022). *Barbara* was studied as a part of the Flinders University Maritime Archaeology Program in conjunction with Heritage Victoria. A report is in preparation however, was unavailable for this study.

Barangaroo Boat UDBH1 (estimated early 1800s)

Barangaroo Boat was a 28-30ft (8.53 m - 9.14 m) clinker boat, built from local timbers (Coroneos et al. 2022). It was most likely constructed in the early 1800s and estimated to be abandoned as early as the 1830s (Coroneos et al. 2022). The vessel was identified laying on its starboard site with a cut sandstone block underneath its port keel, suggesting it was likely brought to this location and beached (Coroneos et al. 2022). Timber sampling was conducted on a variety of structural components of the remaining vessel and results were published.

*Heroin*e (1894)

Heroine was a schooner built in Coolangatta New South Wales, in 1894 (Sydney Morning Herald 1847; Australian Register of British Shipping for Port of Sydney 1844, 1894; Lloyd's Register of Shipping 1896). It was used up until it was transporting a cargo of coal for the Colonial Sugar Company when it was blown ashore on the beaches north of Point Danger (Smith 1980; Carling-Rodgers 1981; Dwyer 1984; Noffke 2008:1,5, 2009:7; Potts 2014). Whereby it broke apart on the shore and became disarticulated. Once the vessel became exposed in 1974, Gold Coast City Council removed exposed timbers which subsequently lead to sections being used in sculptures, memorials and trophies exhibited around the city (van Duivenvoorde et al. 2023). The dispersed remains of Heroine were assessed in three locations: Gold Coast City Council depot, Gold Coast and Hinterland Historical Society, and Queen Elizabeth Park. A total of 14 timber samples were collected and were used to aid in determining the identity of the vessel, alongside nine metal samplings. Timber species identified included blackbutt (*Eucalyptus pilularis*), tallowwood (*E. microcorys*), grey ironbark (*E. paniculate*), Sydney blue gum (*E.salinga*), and red ironbark (*E.fibrosa*).

Below is a table displaying each structural component that has been sampled across the 15 comparative vessels (Table 7). This table includes what feature was sampled, scientific and common names of wood species, origin of wood and what vessel each sample is related to. As mentioned above, samples were not obtained in the comparative examples of; *Robert Burns* or *Adonis* and therefore are not displayed in the table below. Additionally, wood species identification has not been published for; *Three Sisters* or *Barbara* and therefore has not been included in the table below.

Despite these comparative examples not having their results published, they have been included for the purpose of highlighting comparisons in colonial built vessels structure and construction techniques. These vessels serve as direct comparison to *Rambler* given the period and locations of their construction. Further research has the potential to relate these vessels and should highlight the comparative construction techniques and materials to better understand European colonial adaption to Australian materials.

Table 7: Comparative vessel timber species identification and correlating structural components

Structure	Timber Species	Common Name	Timber Origin	Vessel/s
Stem	*Acacia melanoxylon*	Blackwood	Tas, Vic, NSW, SA, Qld	Dorothy S
	Eucalyptus saligna	Sydney blue gum	NSW	Barangaroo Boat
Stern	*E. saligna*	Sydney blue gum	NSW, Sth Qld	Alert
	E. globulus	Tasmanian blue gum	Tas	
	E. botryoides	Southern mahogany	NSW, Vic	Barangaroo Boat
Sternson	*Corymbia maculata*	Spotted gum	NSW	Alert
				Barangaroo Boat
Keel	*E. camaldulensis*	River red gum	All mainland states	Water Witch
	E. saligna	Sydney blue gum	NSW, Qld	Alert
	E. grandis	Flooded gum/rose gum	NSW, Qld	
	E. punctate	Grey gum	NSW	Barangaroo Boat
Keelson	*E. siderophloia*	Ironbark	Nth NSW, Qld	Water Witch
	E. regnans	Giant gum	Tas, Vic, NSW	Dorothy S
Rider Keel	*E. punctate*	Grey gum	NSW	Barangaroo Boat

	E. baxteri	Stringybark	SA, Vic	
Cutwater	*A. melanoxylon*	Blackwood	Tas, Vic, NSW, SA, Qld	Dorothy S
Apron	*A. melanoxylon*	Blackwood	Tas, Vic, NSW, SA, Qld	Dorothy S
Framing	*E. regnans* *E. resinfera* *E. saligna* *Melaleuca* spp. *A. melanoxylon* *E. saligna* *E. grandis* *Corymbia maculate* *Banksia integrifolia* *E. punctate* *E. baxteri* *E. botryoides*	Giant gum Red mahogany Sydney blue gum Tea tree Blackwood (wattle) Sydney blue gum Flooded gum/rose gum Spotted gum Banksia Grey gum Stringybark Southern mahogany	Tas, Vic, NSW NSW, Qld NSW Tas, Vic, NSW, SA, Qld NSW, Qld NSW, Qld NSW NSW NSW SA, Vic NSW, Vic	Dorothy S Clarence Clarence Alert Thomas & Annie Alert Heroine Barangaroo Boat

	E. pilularis	Blackbutt	NSW, Qld	Heroine
	Corymbia gummifera	Red bloodwood	VIC, NSW, Qld	
Floors	*E. leucoxylon*	Yellow gum, SA gum	SA, Vic	Water Witch
	E. microcorys	Tallowwood	NSW, Qld	Water Witch
Structure	*Timber species*	Common name	Timber origin	Vessle/s
Floors	*E. baxteri*	Stringybark	SA, Vic	Water Witch
	E. camaldulensis	River red gum	All mainland states	Water Witch
	E. regnans	Giant gum	Tas, Vic, NSW	Alert, Dianella,
	Flindersia australis	Native Teak	Nth NSW, Sth Qld	Lady Daly
Outer Planking	*E. gobulus*	Tasmanian blue	Tas, NSW, Vic	Water Witch
	E. regnans	Giant gum	Tas, NSW, Vic	Thomas & Annie, Lady Daly Dianella
	E. eugenioides	White stringybark	Vic, NSW, Qld	Alert
	Melaleuca smithii	Broad-leaved tea tree	NSW	Dorothy S
	E. saligna	Sydney blue gum	NSW, Qld	Alert
	E. grandis	Flooded gum/rose gum	NSW, Qld	

	E. punctate *E. baxteri* *E. saligna* *E. pilularis* *E. microcorys*	Grey gum Stringybark Sydney blue gum Blackbutt Tallowwood	NSW SA, Vic NSW NSW, Qld NSW, Qld	Barangaroo Boat Heroine
Inner Planking	*Pinus sylvestris*	Baltic pine	Non-indigenous	Clarence
Wale	*E. paniculata*	Grey ironbark	NSW	Heroine
Caprail	*E. fibrosa*	Red ironbark	NSW, Qld	Heroine
Centreboard Casing	*E. rubida* *Acacia* spp.	Mountain gum Unknown	NSW, Vic, SA Unknown	Thomas & Annie, Lady Daly Alert
Deck Knee	*E. globulus*	Tasmanian blue gum	Tas	
Treenails	*A. melanoxylon*	Blackwood	Tas, Vic, NSW, SA, Qld	Thomas & Annie, Alert

The 15 comparative vessels date from the early 1800s (Barangaroo Boat) to 1894 (*Heroine*). These vessels have been chosen as they offer a range of structural variations, wood species variations, construction locations and initial purpose, and therefore will serve as a detailed overview for understanding colonial shipbuilding practise across Australia, whilst also contextualising *Rambler* within their datasets. This section aims to highlight the similarities and differences between these vessels and address the selection of wood species chosen to construct each individual structural component.

24 species of wood were identified across the 15 comparative vessels sampled (Table 7). Three of these species were also identified in *Rambler*'s dataset: blackbutt (*Eucalyptus pilularis*), Baltic pine (*Pinus sylvestris*), and red gum (*E. camaldulensis*) outline in Table 4. The primary species identified in the sampling conducted on *Rambler* were jarrah and kauri neither of which have been identified in the comparative vessels. Jarrah is a species that exclusively grows in the south-western region of Western Australia, therefore making it more difficult to resource as opposed to other species (Lake 2019:116). Each outer plank of the port side of the bow was sampled to identify at what point the species changed. This was due to historic archival records highlighting a combination of wood species being used during the construction of *Rambler* in 1875. Planking was a large component of timber sampling conducted across *Rambler* as there was limited access to the internal structural features.

As highlighted in the previous chapters, the selection of timber for ship construction was a methodical process, used to select particular species for certain components of a vessel's construction. In the case of *Rambler*, species of red gum, stringybark, elm and jarrah were selected for their strength and durability as structural features of the vessel. Similarly, other gum species (grey gum, spotted gum, Sydney blue gum, flooded gum, giant gum and yellow gum) were also identified in the comparative studies of: *Dorothy S, Clarence, Alert, Water Witch, Thomas & Annie, Alert,* Barangaroo Boat and *Heroine*. These species were typically found in Tasmania, New South Wales, Victoria, South Australia, and Queensland and would most likely have been locally if not regionally sourced materials for each of these vessels. Of these variations of gum trees identified in the comparative samples, only red gum was identified in *Rambler*'s dataset (stem and stern timbers) sample number 17, 22, and 23. This species of gum is present in all mainland states so would be readily accessible to shipwrights of the nineteenth century.

Shipwrights favoured using locally sourced timbers over imported timbers (Bullers 2006:17, Clayton 2012:55). This is supported by the origin of each species identified correlating with the state in which their correlating vessel was constructed.

This further supports the idea that particular wood species were chosen for certain features of the vessel. Additionally, if these timbers could not be locally sourced, the value of obtaining a particular wood species for the purpose of a particular structural component of the vessel would become more of value. By sourcing timbers that were not locally available, the trade of wood species for the purpose of colonial built vessels became an important national trade (Bullers 2006:20). In the case of *Rambler*, no species identified were locally sourced materials, thus reiterating the methodical selection of each species for the purpose of its construction.

5.4 Material Selection in Australian Colonial Shipbuilding

One form of cultural adaption that was applied to Australian coastal built vessels was the design and innovation techniques applied during the construction phase. In the early years of European settlement, traditional methods of shipbuilding played an important role in the design of colonial built vessels (Bullers 2006:20). It can then be seen that these designs followed similar styles in construction to that of those built in Britain (Bullers 2006:8). These traditional methods of shipbuilding however, quickly became unsuccessful when navigating the rugged Australian coastline, and thus, cultural adaption began.

Murphy 1983 highlights that vessels are a product of the technical abilities, materials, and use intent of the parent culture (Murphy 1983:71). Greenhill takes this further, describing ship development as being conditioned by the geography, local waters, climate, purpose, accessibility and availability of materials, traditions and the culture of the people building which are all factors that influence the construction during the ship building process (Greenhill 1976:25).

During the early years of European settlement, the vessels that would have been constructed would have been greatly influenced by the knowledge and techniques of European shipbuilding. Overtime, these techniques would have gradually been adapted to the materials available, maritime landscape and purpose of the vessel. Therefore, a distinct style of ship construction emerged to suit the local needs and conditions (O'Reilly 1999:35). Small coastal traders maintained the typical breadth and depth measurements but were lengthened considerably so that a vessel had a shallow depth in relation to its length (Bullers 2006:20). This same design was continued in ketches and schooners, primarily those vessels that would be servicing local, coastal trade between colonies (Bullers 2006:20). This is clearly displayed with the above examples, each of the previously described vessels served as a local, coastal trader to support the colony in some form.

Modification and refining of traditional methods of ship construction would have gradually taken place over the early years of colonial adaption (Bullers 2006:20). Access to new timbers along with different surrounding maritime environments would have been two significant contributing factors to the adaption and modification of traditional European shipbuilding techniques. Thus, it is through the analysis of early colonial shipbuilding and the materials used to construct such vessels that a detailed understanding of colonial shipbuilding in the nineteenth century can be more clearly understood.

5.5 Conclusion

This project represents the first archaeological dataset collected from *Rambler* and determined that initial investigation into the material remains was essential to understand and confirm the history of this vessel. The methods of timber species identification, metal analysis and artefact photography, provided evidence of the ship building techniques and methods of construction that were implemented. Furthermore, exploring archaeological theory of cultural transmission and colonial identity further reinforced the construction techniques and methods shown through the datasets collected and in-turn allowed for a thorough first investigation of South Australia's oldest fishing vessel. Using this data validates the historical archives and identity of this vessel and supports the hypothesis of locally sourced materials and knowledge were used to construct *Rambler*.

CHAPTER SIX: CONCLUSION

6.0 Conclusion

This thesis investigated *Rambler*, a nineteenth century, South Australian fishing vessel, to examine the similarities and differences between nineteenth century colonial built vessels across Australia. Structural features and materials were examined through the use of timber species identification and metal SEM analysis to understand the materials, techniques and methods of *Rambler*'s construction. This thesis set out to answer the research question:

How do the remains of the historic fishing vessel *Rambler* inform us about nineteenth century ship construction in South Australia? And, how do the techniques and materials found in *Rambler*'s construction compare to that of the vessels built in other Australian colonies?

The remains of *Rambler* were examined along with comparable data published on 15 other colonial built vessels. This allows for *Rambler*'s results to be contextualised amongst other colonial built vessels, highlighting similarities and differences in material analysis and structural features.

This chapter will outline the results of this study and then discuss the limitations of this project. Proposed areas of further research will be suggested to broaden the understanding of *Rambler* along with colonial shipbuilding practices in Australia.

6.1 Results

The timber planking that was sampled identified a variety of wood species were used to construct *Rambler*. Jarrah and kauri were the primary species used to construct the vessels exterior, whilst red gum, baltic pine, stringybark, elm and rock elm were all identified in the structural features sampled (Illic 2023). Whilst some of these species are native Australian timbers, none of these species would have been locally sourced. Therefore, it is likely that these species of timber selected were carefully curated. A single transverse plug was sampled and was identified as douglas fir, a species of wood that is readily available across Australia (Illic 2023). Noticeable wooden plugs were present across the bow of the vessel, that would have originally been where sheathing tacks where inserted into the exterior planking. No copper sheathing was present across the vessel; however, some did remain along the keel and was sampled.

Nine fastenings were taken for sampling. This was conducted alongside timber species identification to shed more light on the materials used to construct *Rambler* as well as observe any elemental differences between other colonial built vessels from this period. Given that *Rambler* was constructed towards the end of the nineteenth century it was crucial to identify whether pure copper or Muntz metals were used for its construction. Elemental analysis of the metal sampling conducted found similarities between materials used on *Rambler* and other comparative vessels used in this case study. Results concluded that the metals sampled showed presence of pure copper and copper-zinc-tin alloys (van Duivenvoorde 2023:11). Six samples were identified to be made of pure copper (96.09% to 99.48%) with only small trace elements of iron and lead suggesting that these elements were manually added (van Duivenvoorde 2023:11). Three sheathing tacks were also sampled and tested positive for Cu (copper), Zn (zinc), and Sn (tin). The weight percentages of the copper alloy used to manufacture the tacks vary from 72.92% to 76.53% copper, 18.71% to 22.24% for zinc, 2.44% to 2.86% tin, and 1.51% to 1.62% for lead and 0.61% to 0.81% iron (van Duivenvoorde 2023:11). The percentage of lead and iron are so low that these we most likely trace elements rather than purposely added metals to alloys (van Duivenvoorde 2023:11). These results indicate that a combination of pure copper and Muntz metals were used to construct *Rambler*.

These results allow for an initial understanding of *Rambler*'s construction materials alongside 15 other comparable vessels. *Rambler* contributes to the understanding of nineteenth century colonial built vessels across Australia. The case study of *Rambler* serves as a primary example of cultural transmission with European shipbuilding methods that have adapted to the Australian materials and the maritime landscape. It is important to continue further researching colonial building practices in Australia in relation to cultural transmission and colonial identity to further our understanding of shipbuilding practices during this period.

6.2 Limitations

Colonial ship comparisons were limited, with few examples having their results and data published and accessible. By not publishing the original results of their timber species identification this does not allow for other observations to be made by wood specialists without being able to access the micrographs. In addition, small sample sets were often conducted on these comparative studies which limits the broader analysis of the vessel. Furthermore, no comparisons could be made against another South Australian vessel. This created a lot of unconfirmed assumptions to be made about small coastal traders in South Australia by using comparative vessels from other colonies.

The scope of this research project was to establish an understanding of South Australian colonial ship construction. Aspects of *Rambler*s history were not further explored as this did not align with the overall scope of this thesis. Interviewing previous owners and individuals whom had a relationship with *Rambler* were not explored. This is an area that further research should be conducted.

6.3 Future Research

This historical research project revealed details surrounding *Rambler*'s origins and ship construction techniques used during nineteenth century colonial South Australia. Future archaeological and historical research should develop further investigation into the expanding this dataset for *Rambler* but additionally, for comparative vessels that will significantly benefit maritime archaeologists and researchers alike.

Further investigations surrounding the investigation of province for metal element would also be beneficial in understand where *Rambler* was constructed. As identified in this research project, the historic record does not always align with scientific data and this would be a key component in confirming *Rambler*'s construction. In doing so, this would allow for an understanding of where raw materials were sourced to benefit this vessels construction.

It is also recommended that additional detailed site surveys be conducted on *Rambler* to revisit and assess any changes. Additionally, conducting thorough site surveys will aid in further research of the structural components of the vessel. Due to its rapid deterioration this would be a key component in documenting the condition of the vessel but also the individual timbers and structural features to keep records that can be used for conservation. An accurate site record will also contribute to further site management and local conservation of this historic vessel.

Finally, this research project is the first to survey and record a South Australian colonial built vessel, combining the data collected and comparing it with 15 comparative colonial built vessels. With the data cross examined, further research can more broadly explore the materials used to construct these vessels, delving further into timber species selection and origins, metal element composition, construction techniques and methods, and the societies that created these vessels. This is would establish a significant and detailed understanding for colonial built vessels with European construction techniques with foreign materials and could explore influences of culture, and environment through the study of early colonial shipbuilding practices.

6.4 Conclusion

This thesis contributes to the understanding of nineteenth century colonial shipbuilding in South Australia. This research project explored colonial adaption and cultural transmission through ship design and construction of a South Australian fishing vessel, *Rambler*. Using a combination of research methods, this project successfully established the first surveying and recording of *Rambler*, establishing a dataset that can be further explored and expanded by future researchers. The study of *Rambler* serves as another link in the growing chain of understanding colonial built vessels across Australia.

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APPENDIX 1: METAL SEM REPORT

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REPORT ON THE RESULTS OF THE SEMI-QUANTITATIVE CHEMICAL ANALYSIS OF THE *RAMBLER* METAL SAMPLES
By Wendy van Duivenvoorde

Introduction

Nine samples from ships' fasteners and fittings, all collected from the 1870s South-Australian built ship *Rambler* (currently located in the Waitpinga tip, Encounter Bay) were analysed to determine their elemental composition (Table 1).

Table 1 Samples analysed for elemental composition, *Rambler*

Sample No.	Registration	Description
1	National Trust Museum, Victor Harbour	Fastener, head
2	002	Fastener, head, starboard side
3	003	Small staple
4	003	Small staple
5	Loose finds	Screw head, starboard side, on ground near ship
6	Loose finds	Sheathing tack head, starboard side, on ground near ship
7	Loose finds	Sheathing tack shaft, starboard side, on ground near ship
8	Loose finds	Sheathing tack shaft, starboard side, on ground near ship
9	Loose finds	Sheathing tack shaft, starboard side, on ground near ship

Sample preparation

Sample preparation for all fasteners included embedding a small fragment of each sample in phenolic hot mounting resin for general use (brand: Struers MultiFast). The resin was added and set in a Struers CitoPress-10 hot mounting machine (Fig. 1). The mounted samples were then polished using a Struers TegraPol-11 diamond polisher to get clean, uncorroded surfaces for analyses (Figs 2–3).

inspiring achievement

Fig. 1. Struers CitoPress-10 hot mounting press (W. van Duivenvoorde, Flinders University, 2020).

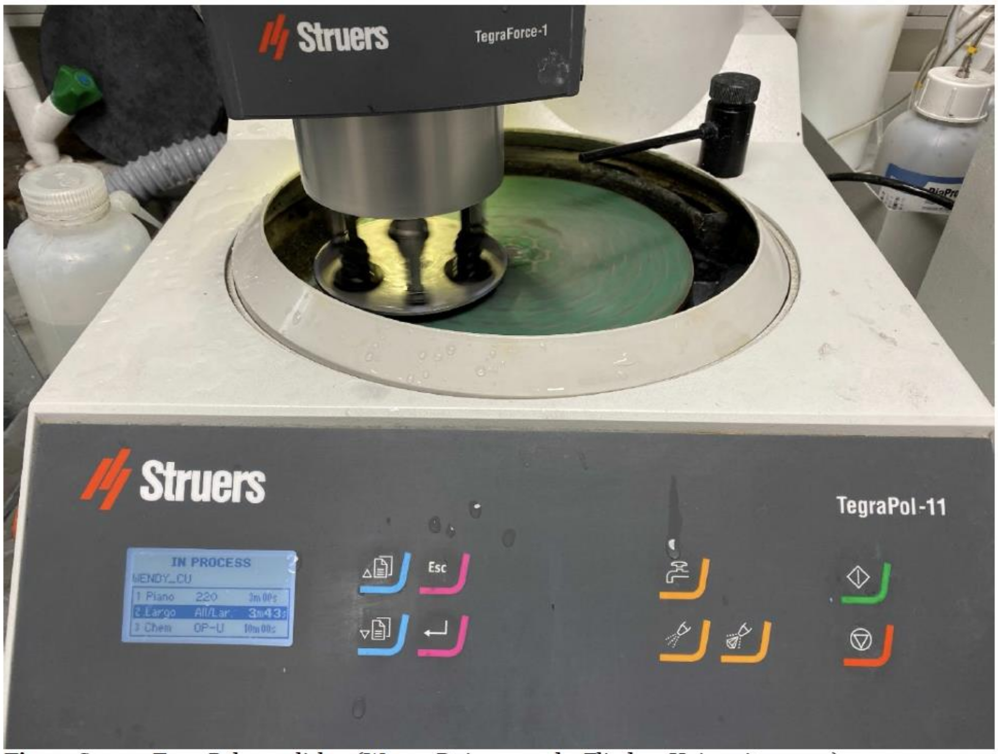

Fig. 2. Struers TegraPol-11 polisher (W. van Duivenvoorde, Flinders University, 2020).

2

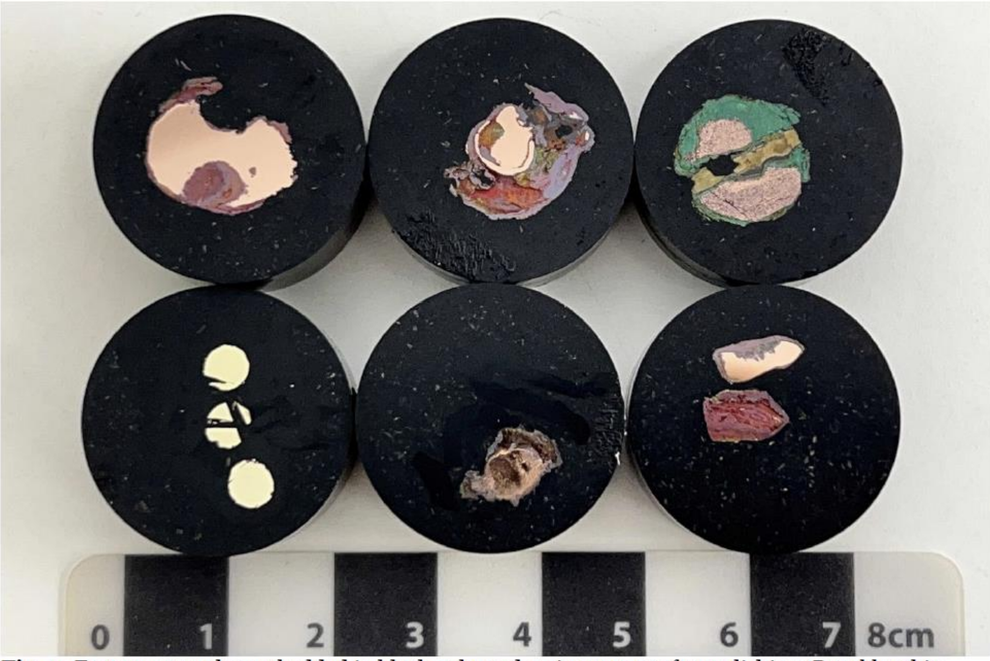

Fig. 3. Fastener samples embedded in black-coloured resin mounts after polishing, *Rambler* ship. From left to right on top: Sample no. 2, 1, and 5; bottom: Sample nos 7–9, no. 6, and nos 3–4 (W. van Duivenvoorde, Flinders University, 2022).

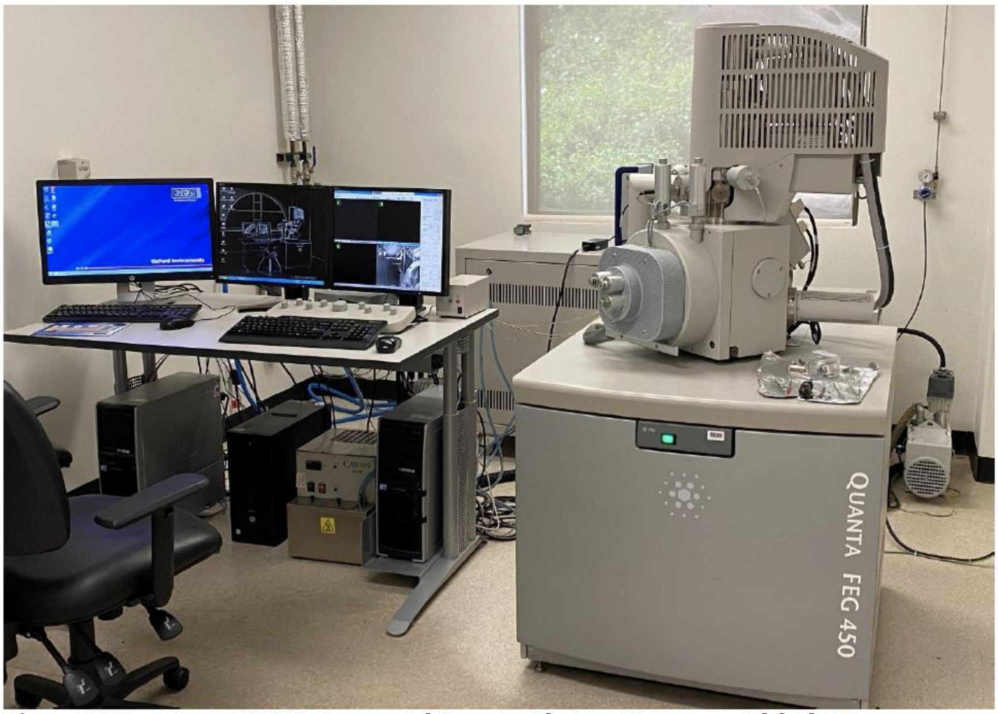

Fig. 4. FEI Quanta 450 FEG Environmental Scanning Electron Microscope, Adelaide Microscopy, University of Adelaide (W. van Duivenvoorde, Flinders University, 2020).

Analytical method

Metal samples from *Rambler*'s fasteners were analysed at Adelaide Microscopy, South Australia, using a FEI Quanta 450 FEG Environmental Scanning Electron Microscope (ESEM) (Fig. 4).[1] The FEI Quanta 450 is a High-Resolution Field Emission Scanning Electron and is used to image and analyse surface topography, collect backscattered electron images and characterise and determine a sample's elemental composition through x-ray detection with an SDD EDS detector.

The FEI Quanta 450 with SDD EDS detector allows for a semi-quantitative analytical method of elemental composition by area or spot. The areas chosen for elemental determination are those that display solid metal and are free of obvious surface corrosion or unevenness (Figs 5–22).

The following SEM settings were used during data acquisition: High-Vacuum, Kilovoltage: kV 20, Element Normalized, SEC table: default, standardless. The time per sample analysis was automated.

For all samples, carbon (C) was deliberately omitted from the automated results as Carbon is a known corrosion product that can occur as isolated inclusions in the actual metal a few millimetres below the surface (pers. comm. Animesh Bashak, Adelaide Microscopy). It is however known from 19th-century records that charcoal was sometimes added purposely to copper (Bennett 2021:293–294). For the purpose of this study carbon is simply omitted to focus primarily on the metal composition and ratio of metals in alloys.

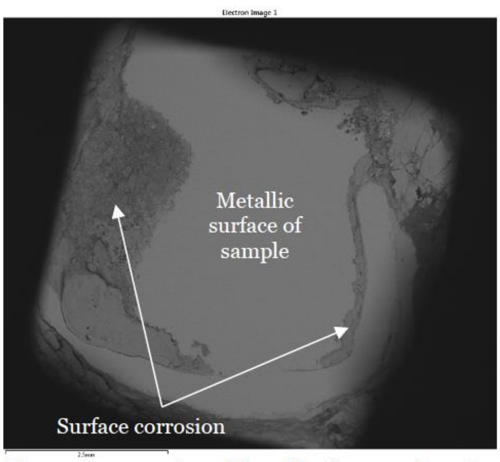

Fig. 5. Cross-section of *Rambler* fastener, Sample no. 1, showing surface corrosion on the edges and metallic surface in centre of the mounted sample. The black area around the sample is the resin of the mount in which it is embedded (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

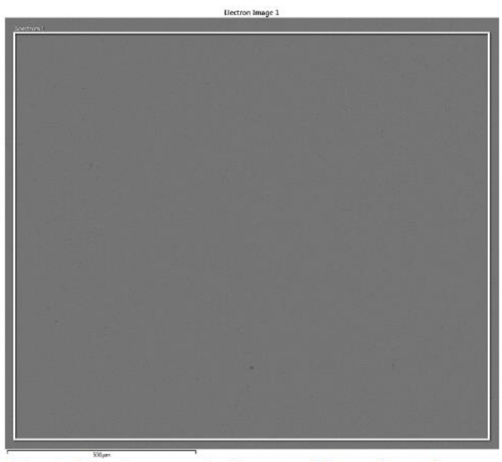

Fig. 6. Testing area in the metallic surface of Sample no. 1 (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

[1] https://www.adelaide.edu.au/microscopy/instrumentation/quanta450.html

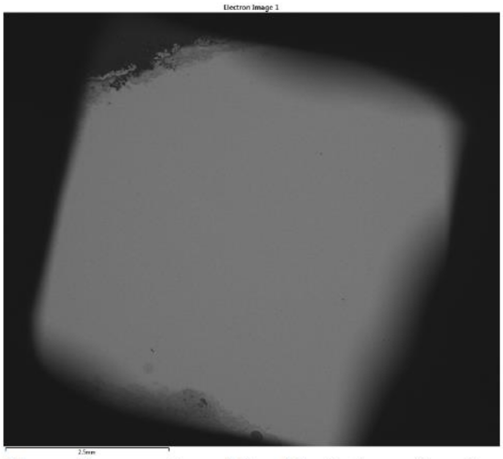

Fig. 7. Cross-section of *Rambler* fastener, Sample no. 2, showing surface corrosion on upper left edge and metallic surface of the mounted sample. The black area around the sample is the resin of the mount in which it is embedded. (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

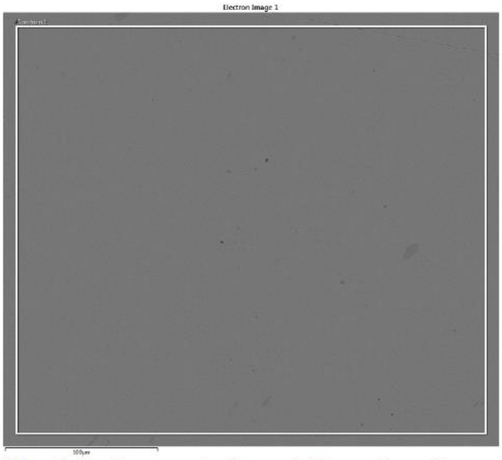

Fig. 8. Testing area in the metallic surface of Sample no. 2 (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

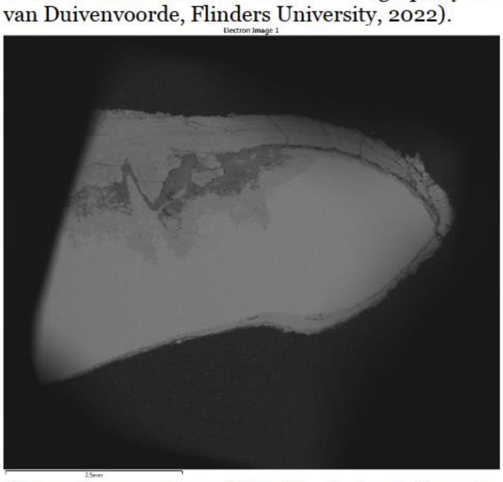

Fig. 9. Cross-section of *Rambler* fastener, Sample no. 3, showing surface corrosion (dark grey areas) and metallic surface of the mounted sample. The black area around the sample is the resin of the mount in which it is embedded. (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

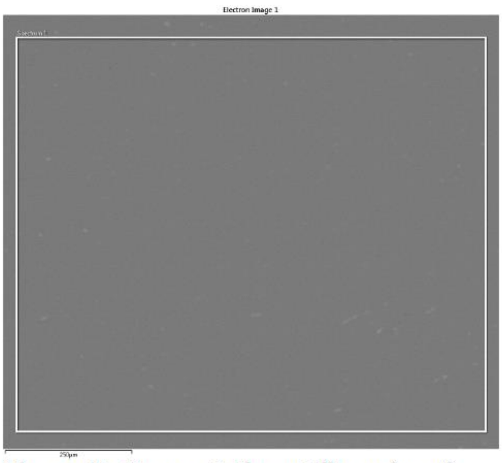

Fig. 10. Testing area in the metallic surface of Sample no 3. (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

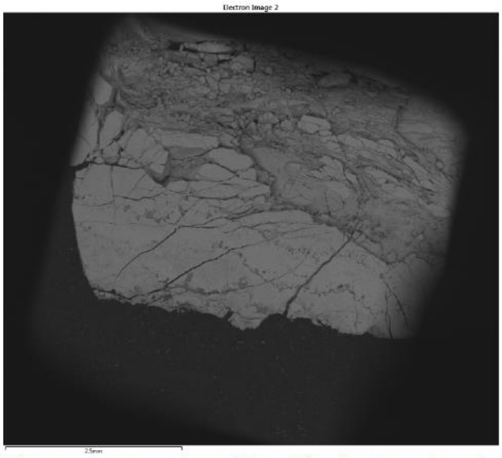

Fig. 11. Cross-section of *Rambler* fastener, Sample no. 4, showing surface corrosion (dark grey areas) and metallic surface of the mounted sample. The black area around the sample is the resin of the mount in which it is embedded. (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

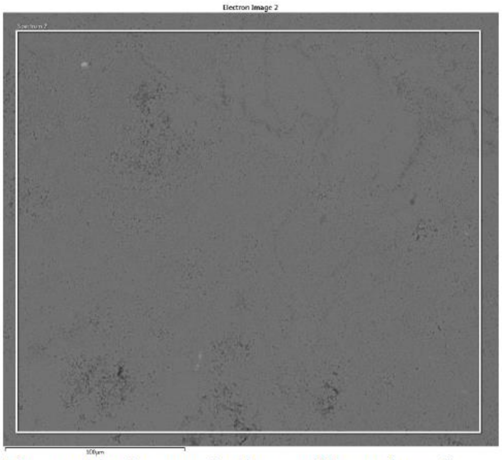

Fig. 12. Testing area in the metallic surface of Sample no. 4 (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

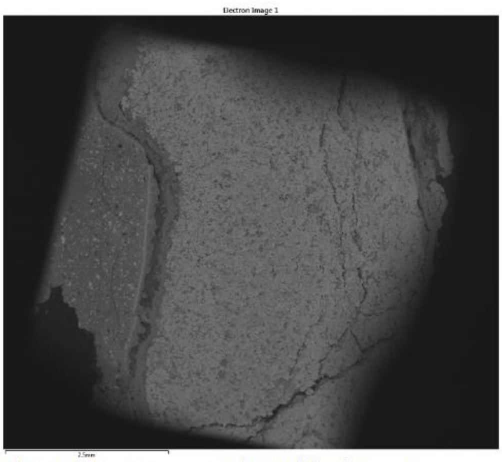

Fig. 13. Cross-section of *Rambler* fastener, Sample no. 5. The black area around the sample is the resin of the mount in which it is embedded. (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

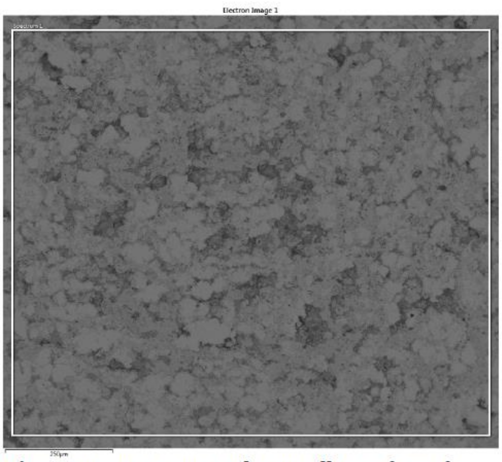

Fig. 14. Testing area in the metallic surface of Sample no 5. Poor surface sample (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

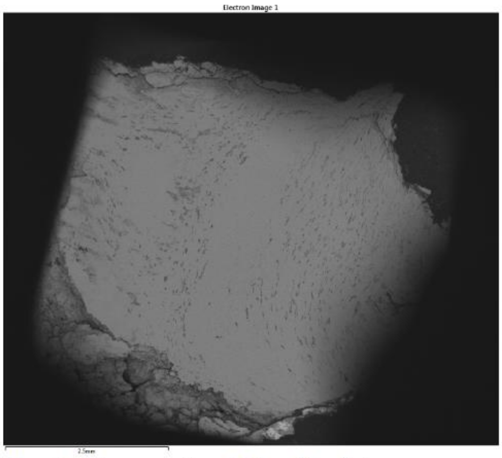

Fig. 15. Cross-section of *Rambler* fastener, Sample no. 6, showing surface corrosion. The black area around the sample is the resin of the mount in which it is embedded. (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

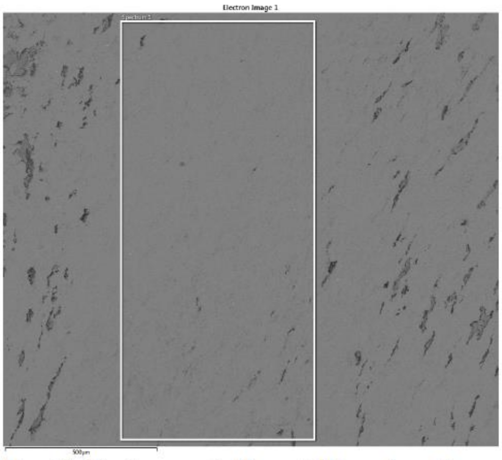

Fig. 16. Testing area in the metallic surface of Sample no. 6 (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

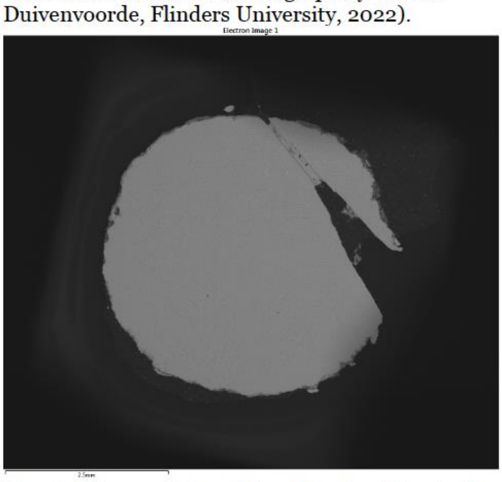

Fig. 17. Cross-section of *Rambler* sheathing tack, Sample no. 7 The black area around the sample is the resin of the mount in which it is embedded. (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

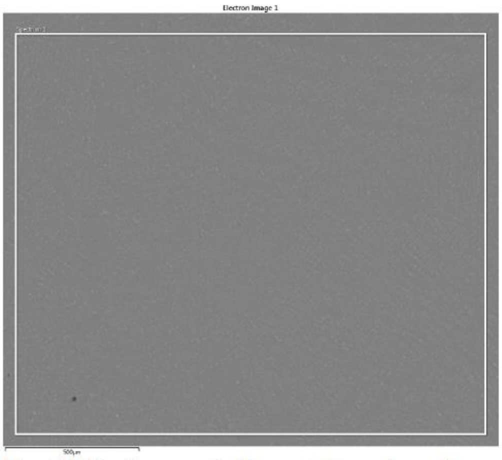

Fig. 18. Testing area in the metallic surface of Sample no. 7 (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

Fig. 19. Cross-section of *Rambler* sheathing tack, Sample no. 8. The black area around the sample is the resin of the mount in which it is embedded. (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

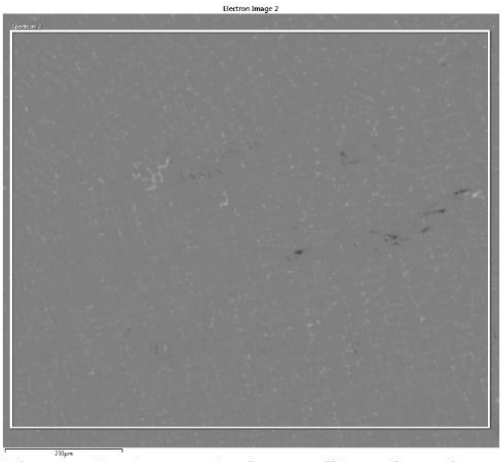

Fig. 20. Testing area in the metallic surface of Sample no. 8 (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

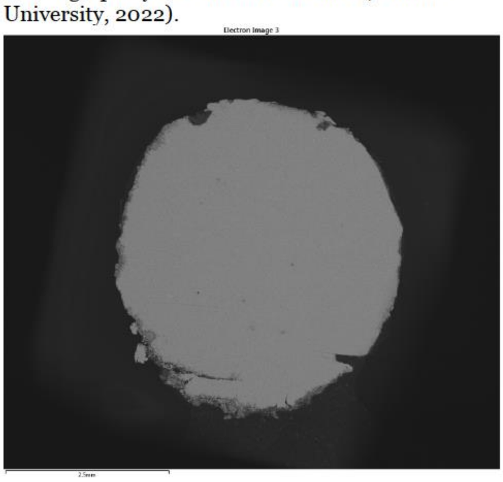

Fig. 21. Cross-section of *Rambler* sheathing tack, Sample no. 9. The black area around the sample is the resin of the mount in which it is embedded. (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

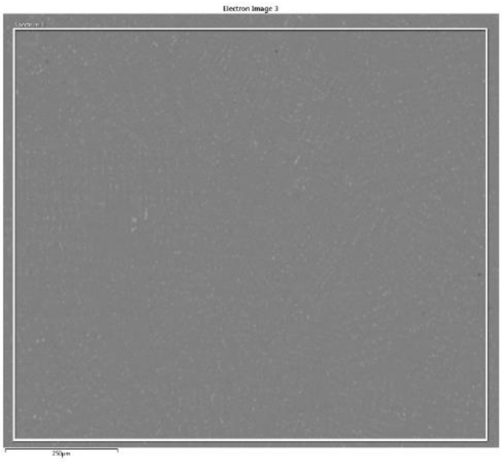

Fig. 22. Testing area in the metallic surface of Sample no. 9 (Micrograph by W. van Duivenvoorde, Flinders University, 2022).

Table 2. Elemental composition of the samples from fasteners from the *Rambler* ships' hull (Group 1). Automated collection (W. van Duivenvoorde, Flinders University, 2023).

	Wt%			Atomic%	
Description	**Cu**	**Total**		**Cu**	**Total**
Sample 1: spectrum 1	100.00	100		100.00	100
Sample 2: spectrum 1	100.00	100		100.00	100
Sample 3: spectrum 1	100.00	100		100.00	100
Sample 4: spectrum 2	100.00	100		100.00	100
Sample 5: spectrum 1	100.00	100		100.00	100
Sample 6: spectrum 1	100.00	100		100.00	100

Table 3. Elemental composition of the samples from fasteners from the *Rambler* ships' hull. Predefined collection (W. van Duivenvoorde, Flinders University, 2023).

	Wt%												Atomic%										
Description	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Ag**	**Sn**	**Sb**	**Pb**	**Bi**	**Total**		**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Ag**	**Sn**	**Sb**	**Pb**	**Bi**	**Total**
Sample 1: spectrum 1	0.10	0.00	99.45	0.00	0.30	0.00	0.00	0.00	0.00	0.15	100		0.11	0.00	99.59	0.00	0.25	0.00	0.00	0.00	0.00	0.05	100
Sample 2: spectrum 1	0.13	0.00	99.48	0.36	0.01	0.00	0.00	0.02	0.00	0.00	100		0.14	0.00	99.48	0.35	0.01	0.00	0.00	0.01	0.00	0.00	100
Sample 3: spectrum 1	0.02	0.06	98.79	0.00	0.33	0.29	0.12	0.14	0.00	0.25	100		0.02	0.06	99.24	0.00	0.28	0.17	0.07	0.07	0.00	0.08	100
Sample 4: spectrum 2	0.00	0.11	99.00	0.37	0.00	0.04	0.00	0.08	0.40	0.00	100		0.00	0.12	99.33	0.36	0.00	0.02	0.00	0.04	0.12	0.00	100
Sample 5: spectrum 1	0.11	0.05	96.09	2.70	0.00	0.41	0.00	0.00	0.64	0.00	100		0.13	0.06	96.73	2.64	0.00	0.24	0.00	0.00	0.20	0.00	100
Sample 6: spectrum 1	0.02	0.00	99.16	0.01	0.78	0.03	0.00	0.00	0.00	0.00	100		0.02	0.00	99.29	0.01	0.66	0.02	0.00	0.00	0.00	0.00	100

Table 4. Elemental composition of the samples from fasteners from the *Rambler* ships' hull (Group 2). Automated collection (W. van Duivenvoorde, Flinders University, 2023).

	Wt%							Atomic%					
Description	**Fe**	**Cu**	**Zn**	**Sn**	**Pb**	**Total**		**Fe**	**Cu**	**Zn**	**Sn**	**Pb**	**Total**
Sample 7: spectrum 1	0.76	73.02	21.81	2.78	1.62	100							0
Sample 8: spectrum 1	0.61	72.92	22.24	2.86	1.36	100		0.72	75.03	22.24	1.58	0.43	100
Sample 9: spectrum 1	0.81	76.53	18.71	2.44	1.51	100		0.95	78.56	18.67	1.34	0.47	100

Table 5. Elemental composition of the samples from fasteners from the *Rambler* ships' hull. Predefined collection (W. van Duivenvoorde, Flinders University, 2023).

	Wt%												Atomic%										
Description	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Ag**	**Sn**	**Sb**	**Pb**	**Bi**	**Total**		**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Ag**	**Sn**	**Sb**	**Pb**	**Bi**	**Total**
Sample 7: spectrum 1	0.76	0.14	72.46	21.63	0.21	0.15	2.84	0.25	1.57	0.00	100		0.89	0.16	74.78	21.70	0.18	0.09	1.57	0.13	0.50	0.00	100
Sample 8: spectrum 1	0.61	0.21	72.40	22.07	0.42	0.00	2.87	0.12	1.31	0.00	100		0.71	0.23	74.54	22.08	0.37	0.00	1.58	0.06	0.41	0.00	100
Sample 9: spectrum 1	0.81	0.26	76.23	18.63	0.08	0.01	2.45	0.07	1.45	0.00	100		0.95	0.29	78.26	18.58	0.07	0.01	1.35	0.04	0.46	0.00	100

Results of analyses fastenings and fittings
The analyses of the fasteners from the *Rambler* ship confirm the presence of two distinct groups of copper and alloys: 1. pure copper (Tables 2 and 3) and group 2. a copper-zinc-tin alloy (Tables 4 and 5).

Group 1. Samples from six different types of fasteners, i.e. nails, sheathing tack and a screw, are made of 100% pure copper. Normally such fastenings come from the wrecks of ships built prior to 1832. The SEM only identified the copper when the collection was set to automated (Table 2). The copper itself is very pure—it was not alloyed, and no lead nor iron were added to the copper. All other elements listed in Table 3 are trace elements and they were added manually to the collection (with the weight percentages varying from 96.09% to 99.48%) (see also Appendix 1, Sample nos 1–6).

Group 2. Three sheathing tacks from *Rambler* tested positive for the following elements: Cu (copper), Zn (zinc), and Sn (tin). Lead and iron are listed but their percentages are so low that are probably trace elements rather than purposely added metals to the alloy (note that they show up listed in red in Appendix 1, while the others are listed in white and thus clearly present). The weight percentages of the copper alloy used to manufacture the tacks vary from 72.92% to 76.53% copper, 18.71% to 22.24% for zinc, 2.44% to 2.86% tin, and 1.51% to 1.62% for lead and 0.61% to 0.81% iron (Table 4). All other elements listed in Table 5 were manually added to the spectra and they are trace elements (see also Appendix 1, Sample nos 7–9).

Note that lead can be seen clearly in the micrographs, i.e. little white specks spread throughout the samples (best seen in Figs 10, 20 and 22). Again, the weight percentages of the lead are however low as aforementioned.

The tacks that fastened the sheathing on *Rambler* were manufactured using copper, zinc, and tin. The concentration of copper is usually higher than that in the sheathing at almost 80% percent (sheathing is usually around 65%); plus, there is much less zinc and a higher portion of other metals. Fasteners are required to be harder than the sheathing itself.

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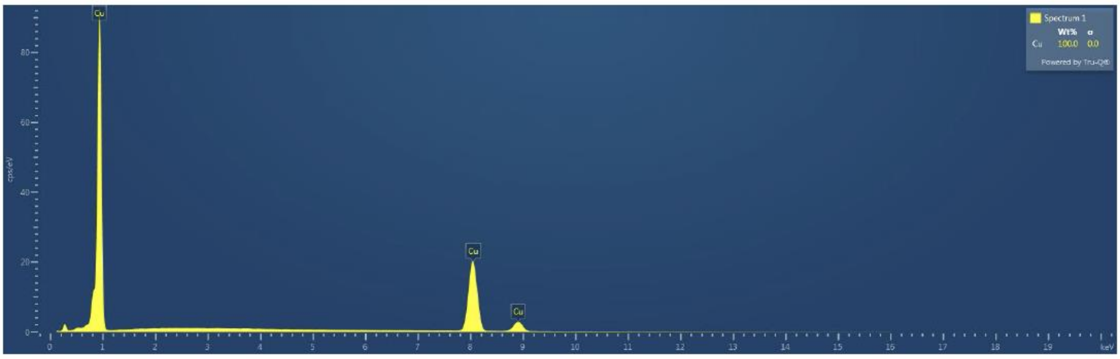
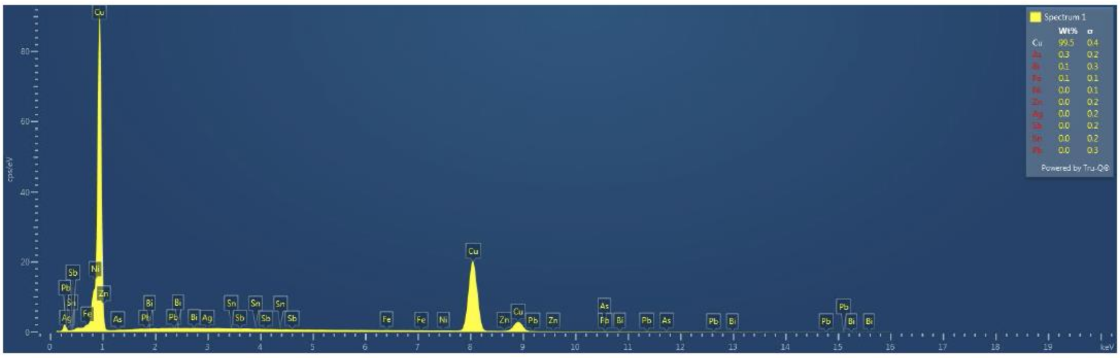
APPENDIX 1: SPECTRA *RAMBLER* SAMPLES

Sample no. 1





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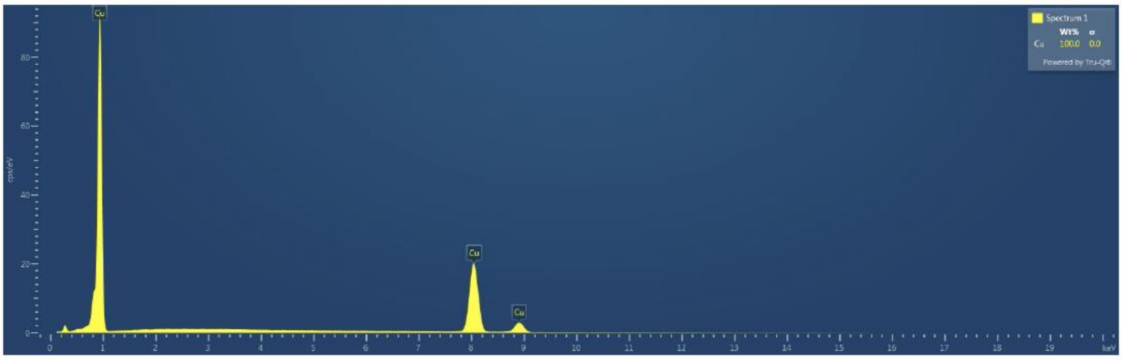

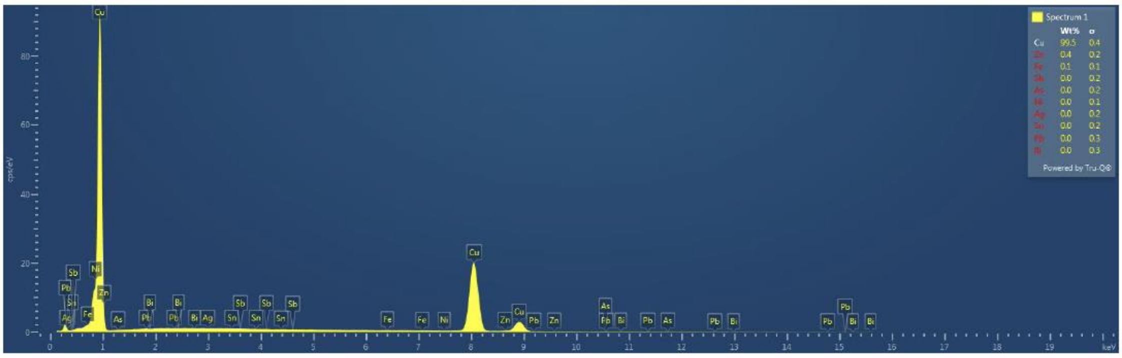

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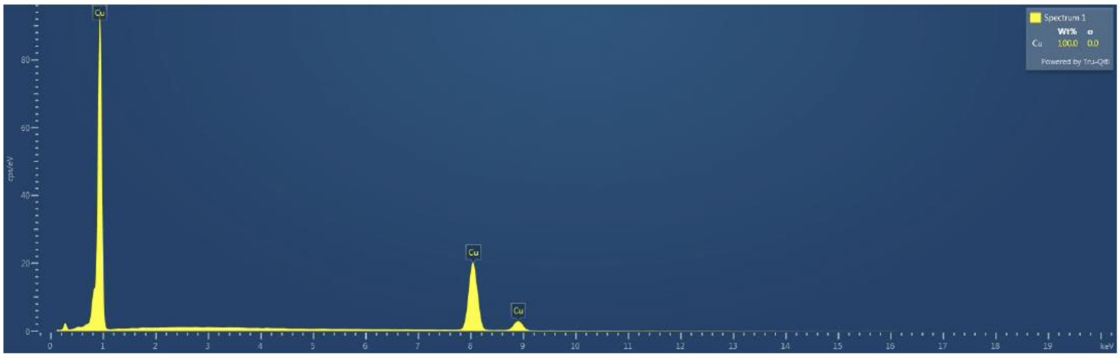
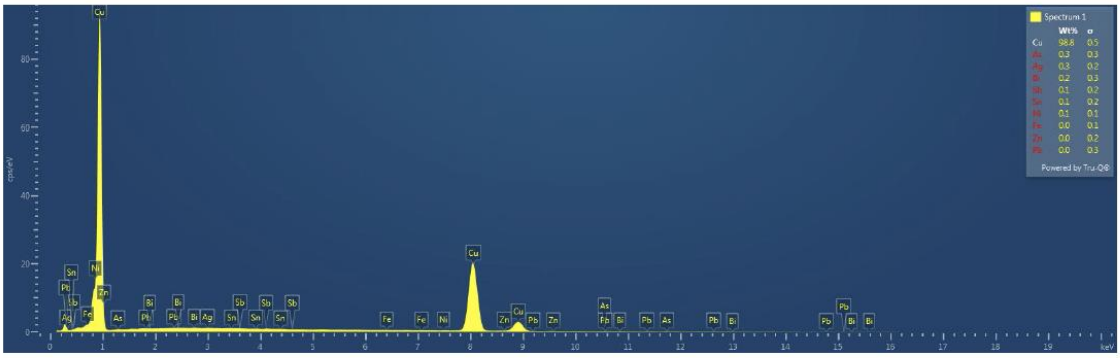
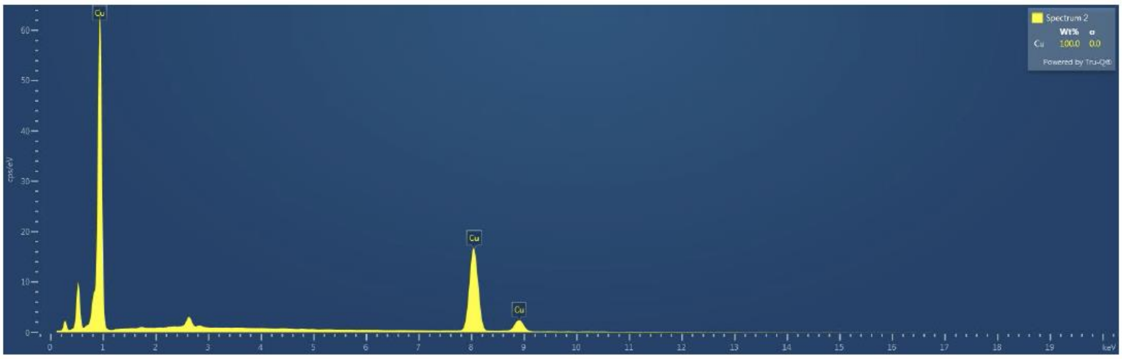
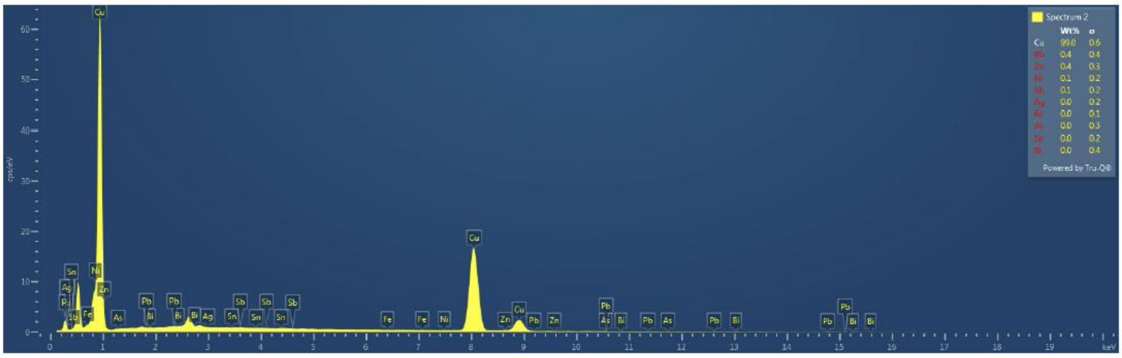

Spectrum 1
Wt% σ
Cu 100.0 0.0
Powered by Tru-Q®


Spectrum 1
Wt% σ
Cu 98.8 0.5
0.3 0.3
0.3 0.2
0.2 0.3
0.1 0.2
0.1 0.2
0.1 0.1
0.0 0.1
0.0 0.2
0.0 0.3
Powered by Tru-Q®

Sample no. 4

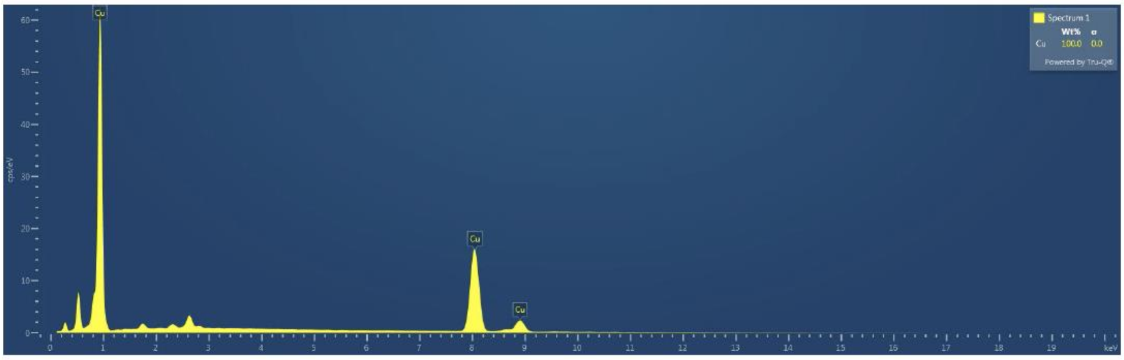


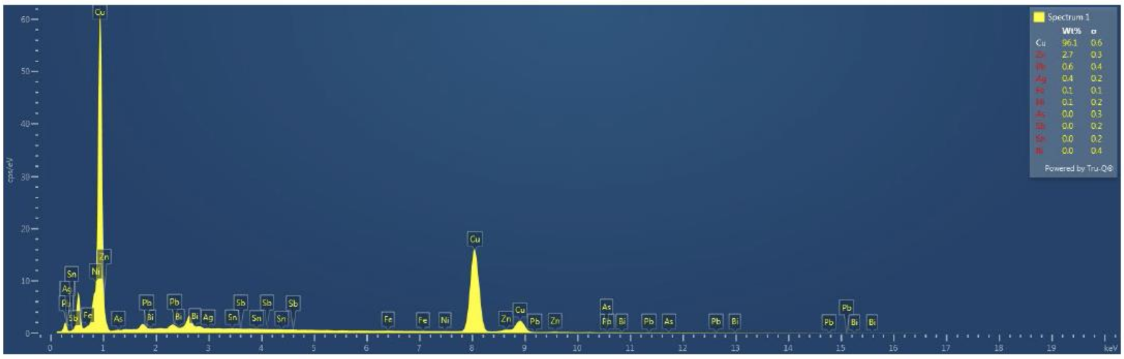
Spectrum 2
Wt% σ
Cu 100.0 0.0
Powered by Tru-Q®
cps/eV
keV



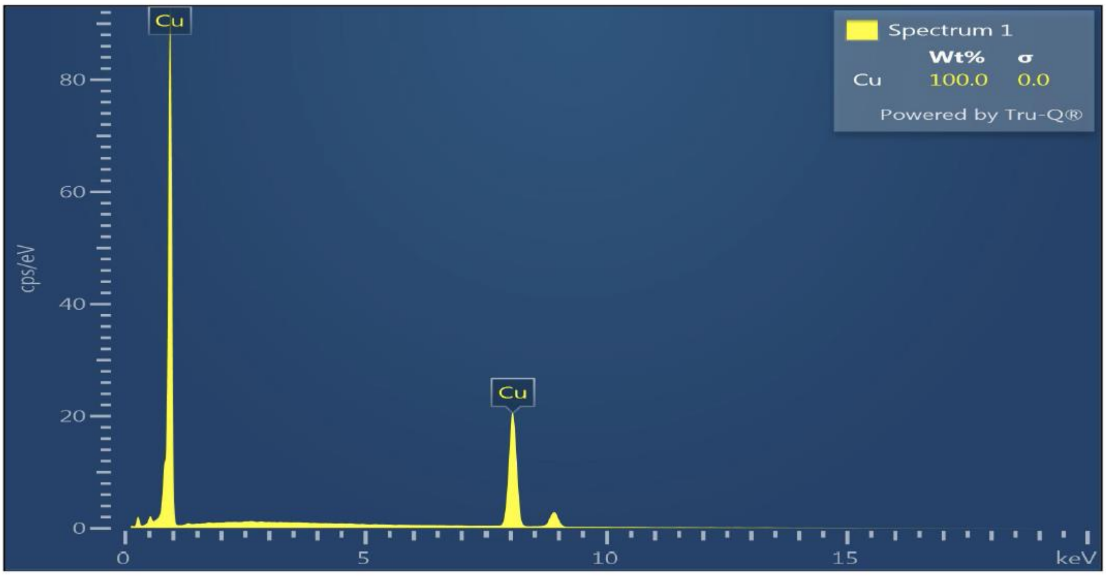
Spectrum 2
Wt% σ
Cu 99.0 0.6
0.4 0.4
0.4 0.3
0.1 0.2
0.1 0.2
0.0 0.2
0.0 0.1
0.0 0.3
0.0 0.2
0.0 0.4
Powered by Tru-Q®
cps/eV
keV

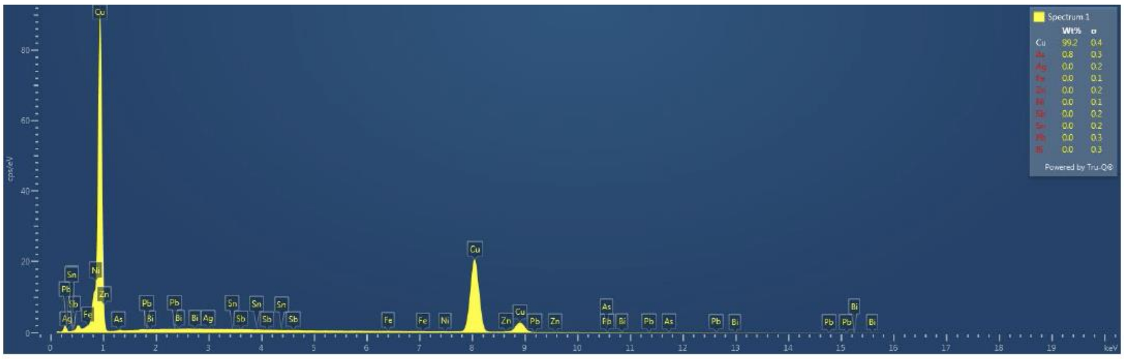
Sample no. 5


Spectrum 1
Wt% σ
Cu 100.0 0.0
Powered by Tru-Q®
Cu
cps/eV
keV


Spectrum 1
Wt% σ
Cu 96.1 0.6
2.7 0.3
0.6 0.4
0.4 0.2
0.1 0.1
0.1 0.2
0.0 0.3
0.0 0.2
0.0 0.2
0.0 0.4
Powered by Tru-Q®
Cu
cps/eV
keV

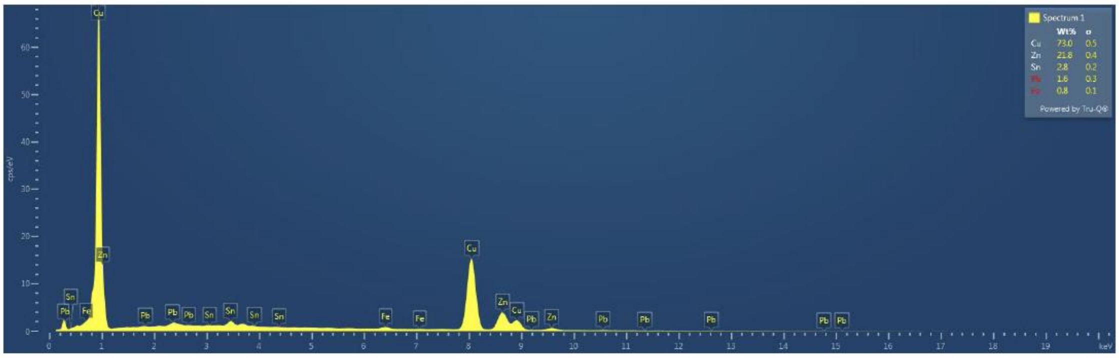
Sample no. 6

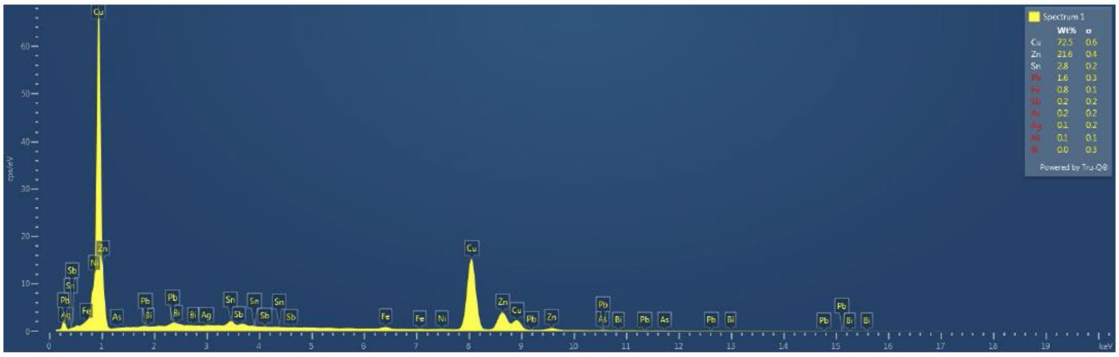




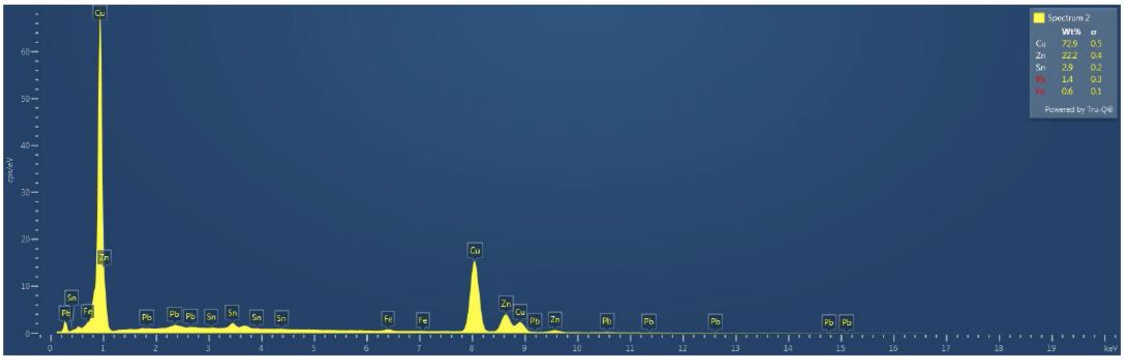
18

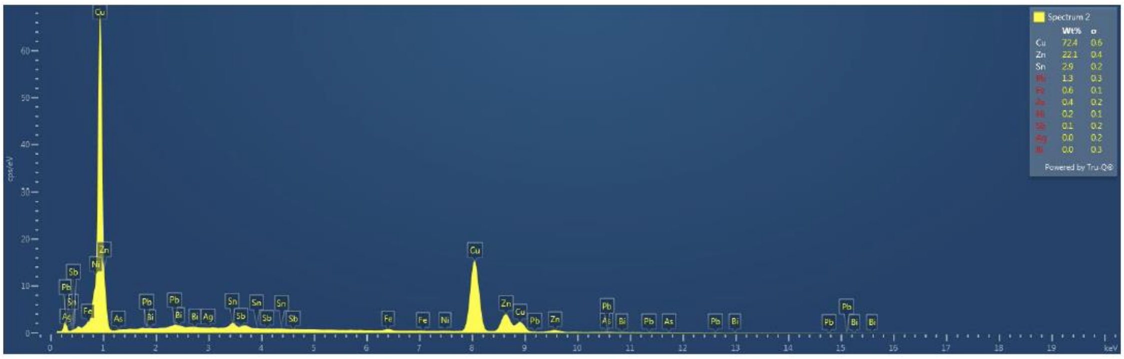
Sample no. 7


Spectrum 1
Wt% σ
Cu 73.0 0.5
Zn 21.8 0.4
Sn 2.8 0.2
Powered by Tru-Q®
keV

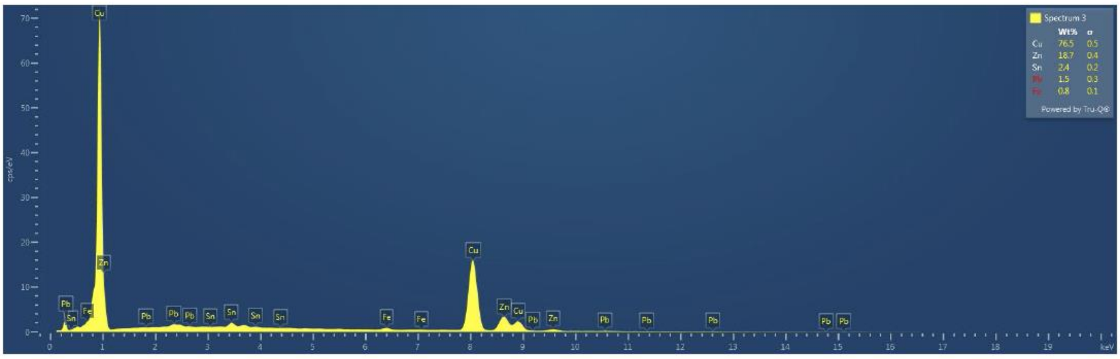

Spectrum 1
Wt% σ
Cu 72.5 0.6
Zn 21.6 0.4
Sn 2.8 0.2
Powered by Tru-Q®
keV

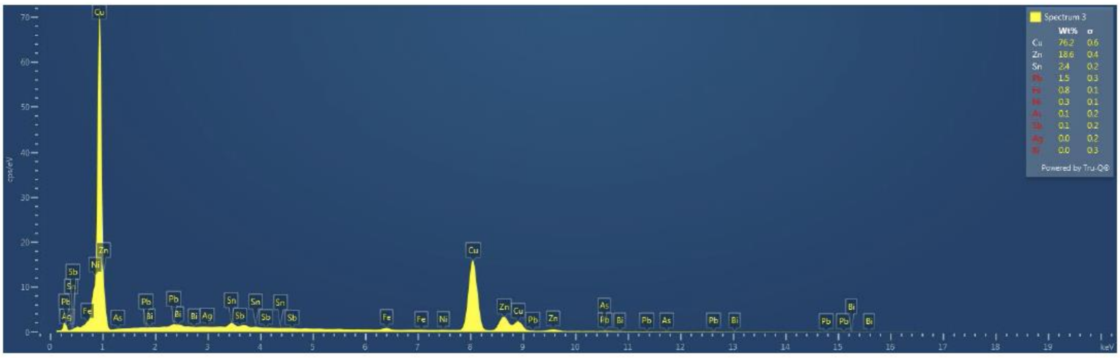
Sample no. 8


Spectrum 2
Wt% σ
Cu 72.9 0.5
Zn 22.2 0.4
Sn 2.9 0.2
1.4 0.3
0.6 0.1
Powered by Tru-Q®
cps/eV
keV


Spectrum 2
Wt% σ
Cu 72.4 0.6
Zn 22.1 0.4
Sn 2.9 0.2
1.3 0.3
0.6 0.1
0.4 0.2
0.2 0.1
0.1 0.2
0.0 0.2
0.0 0.3
Powered by Tru-Q®
cps/eV
keV

Sample no. 9





21

APPENDIX 2: TIMBER SPECIES IDENTIFICATION REPORT

KNOW YOUR WOOD
19 Benambra Street,
South Oakleigh,
Victoria 3167, AUSTRALIA
Phone:
Mobile: 0499 300 208
Email: knowyourwood1@gmail.com
Provider of wood identification services

Date: 2 January, 2023

WOOD IDENTIFICATION RESULTS

Dr Wendy van Duivenvoorde
Associate Professor
Maritime Archaeology
Flinders University
GPO Box 2100 Adelaide, SA 5001

Dear Wendy,

Re: Identification and images of 25 timber specimens, from an historic vessel named 'Rambler' built in 1875 in Port Adelaide. Your request – 20th Dec, 2022.
Following microscopic examination, in my opinion the structure of the wood specimens is consistent with[1]:

Sample number	Timber	Scientific name	Commercial or Trade name + Remarks
1	Planking	*Eucalyptus marginata*	JARRAH
2	Planking	*Eucalyptus marginata*	JARRAH
3	Planking	*Eucalyptus marginata*	JARRAH
4	Planking	*Eucalyptus marginata*	JARRAH
5	Planking	*Eucalyptus marginata*	JARRAH
6	Planking	*Eucalyptus marginata*	JARRAH
7	Planking	*Eucalyptus marginata*	JARRAH
7*x*	Transverse plug	*Pseudotsuga menziesii*	DOUGLAS FIR
8	Planking	*Eucalyptus marginata*	JARRAH
9	Planking	*Eucalyptus marginata*	JARRAH
10	Planking	*Agathis* sp.	KAURI
11	Planking	*Agathis* sp.	KAURI
12	Planking	*Agathis* sp.	KAURI
13	Planking	*Agathis* sp.	KAURI
14	Planking	*Agathis* sp.	KAURI
15	Planking	*Agathis* sp.	KAURI
16	Planking	*Agathis* sp.	KAURI
17	Stem timber	*Eucalyptus camaldulensis*[2]	RED GUM
18	Keel	*Eucalyptus marginata*	JARRAH

[1] *Disclaimer*: The content of this letter is provided in good faith and whilst Dr Jugo Ilic has endeavoured to ensure that the information contained in it is correct and accurate at the time of preparation, he does not accept any liability arising from its use whether provided directly by the above-named client or indirectly from the client providing it to a third party in this or any other format.

[2] River red gum and forest red gum have similar structure and cannot be separated on the wood anatomy from this material.

19	Stem timber	*Pinus sylvestris*	BALTIC PINE
20	Rib	*Ulmus* sp.	ELM
21	Planking	*Agathis* sp.	KAURI
22	Stern timber Scrappy specimens	*Eucalyptus camaldulensis*[3]	RED GUM
23	Stern timber Scrappy specimens	*Eucalyptus camaldulensis*[3]	RED GUM
24	Stringer	*Eucalyptus* sp.	STRINGYBARK or BLACKBUTT
25	Rib	*Ulmus* sp. (*thomasi*[4])	ROCK ELM

I hope the information will help with your research and evaluation process.

Best regards,

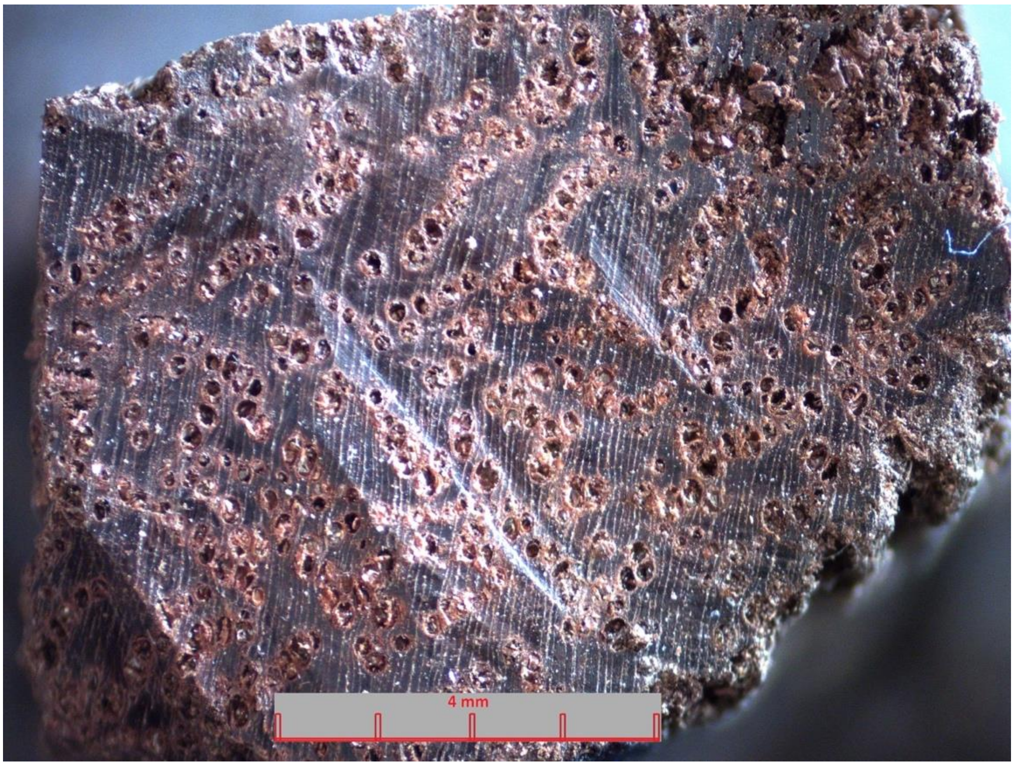
Jugo Ilic

Jugo Ilic MSc, Dr(Forest)Sc, FIAWSc

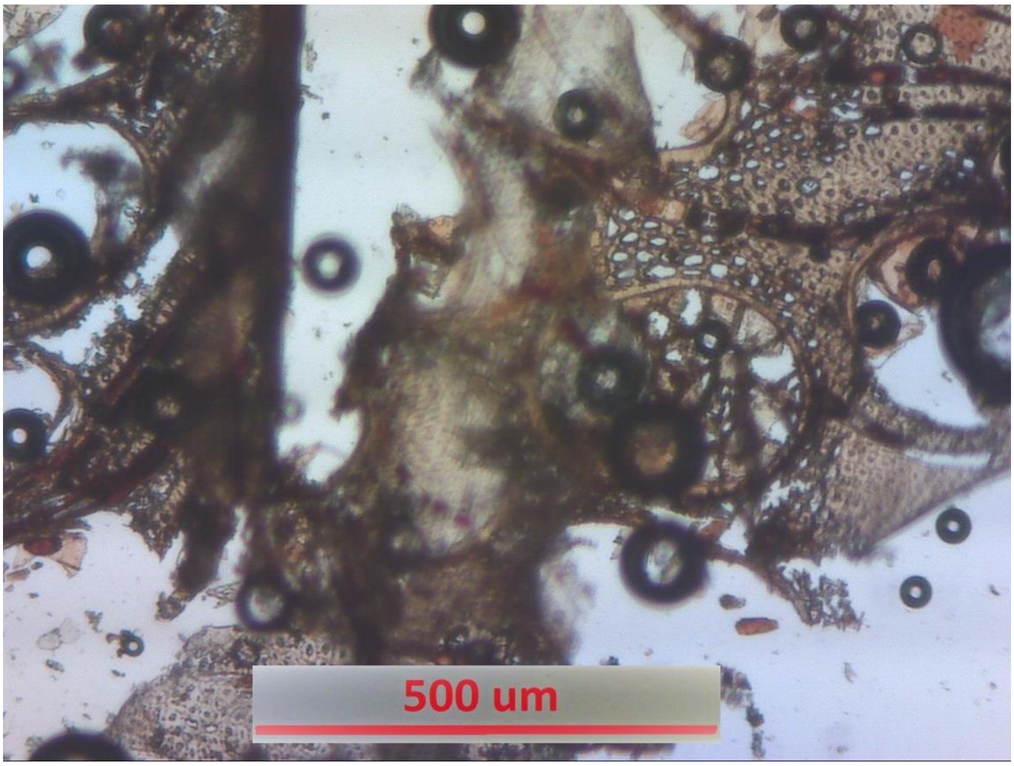
[3] The species of Eucalyptus is difficult to determine form the small-sized and weathered material. Material looks more like red gum than jarrah.

[4] Other species in the rock elm have the same wood structure, originally from North America.

APPENDIX 3: WOOD SAMPLE MICROGRAPHS



Sample 1. *Eucalyptus marginta* (Jarrah). Planking strake 1 (garboard strake), portside bow. Sample from hood end of plank. Identified by Jugo Illic.



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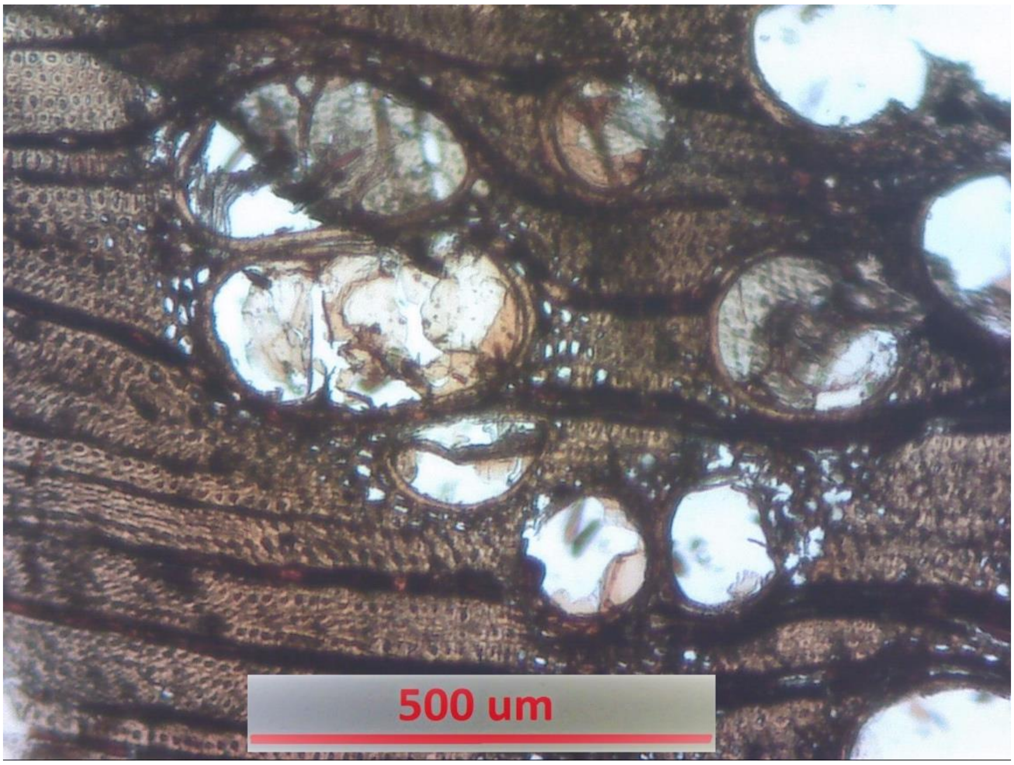

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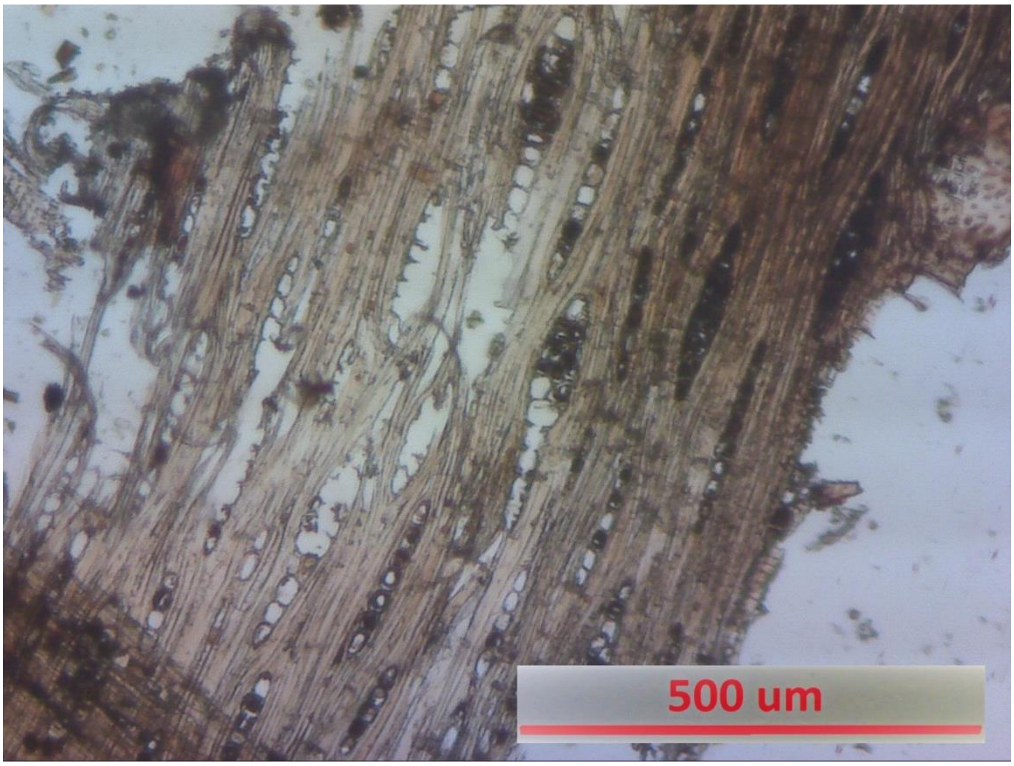

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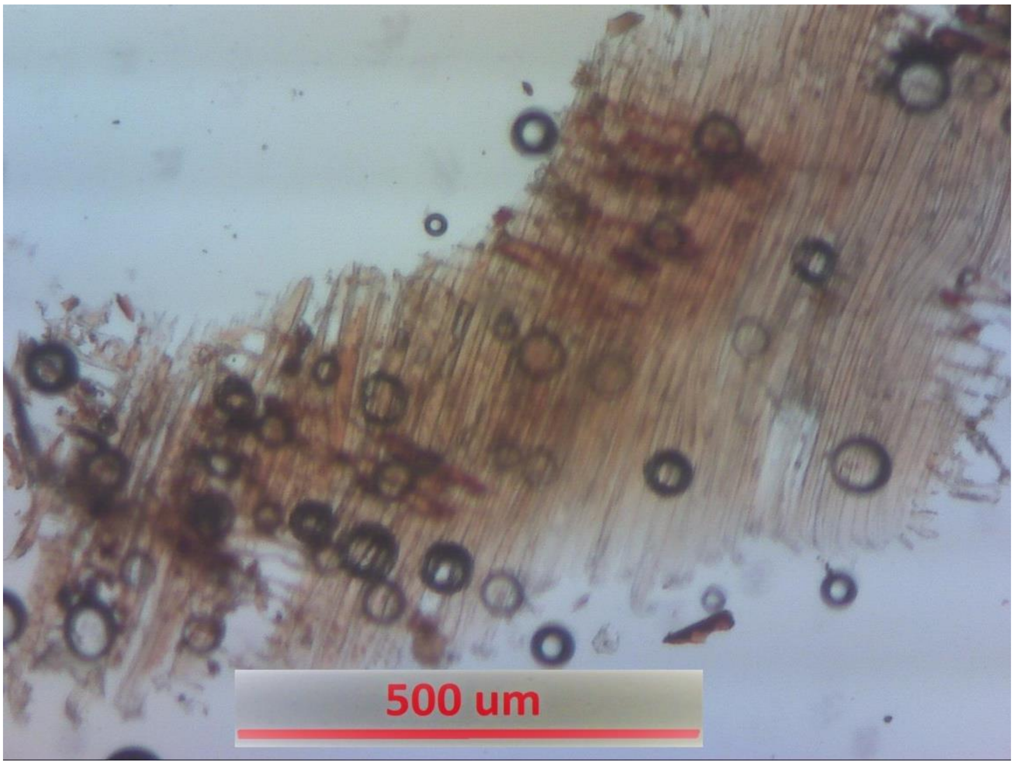
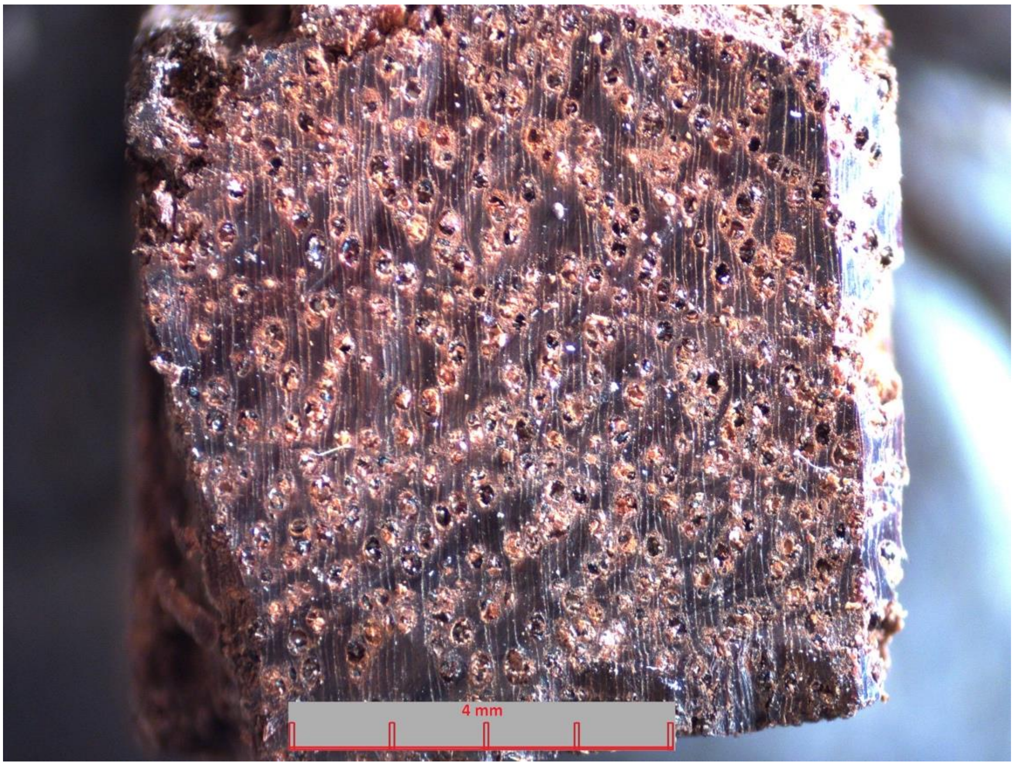


Sample 1. *Eucalyptus marginta* (Jarrah). Planking strake 1 (garboard strake), portside bow. Sample from hood end of plank. Identified by Jugo Illic.



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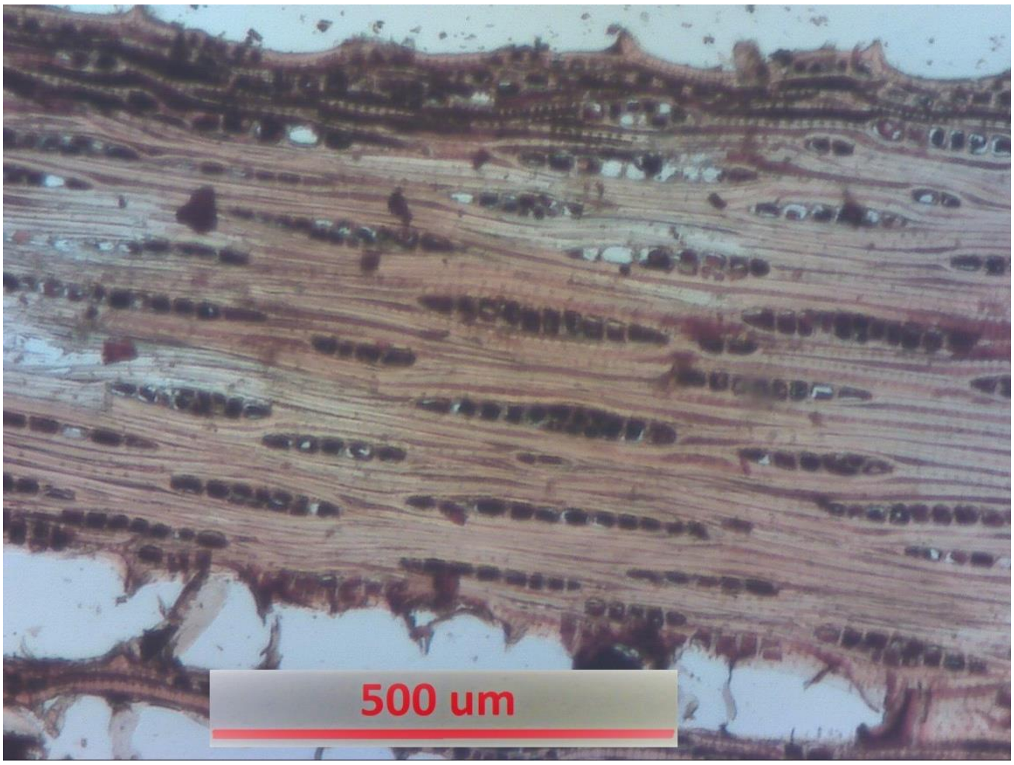

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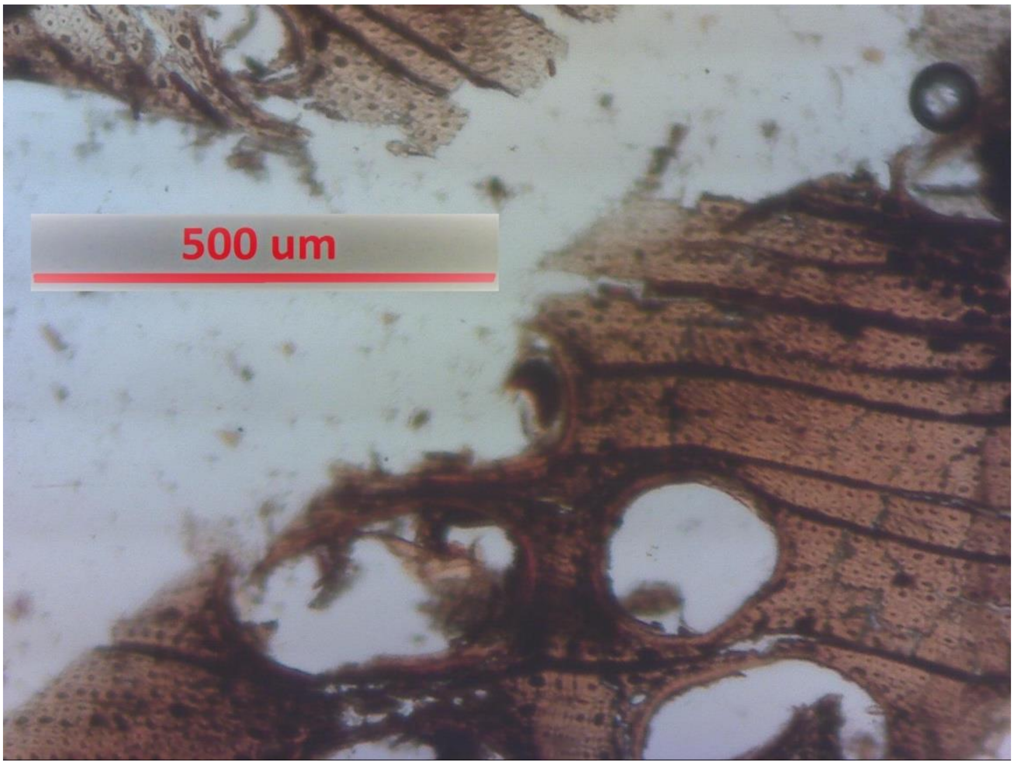

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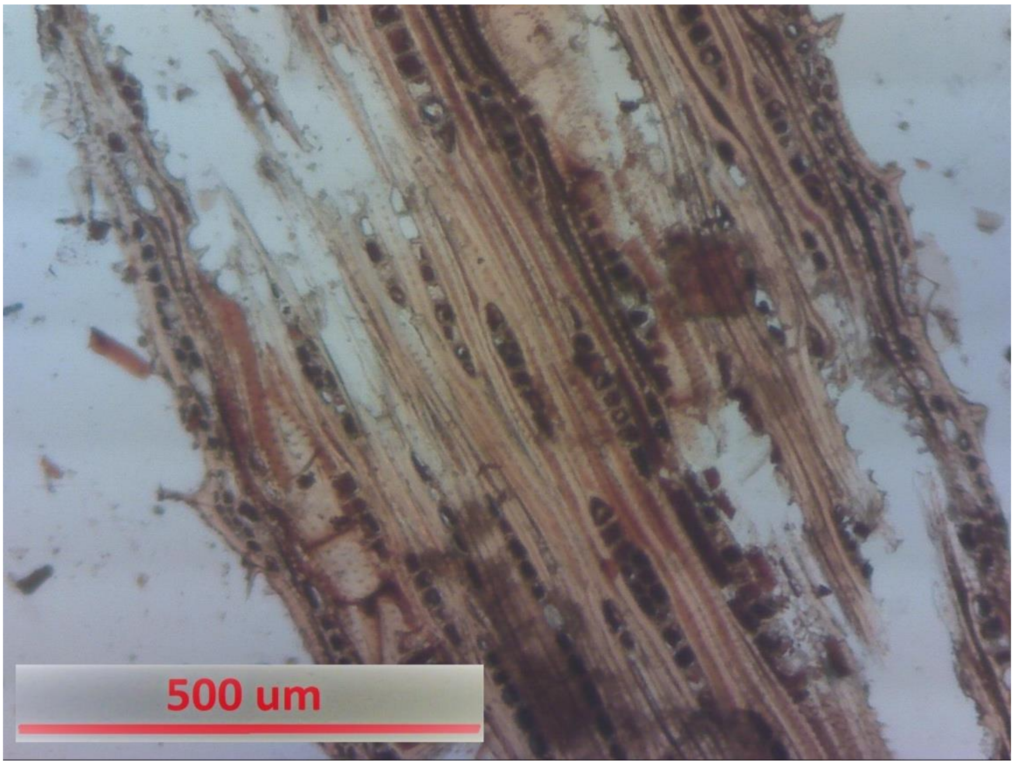

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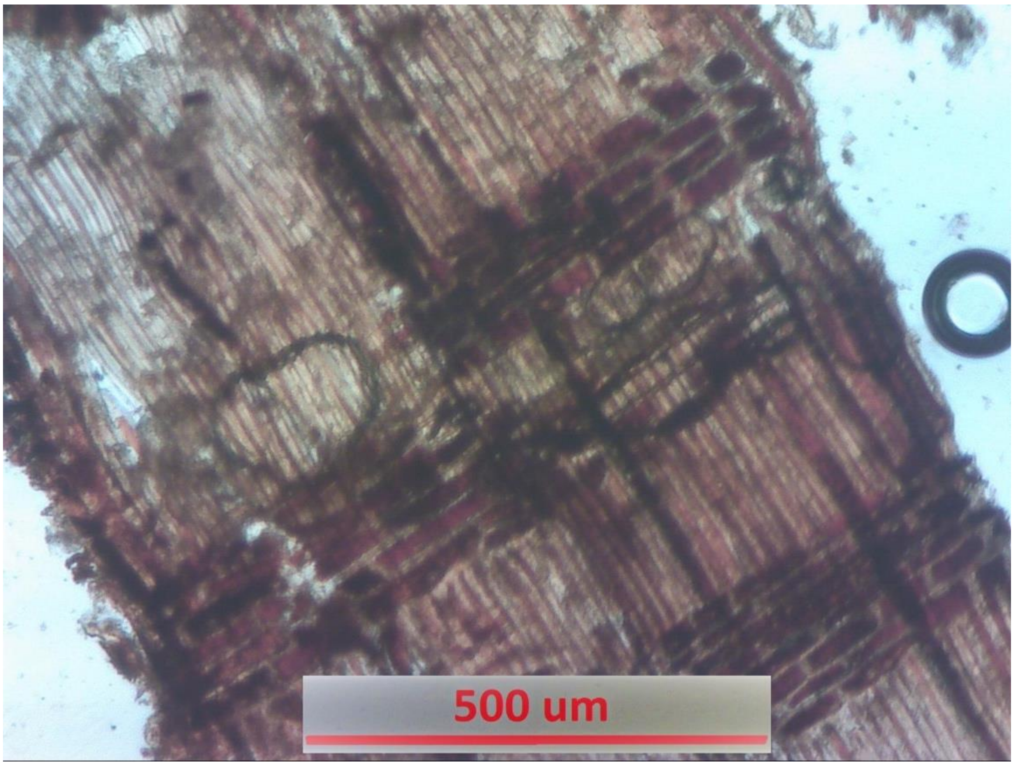

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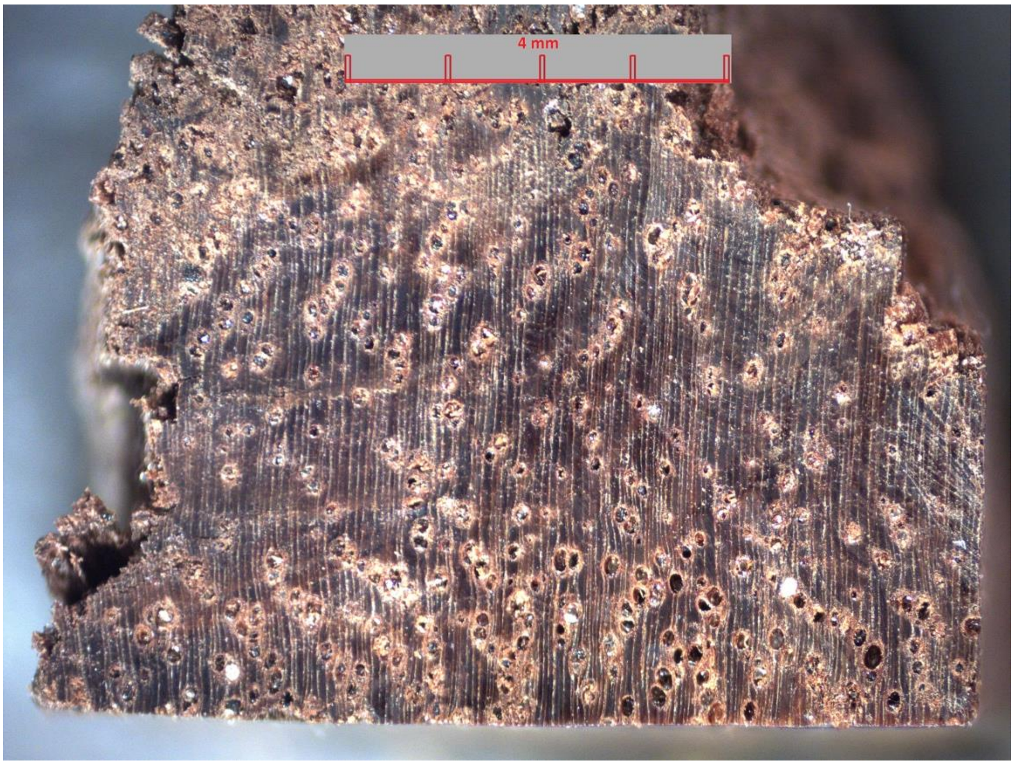

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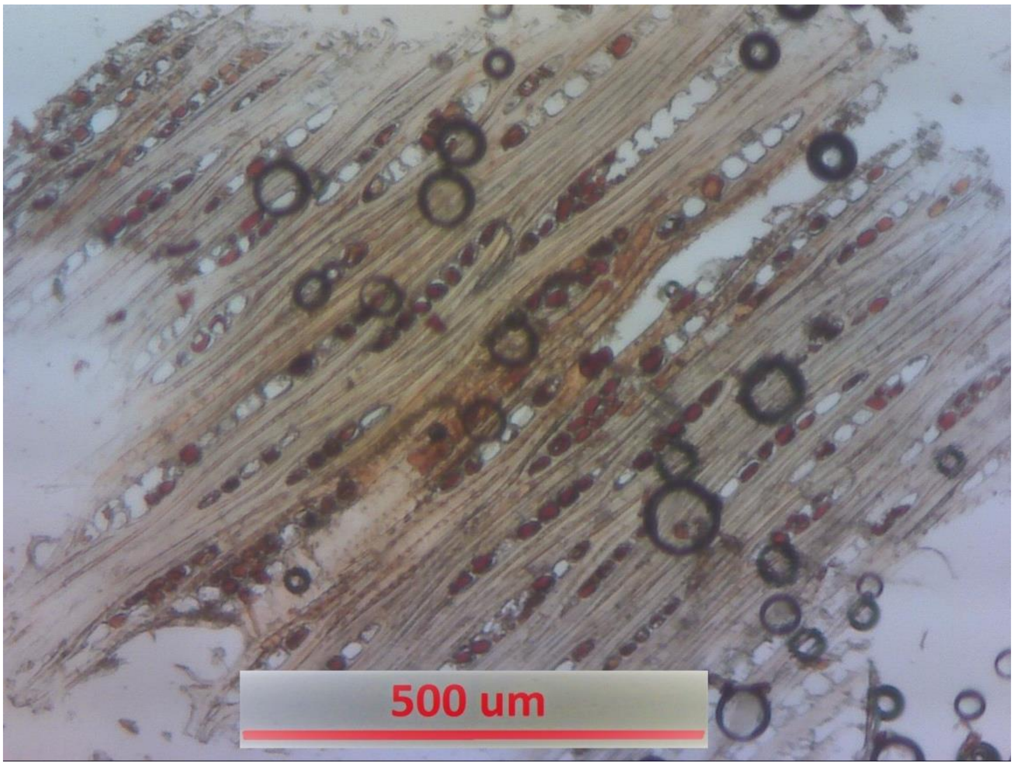
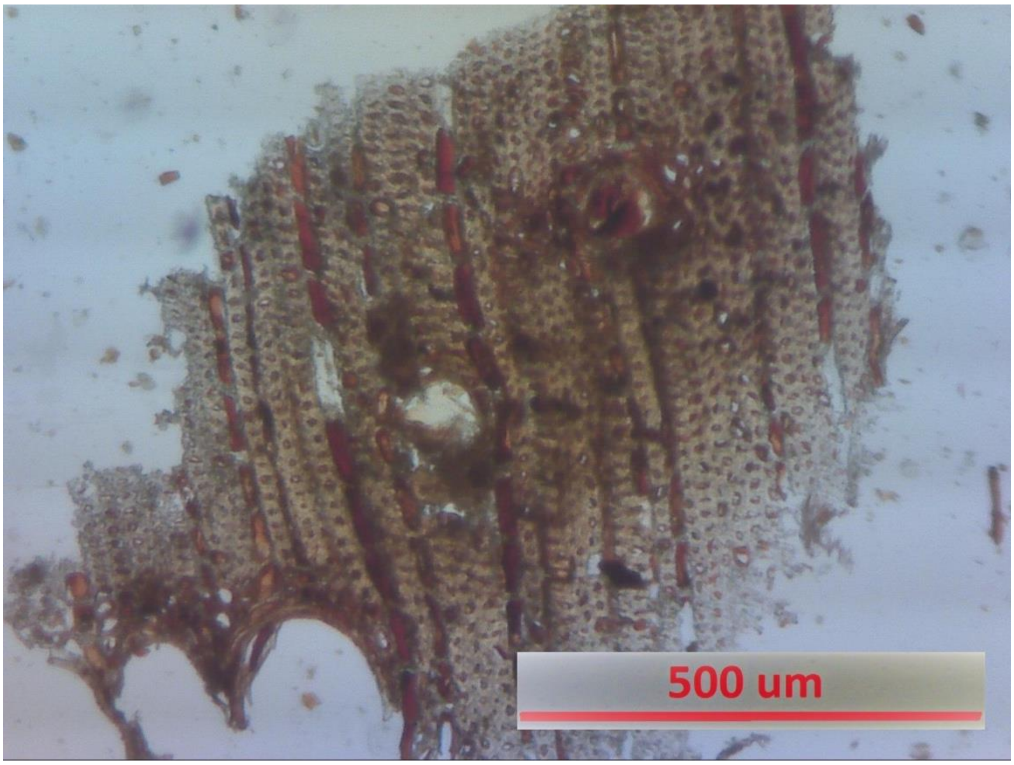


Sample 3. *Eucalyptus marginta* (Jarrah). Planking strake 3, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



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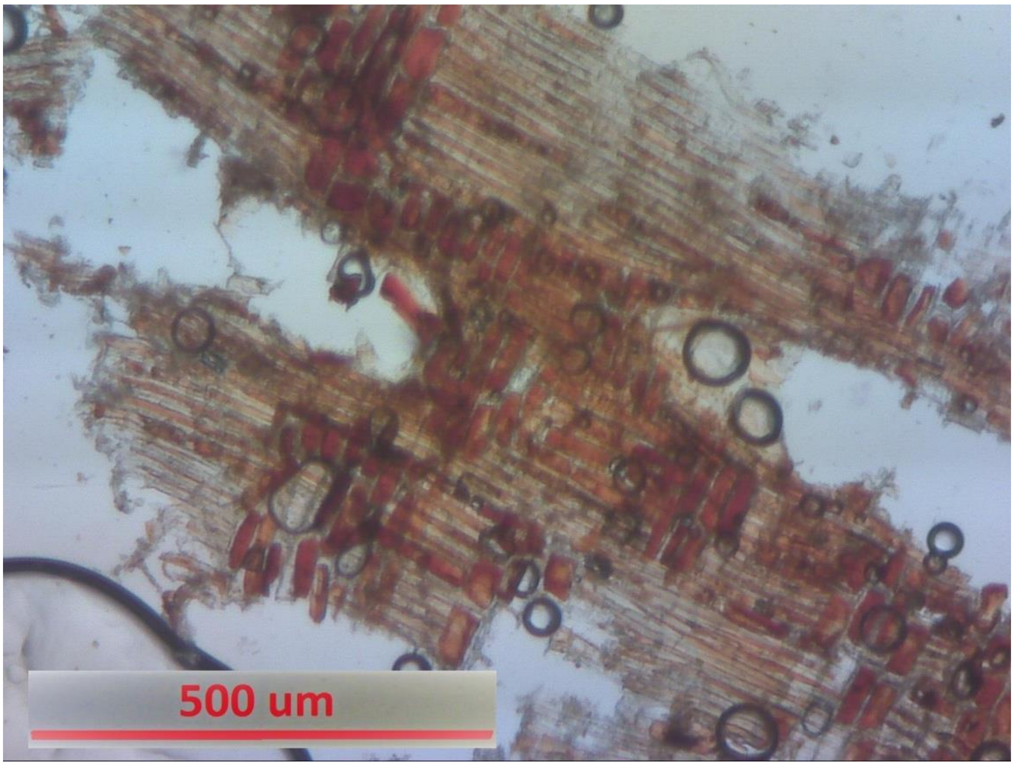
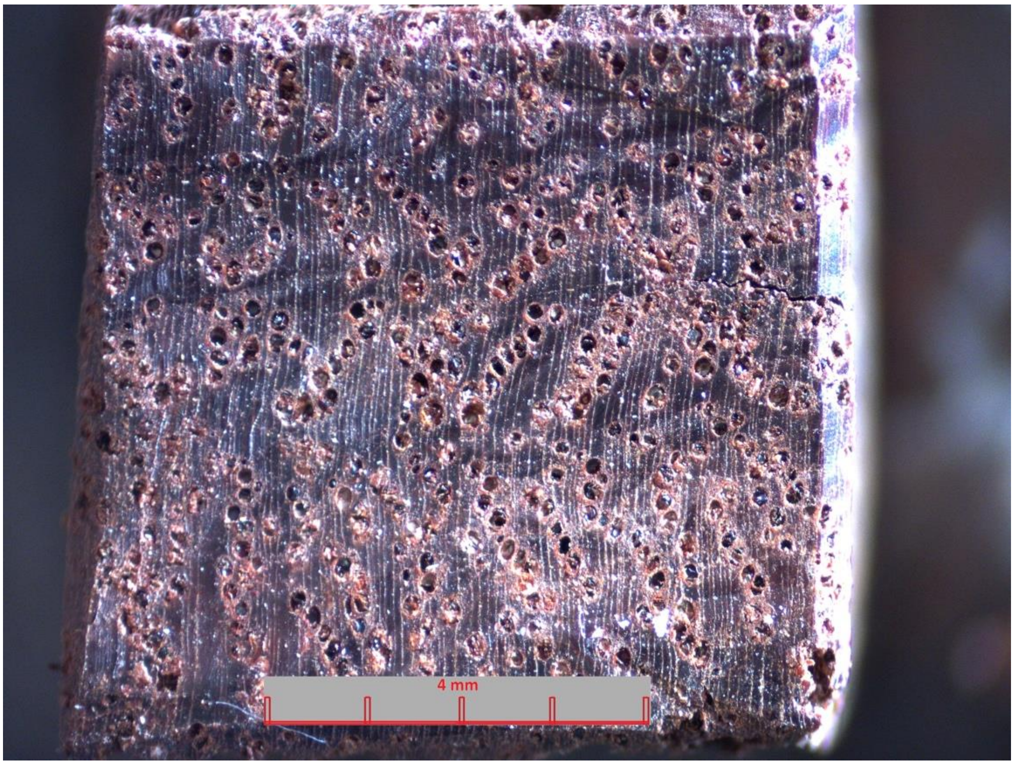
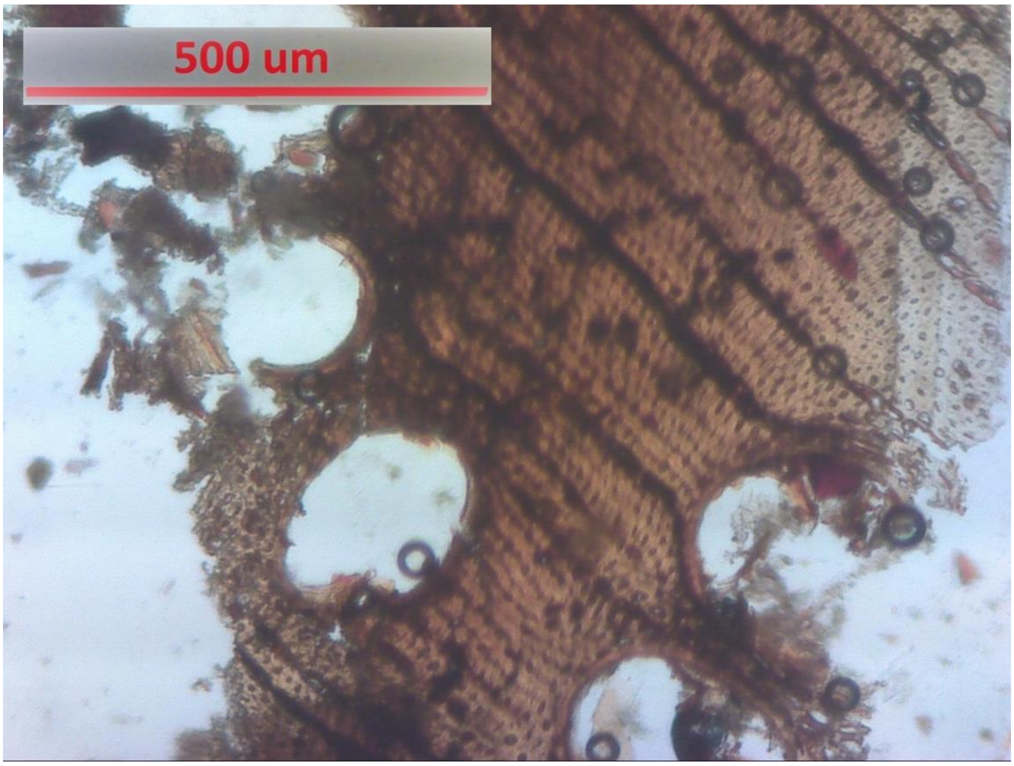


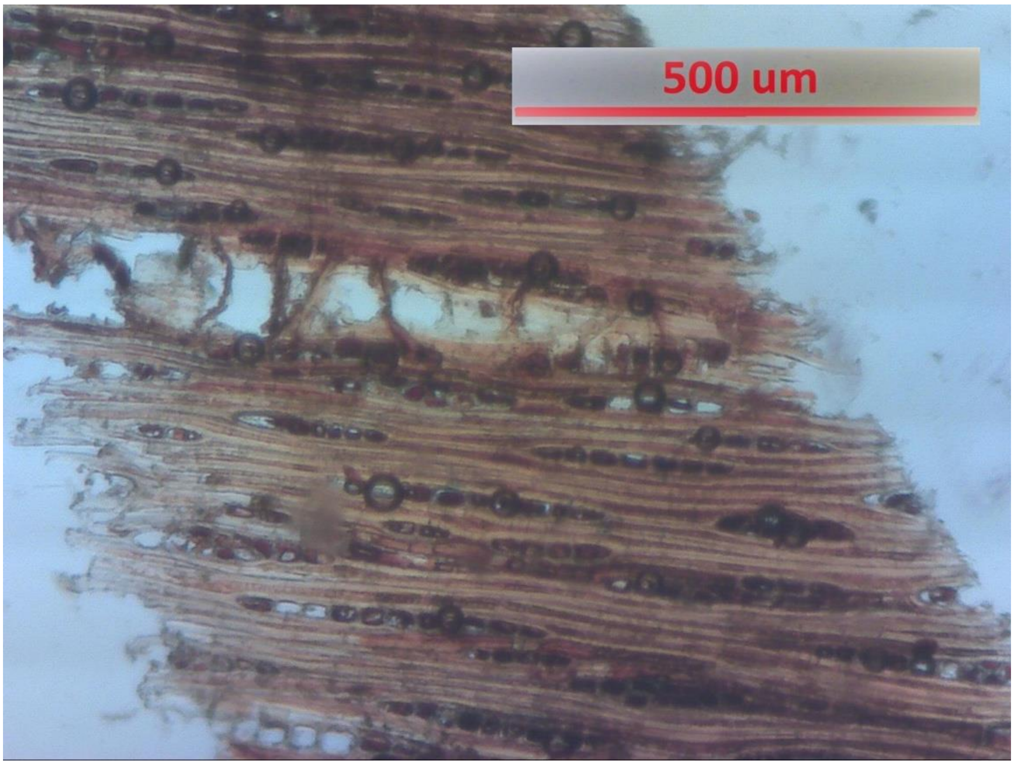
Sample 3. *Eucalyptus marginta* (Jarrah). Planking strake 3, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



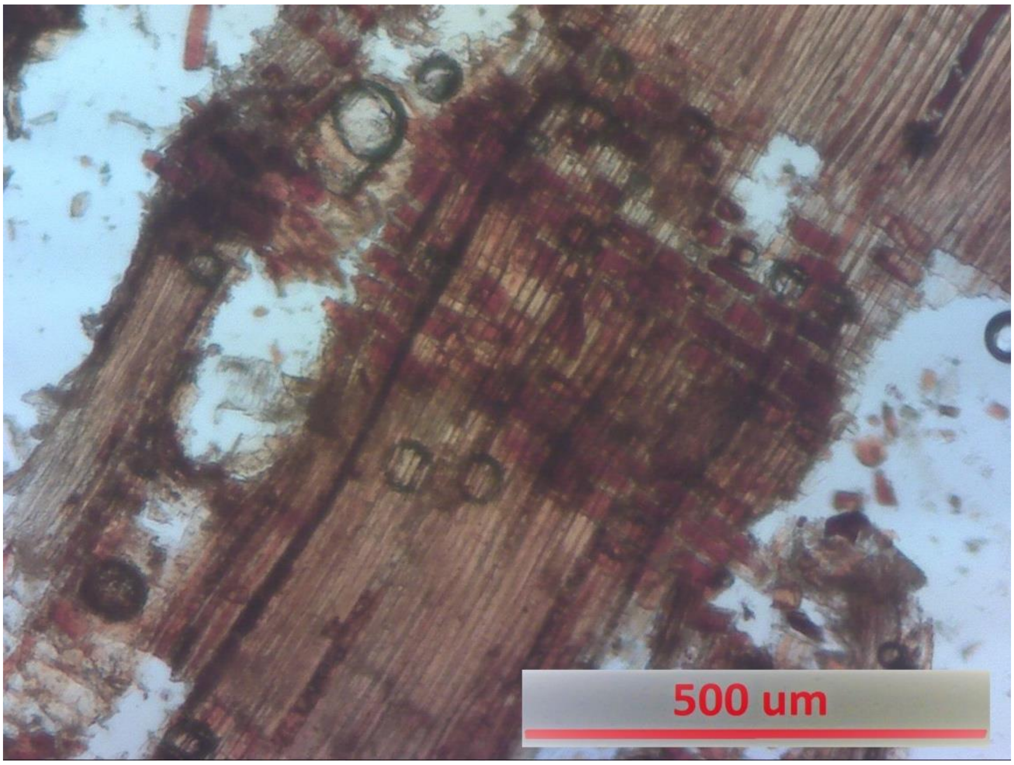
Sample 4. ***Eucalyptus marginta*** (Jarrah). Planking strake 4, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



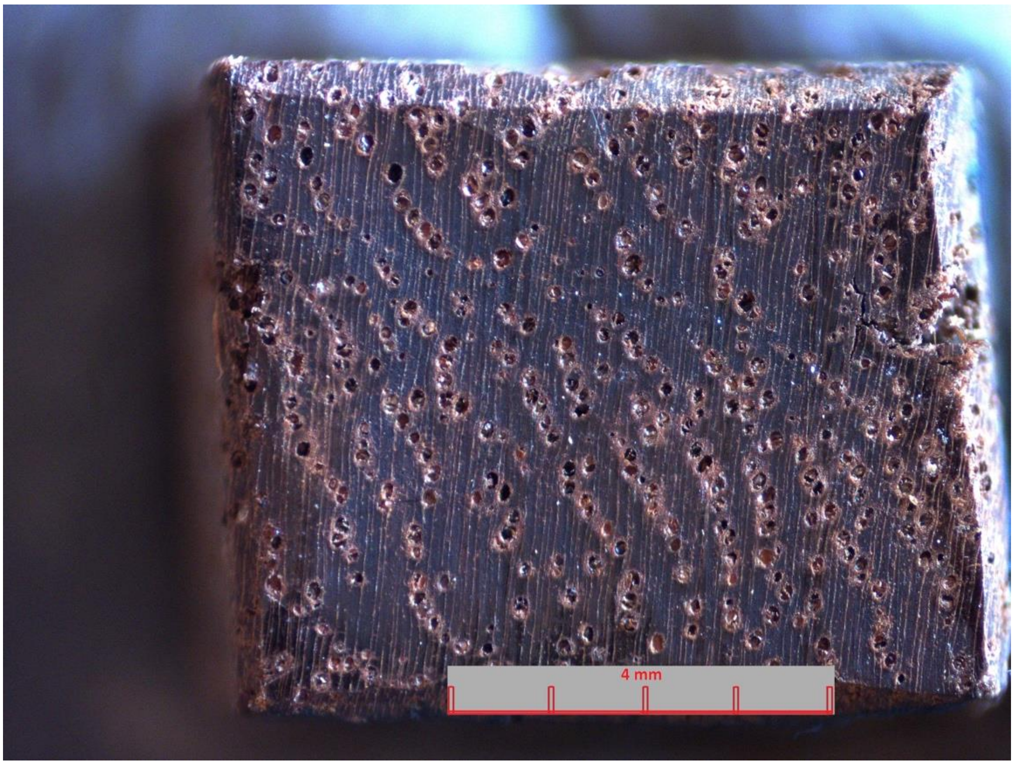
Sample 4. ***Eucalyptus marginta*** (Jarrah). Planking strake 4, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



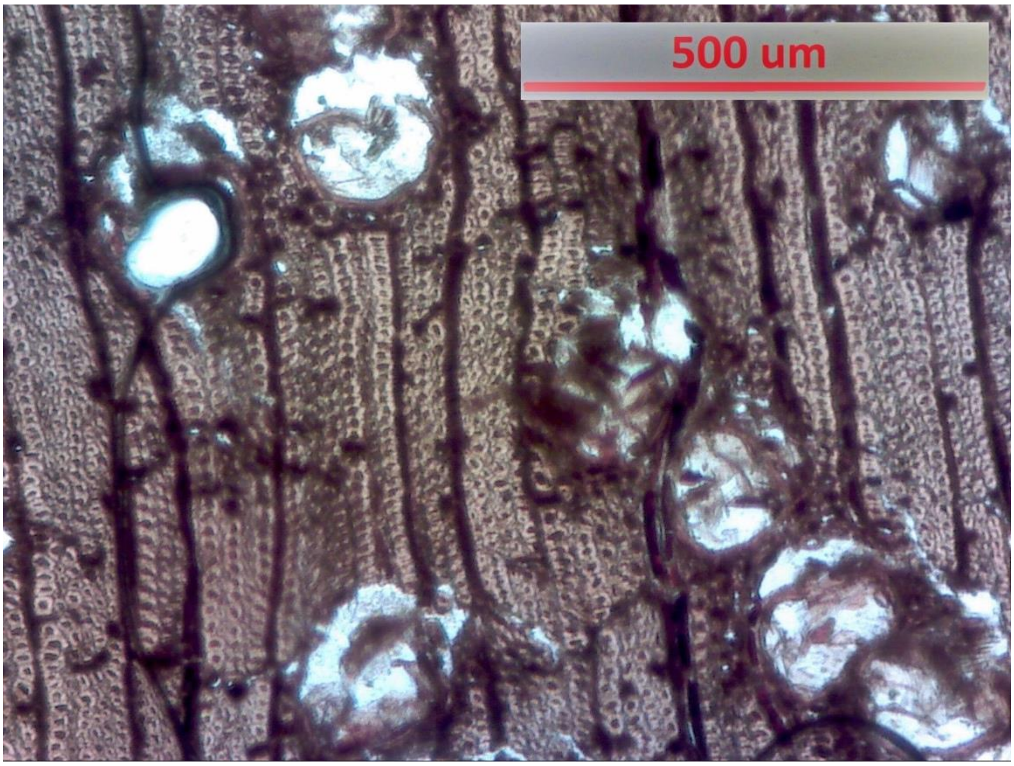
Sample 4. ***Eucalyptus marginta*** **(Jarrah). Planking strake 4, portside bow. Sample from hood end of plank. Identified by Jugo Illic.**



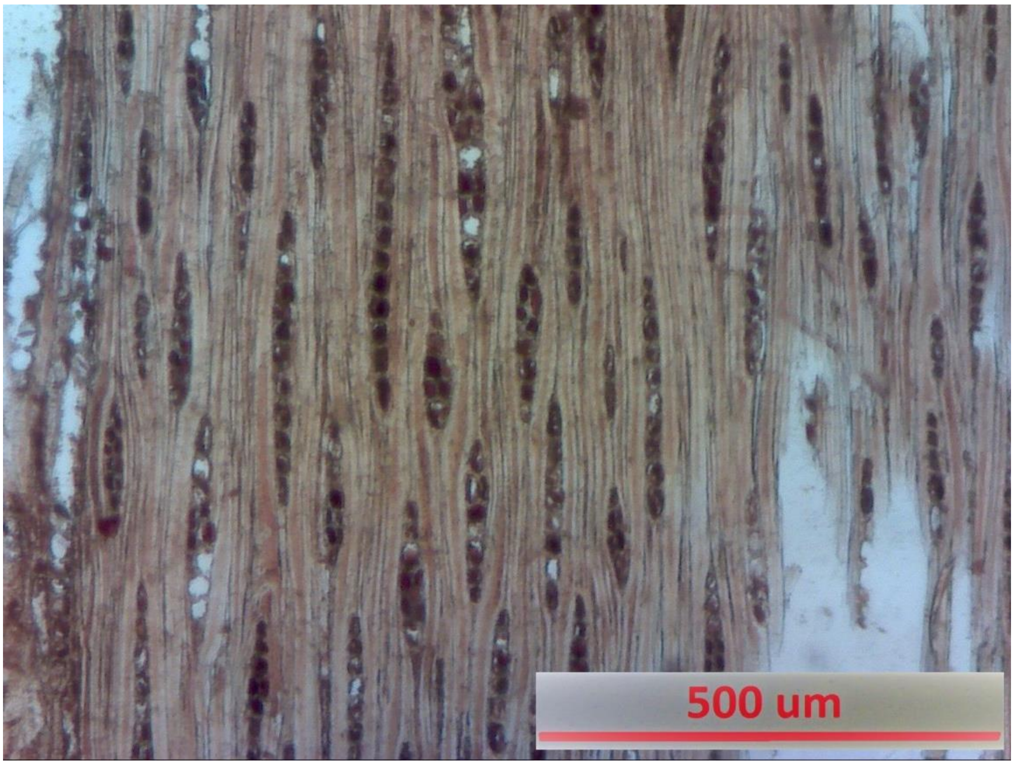
Sample 4. ***Eucalyptus marginta*** **(Jarrah). Planking strake 4, portside bow. Sample from hood end of plank. Identified by Jugo Illic.**



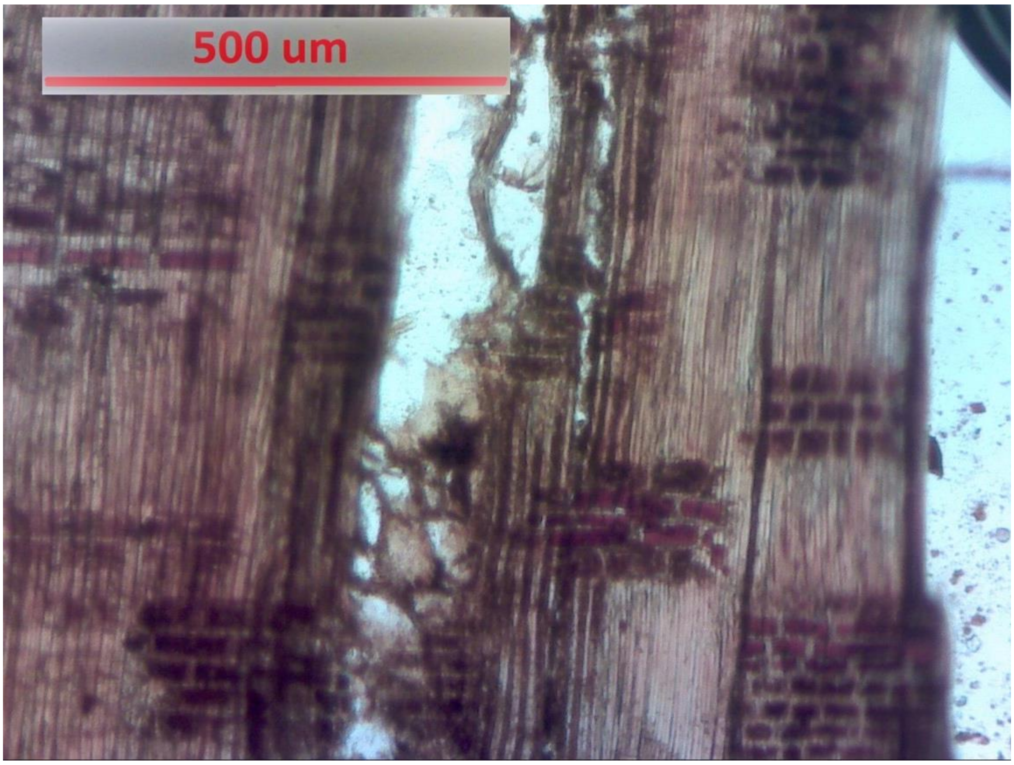
Sample 5. *Eucalyptus marginta* (Jarrah). Planking strake 5, portside bow. Sample from forward area of plank, top side. Identified by Jugo Illic.



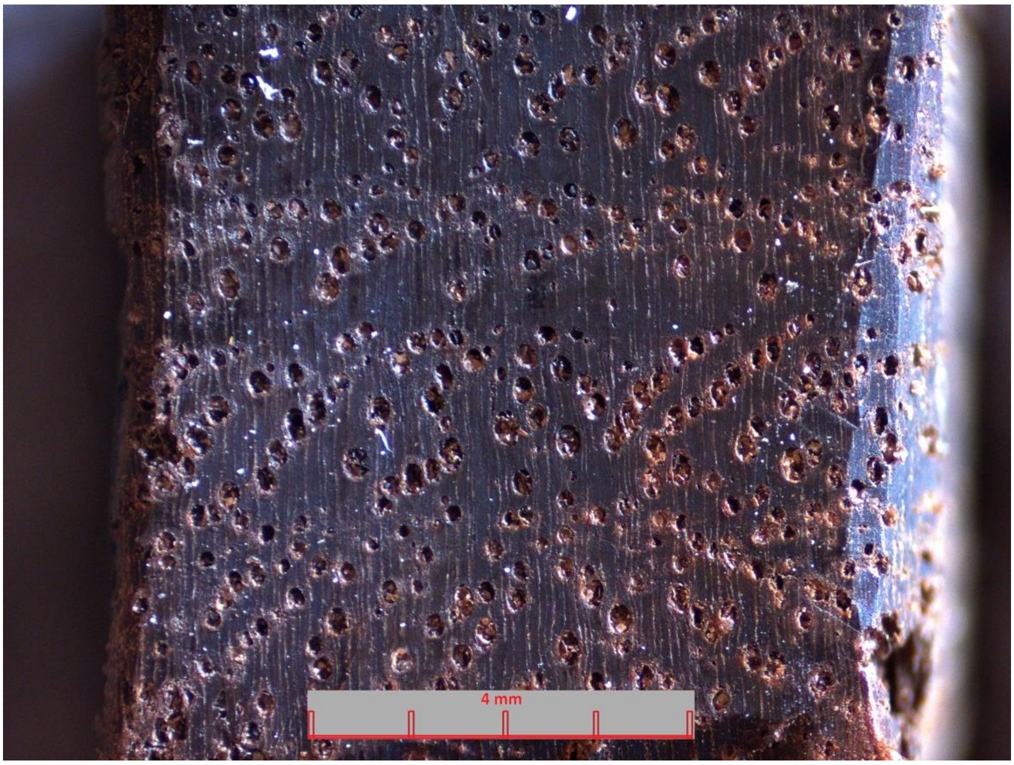
Sample 5. *Eucalyptus marginta* (Jarrah). Planking strake 5, portside bow. Sample from forward area of plank, top side. Identified by Jugo Illic.



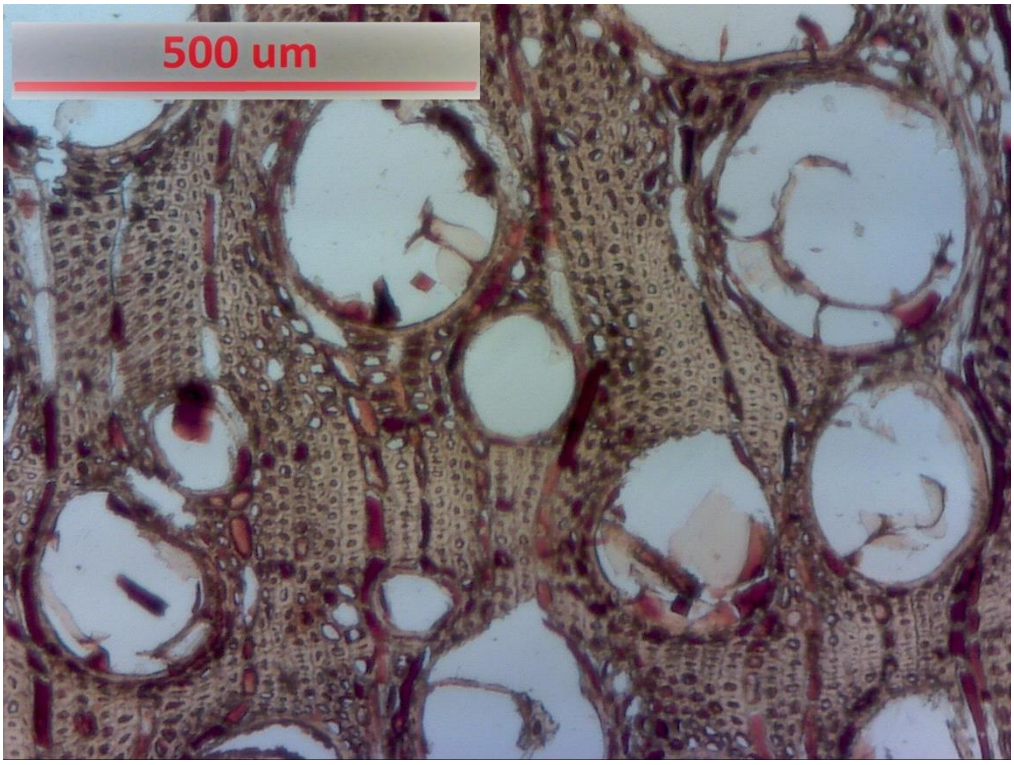
Sample 5. *Eucalyptus marginta* (Jarrah). Planking strake 5, portside bow. Sample from forward area of plank, top side. Identified by Jugo Illic.



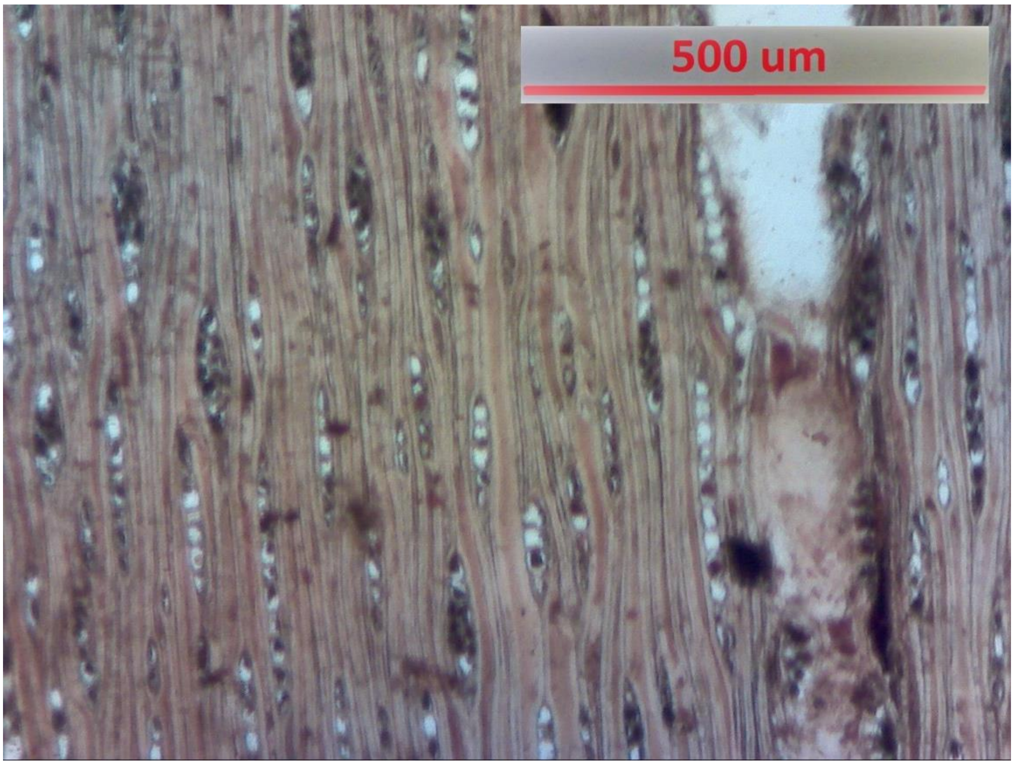
Sample 5. *Eucalyptus marginta* (Jarrah). Planking strake 5, portside bow. Sample from forward area of plank, top side. Identified by Jugo Illic.



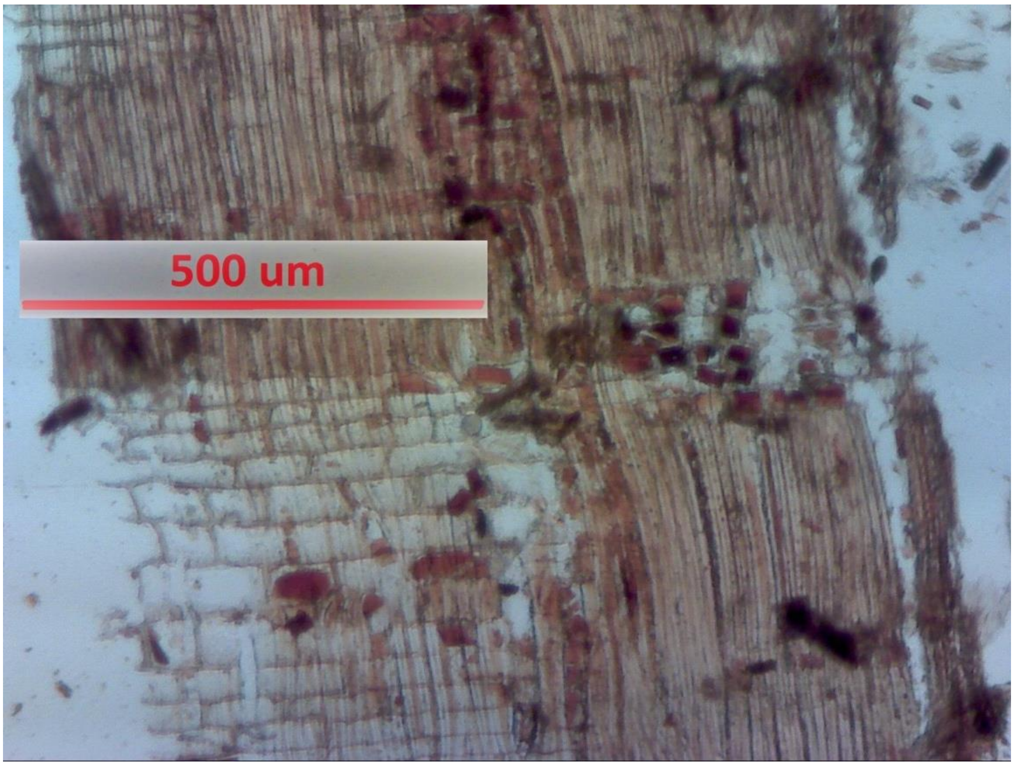
Sample 6. *Eucalyptus marginta* (Jarrah). Planking strake 6, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



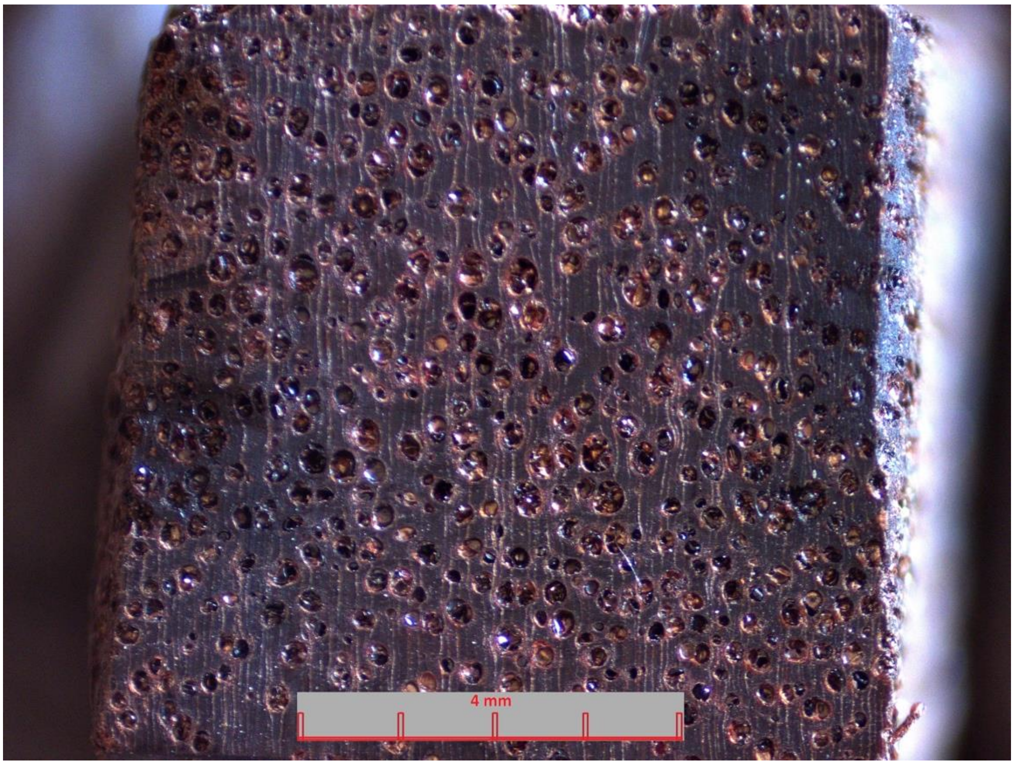
Sample 6. *Eucalyptus marginta* (Jarrah). Planking strake 6, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



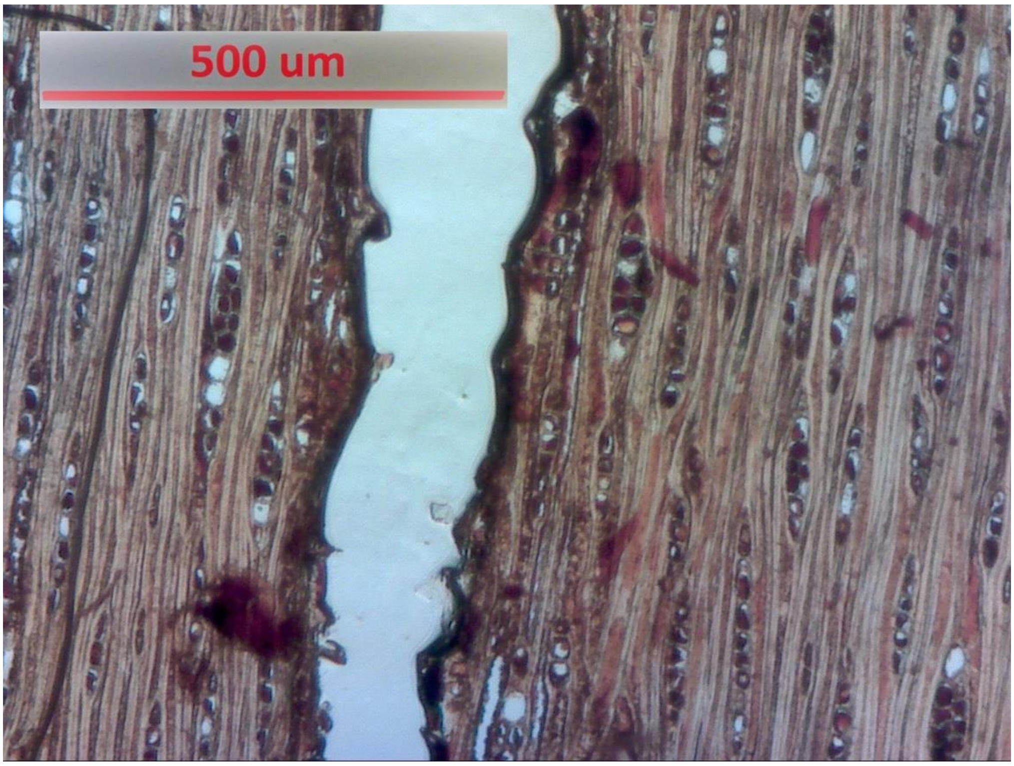
Sample 6. *Eucalyptus marginta* (Jarrah). Planking strake 6, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



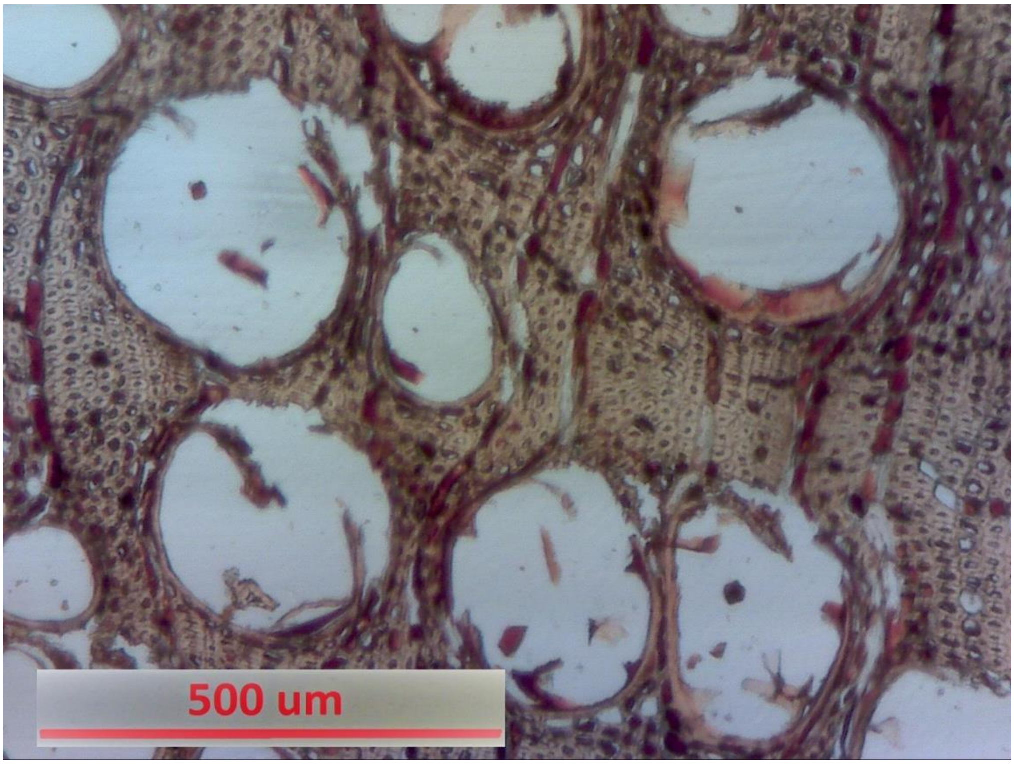
Sample 6. *Eucalyptus marginta* (Jarrah). Planking strake 6, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



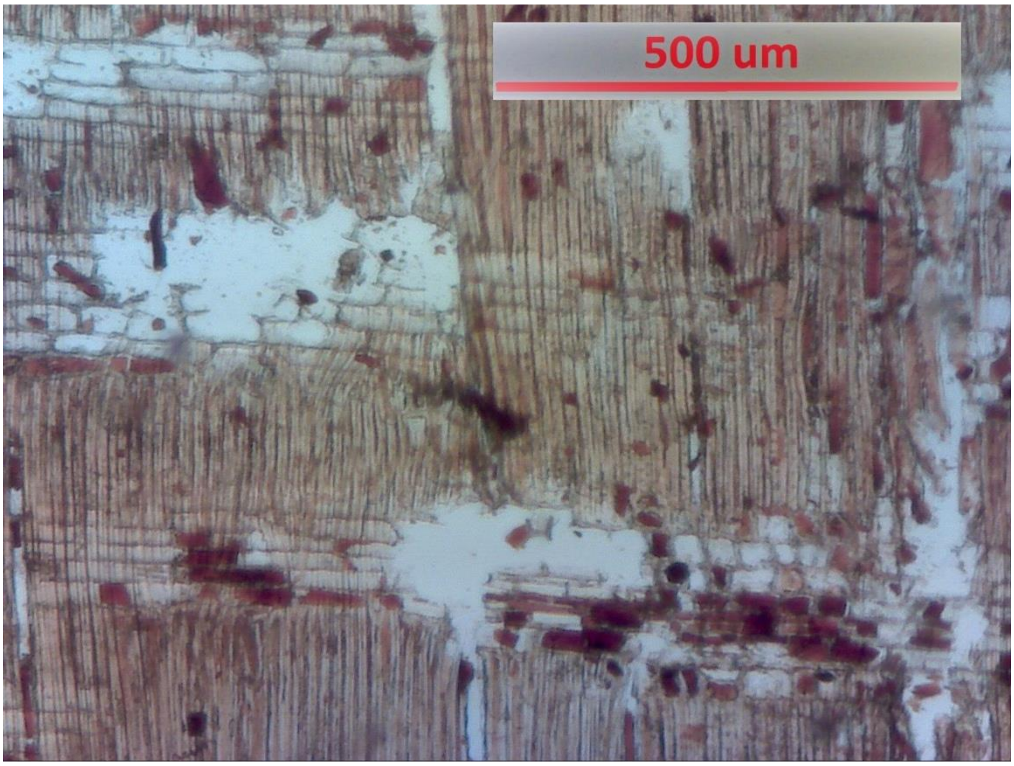
Sample 7. *Eucalyptus marginta* (Jarrah). Planking strake 7, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



Sample 7. *Eucalyptus marginta* (Jarrah). Planking strake 7, portside bow. Sample from hood end of plank. Identified by Jugo Illic.

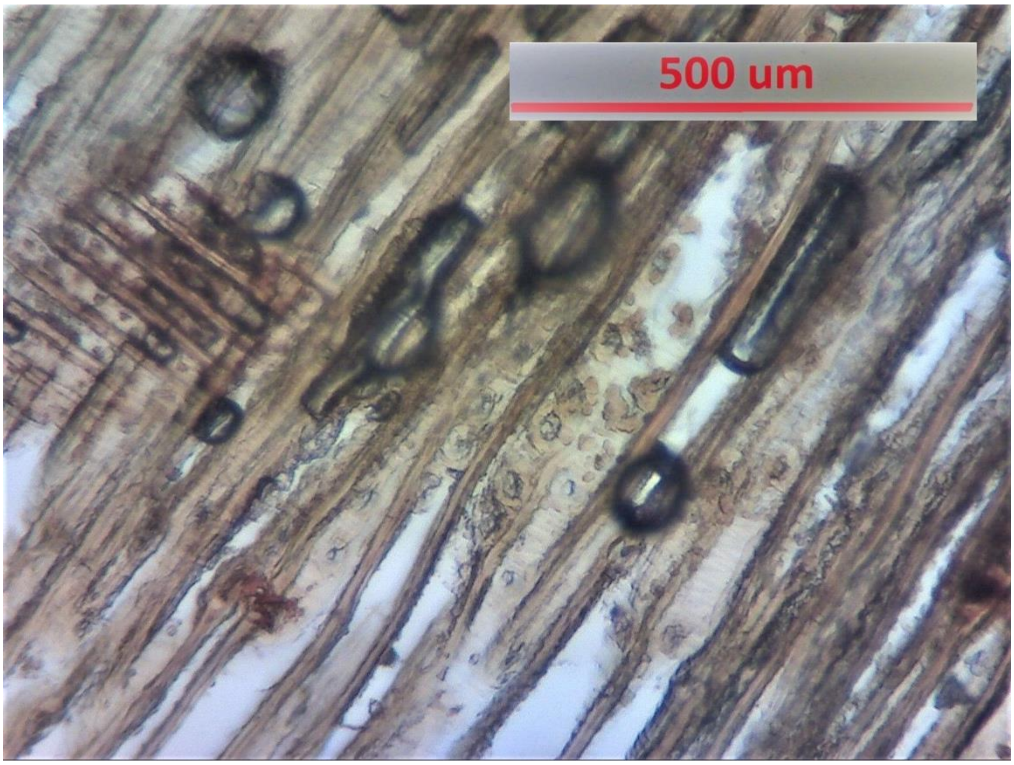


Sample 7. *Eucalyptus marginta* (Jarrah). Planking strake 7, portside bow. Sample from hood end of plank. Identified by Jugo Illic.

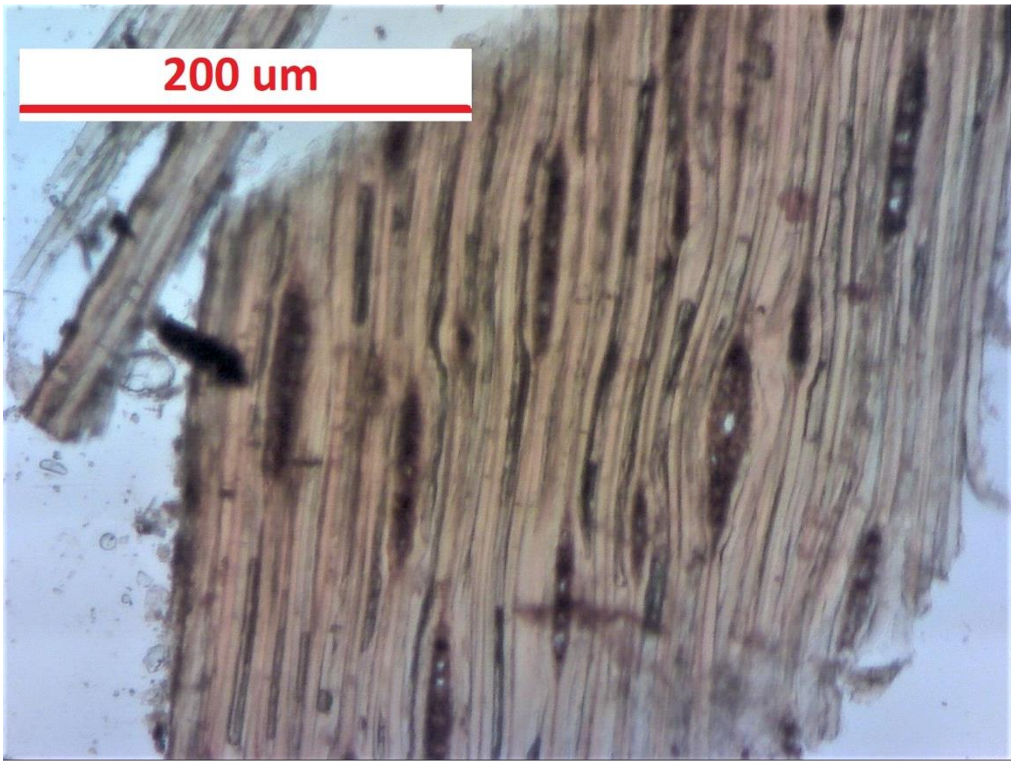


Sample 7. *Eucalyptus marginta* (Jarrah). Planking strake 7, portside bow. Sample from hood end of plank. Identified by Jugo Illic.

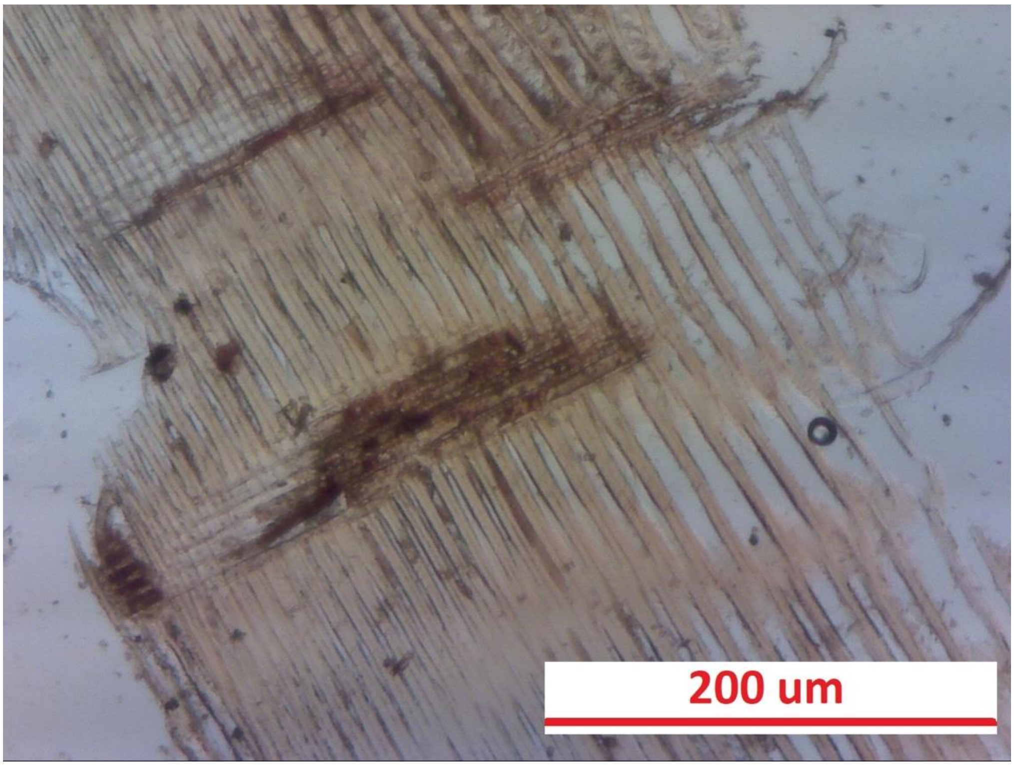
Sample 7x. ***Pseudotsuga menzieii*** **(Douglas fir). Transverse plug. Identified by Jugo Illic.**



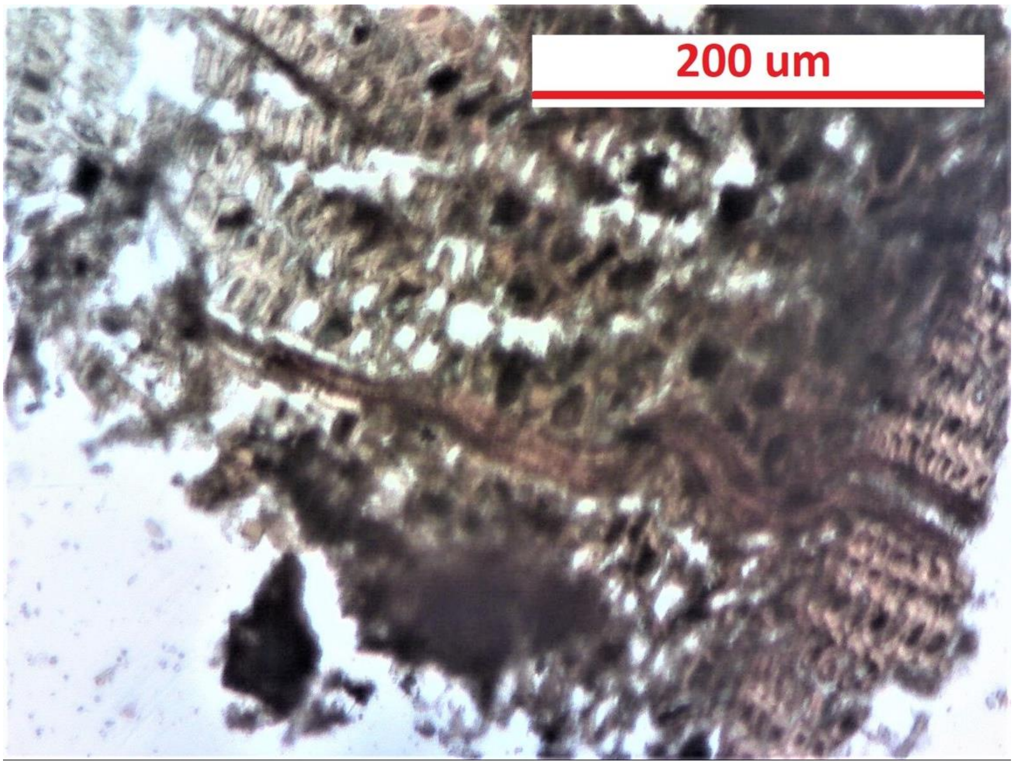
Sample 7x. ***Pseudotsuga menzieii*** **(Douglas fir). Transverse plug. Identified by Jugo Illic.**



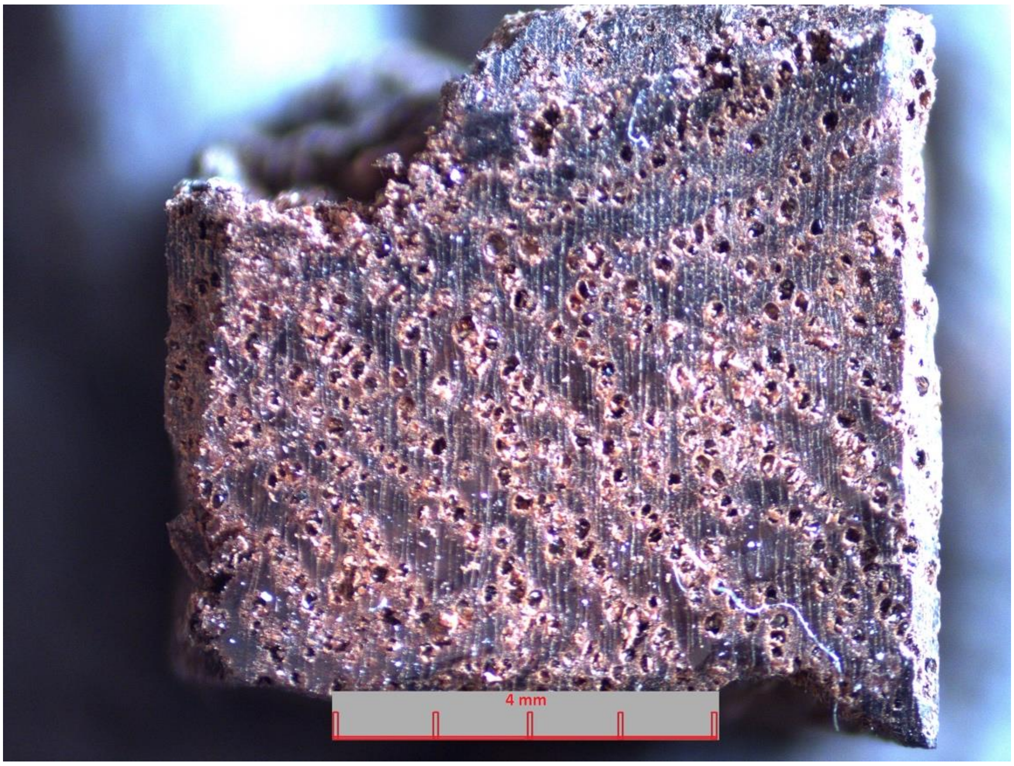
Sample 7x. *Pseudotsuga menzieii* (Douglas fir). Transverse plug. Identified by Jugo Illic.



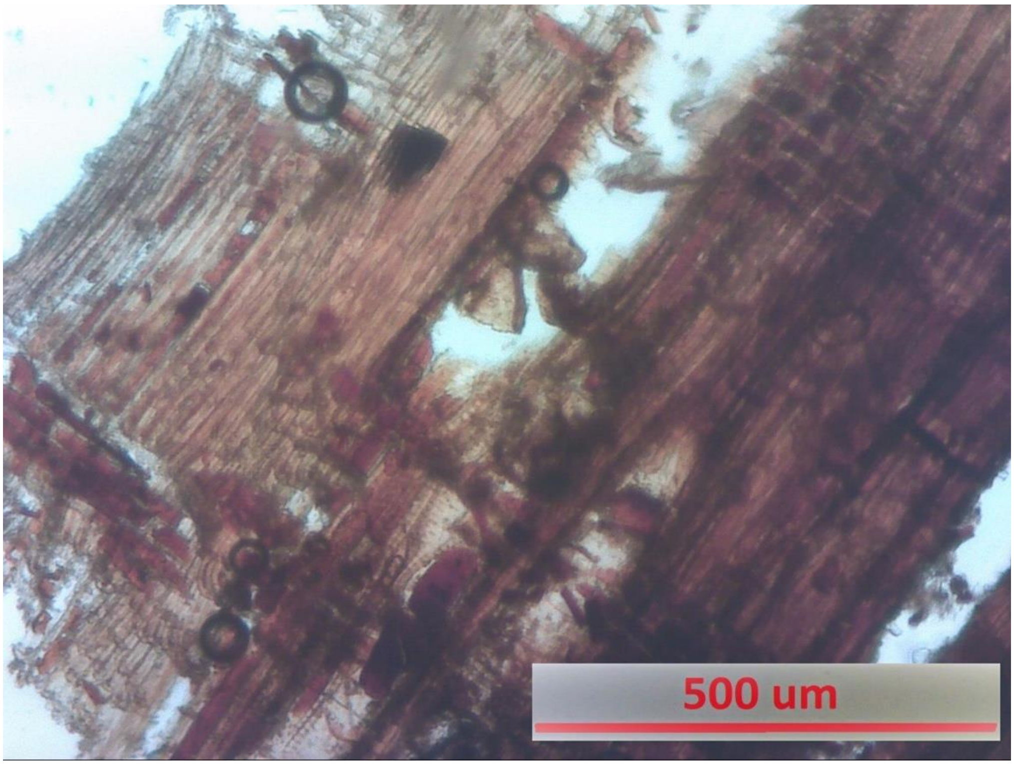
Sample 7x. *Pseudotsuga menzieii* (Douglas fir). Transverse plug. Identified by Jugo Illic.



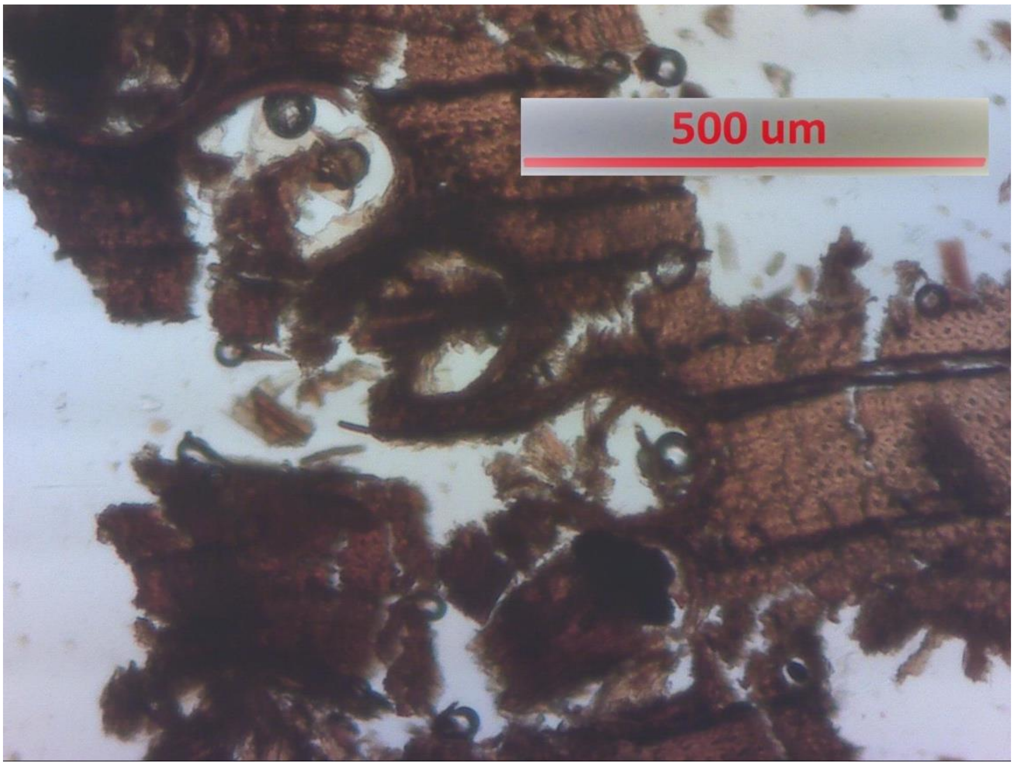
Sample 7x. *Pseudotsuga menzieii* (Douglas fir). Transverse plug. Identified by Jugo Illic.



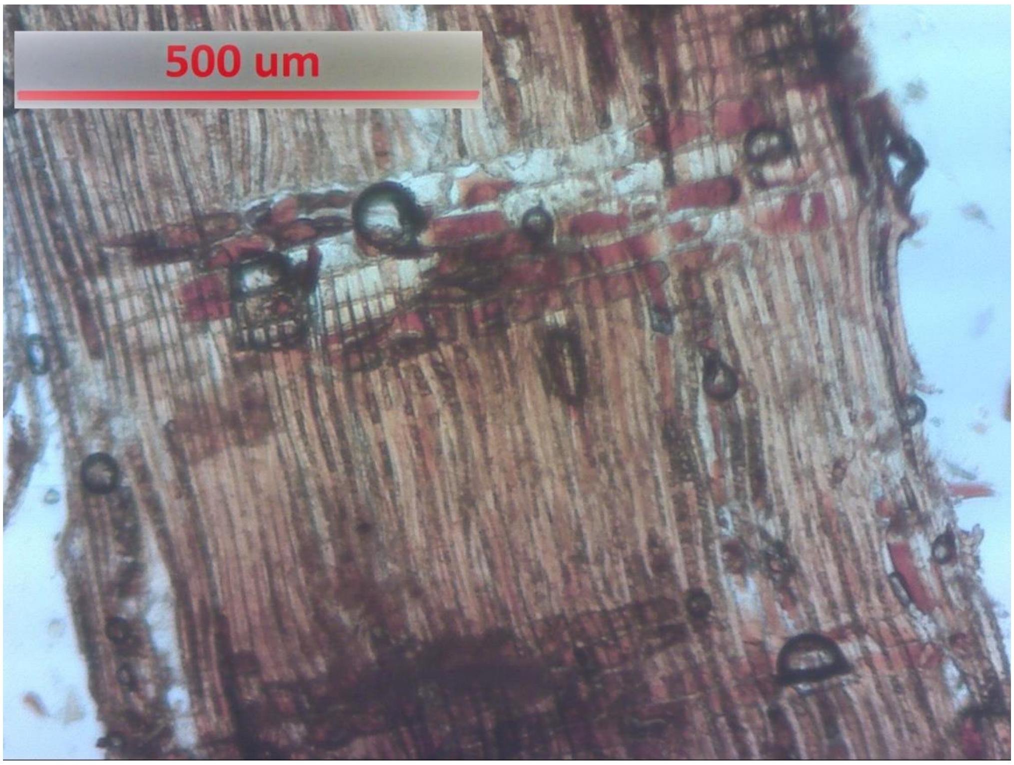
Sample 8. *Eucalyptus marginta* (Jarrah). Planking strake 8, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



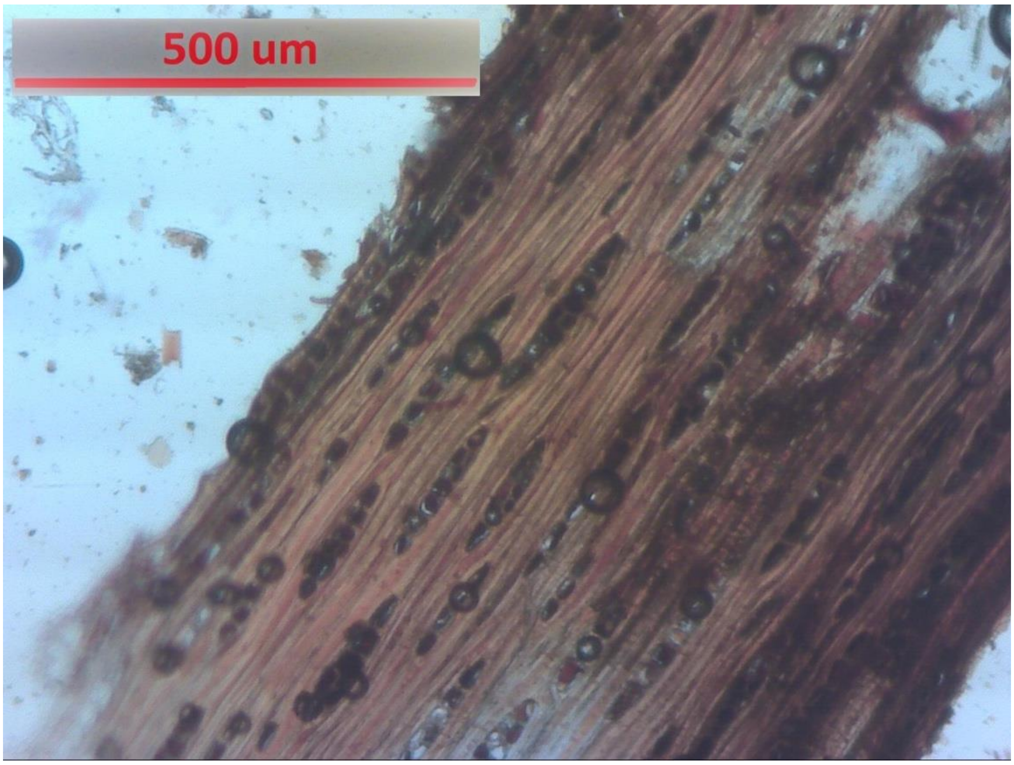
Sample 8. *Eucalyptus marginta* (Jarrah). Planking strake 8, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



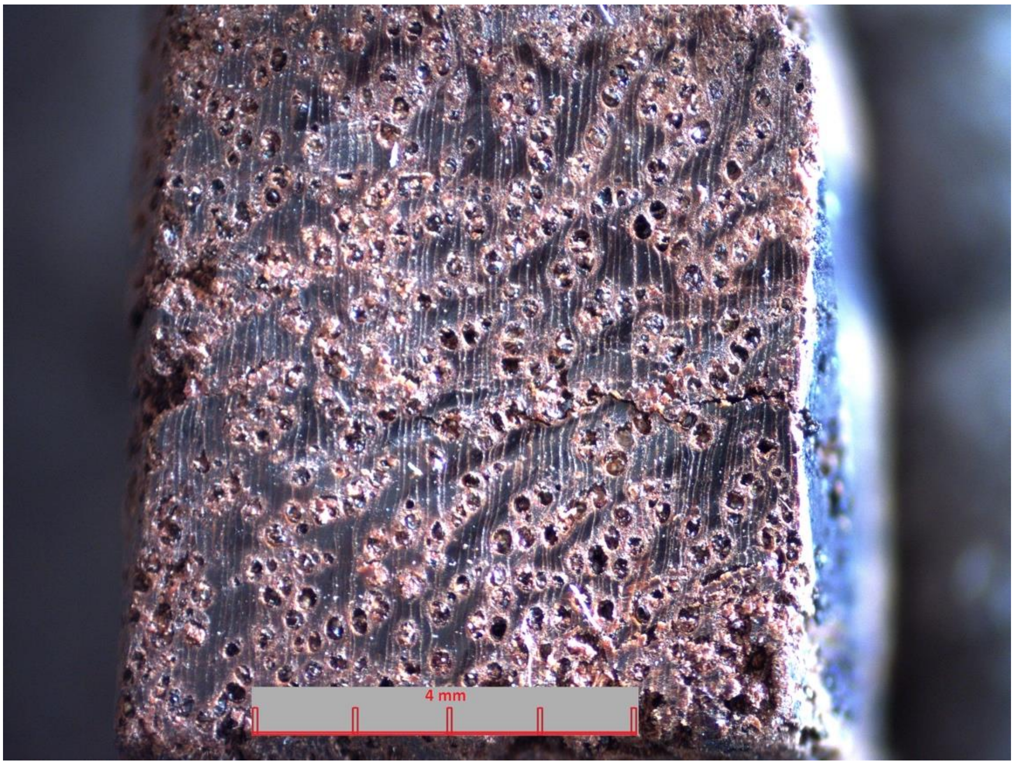
Sample 8. *Eucalyptus marginta* (Jarrah). Planking strake 8, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



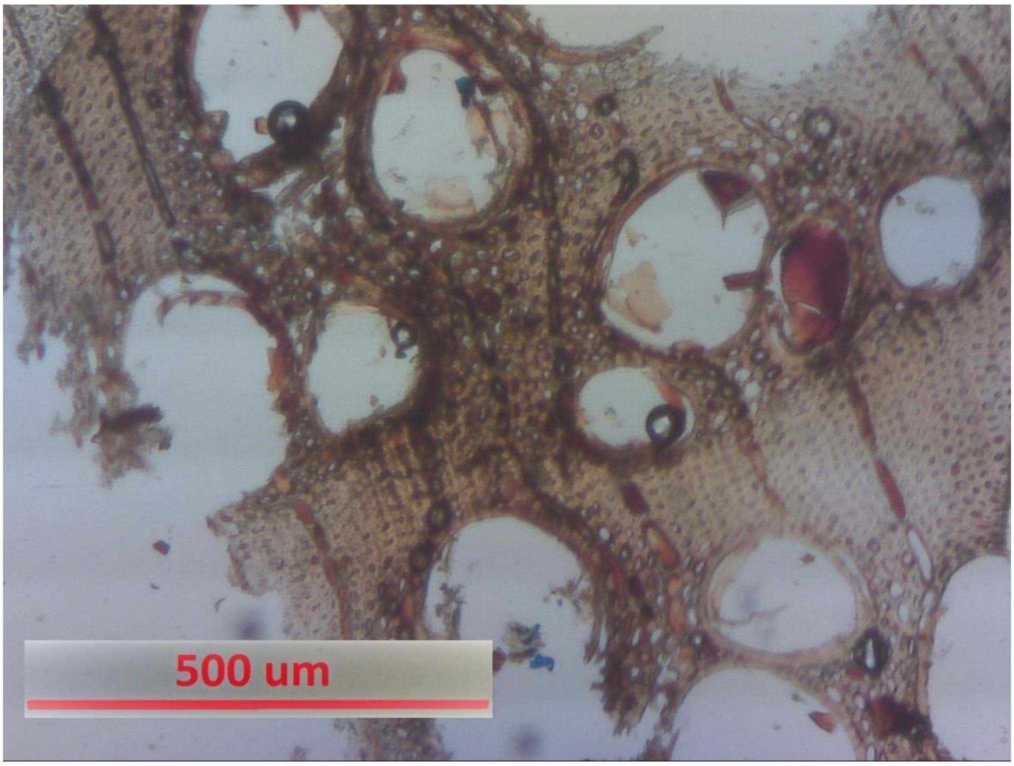
Sample 8. *Eucalyptus marginta* (Jarrah). Planking strake 8, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



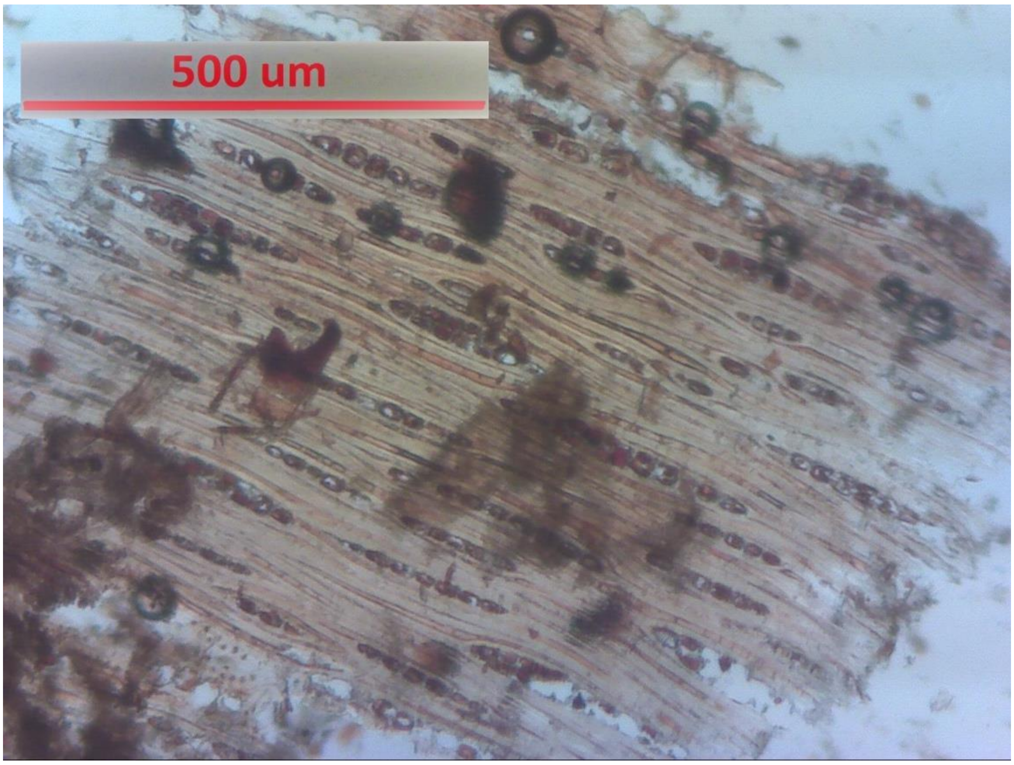
Sample 8. *Eucalyptus marginta* (Jarrah). Planking strake 8, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



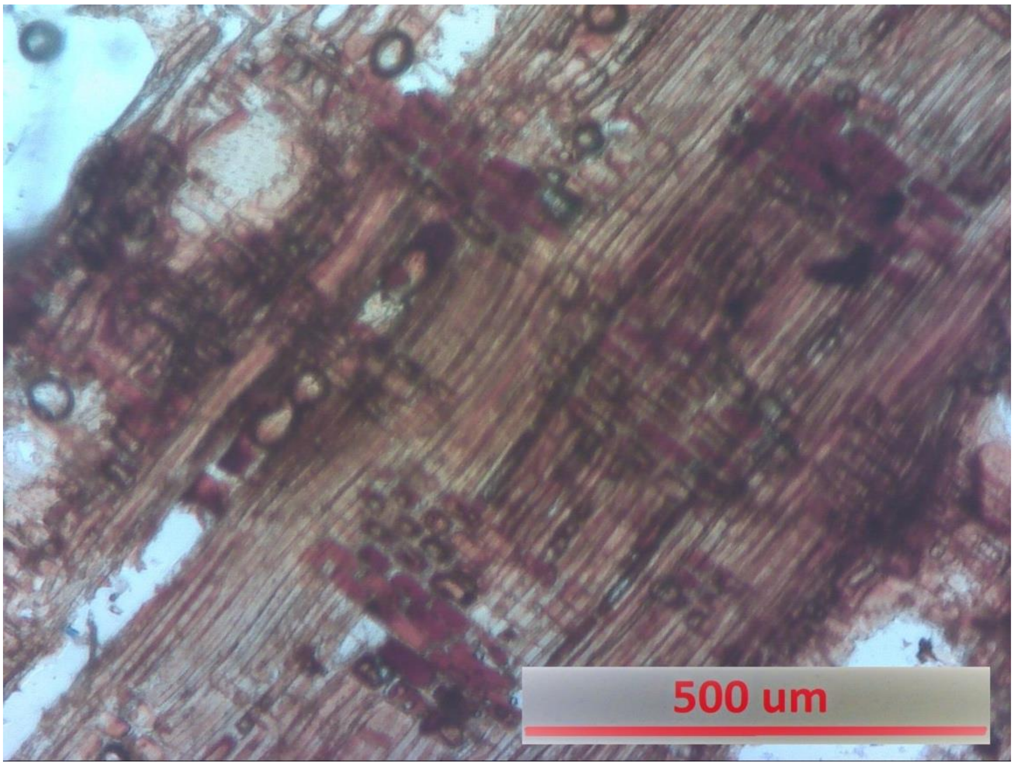
Sample 9. *Eucalyptus marginta* (Jarrah). Planking strake 9, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



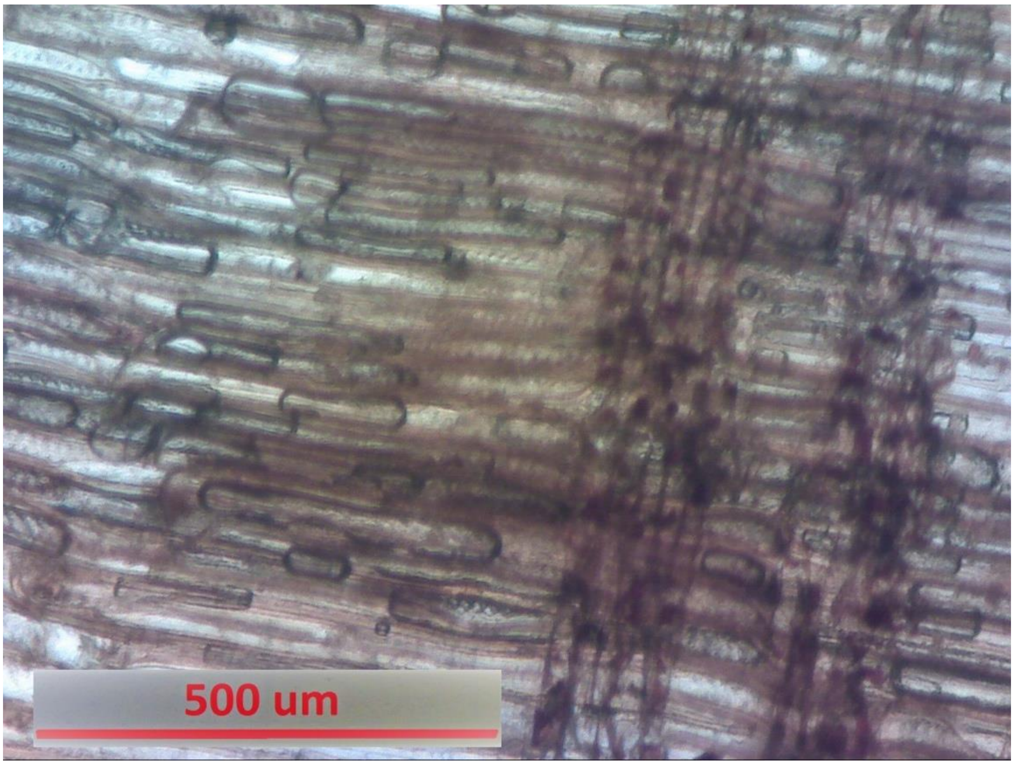
Sample 9. *Eucalyptus marginta* (Jarrah). Planking strake 9, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



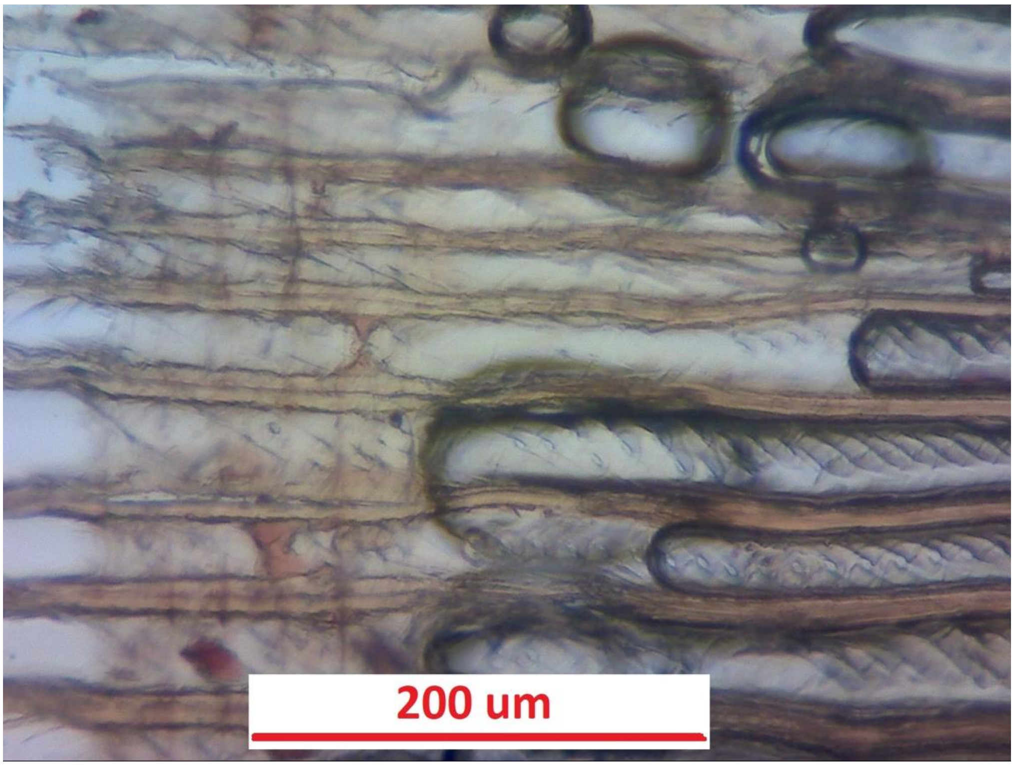
Sample 9. *Eucalyptus marginta* (Jarrah). Planking strake 9, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



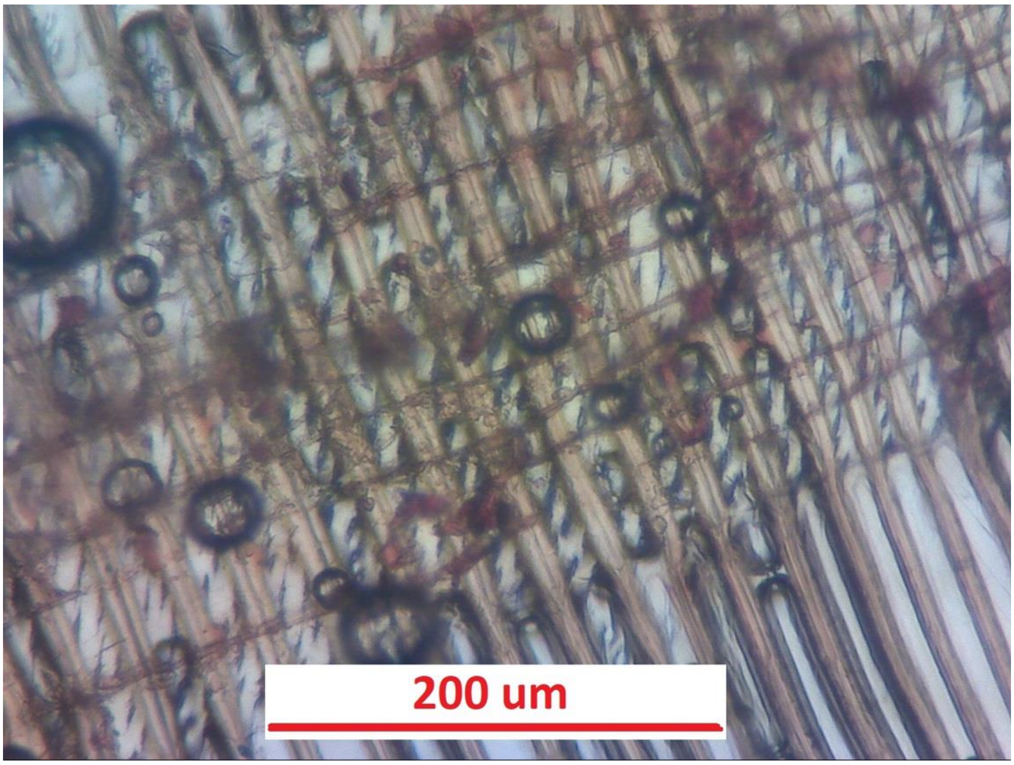
Sample 9. *Eucalyptus marginta* (Jarrah). Planking strake 9, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



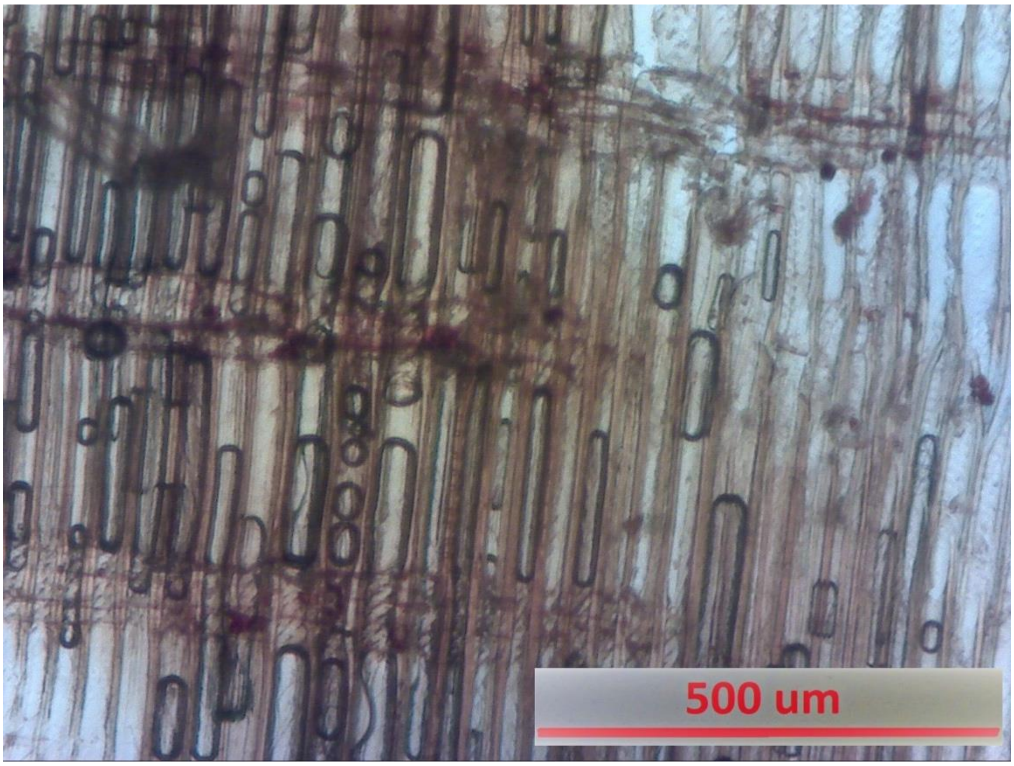
Sample 10. *Agathis sp.* (Kauri). Planking strake 10, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



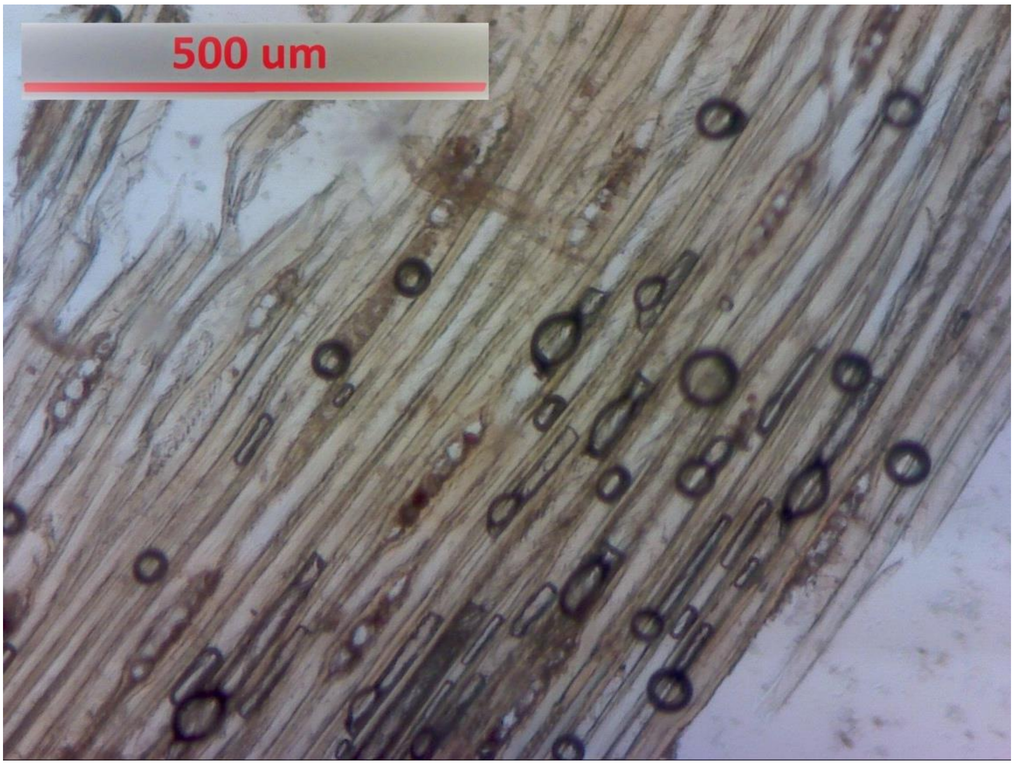
Sample 10. *Agathis sp.* (Kauri). Planking strake 10, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



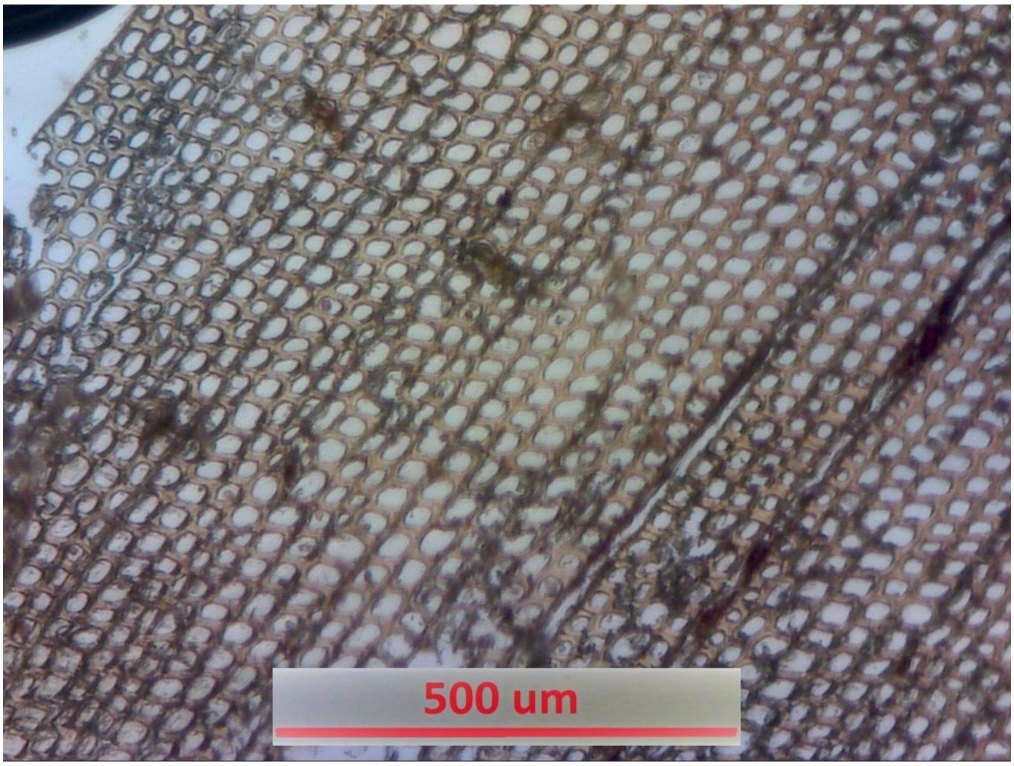
Sample 10. *Agathis sp.* (Kauri). Planking strake 10, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



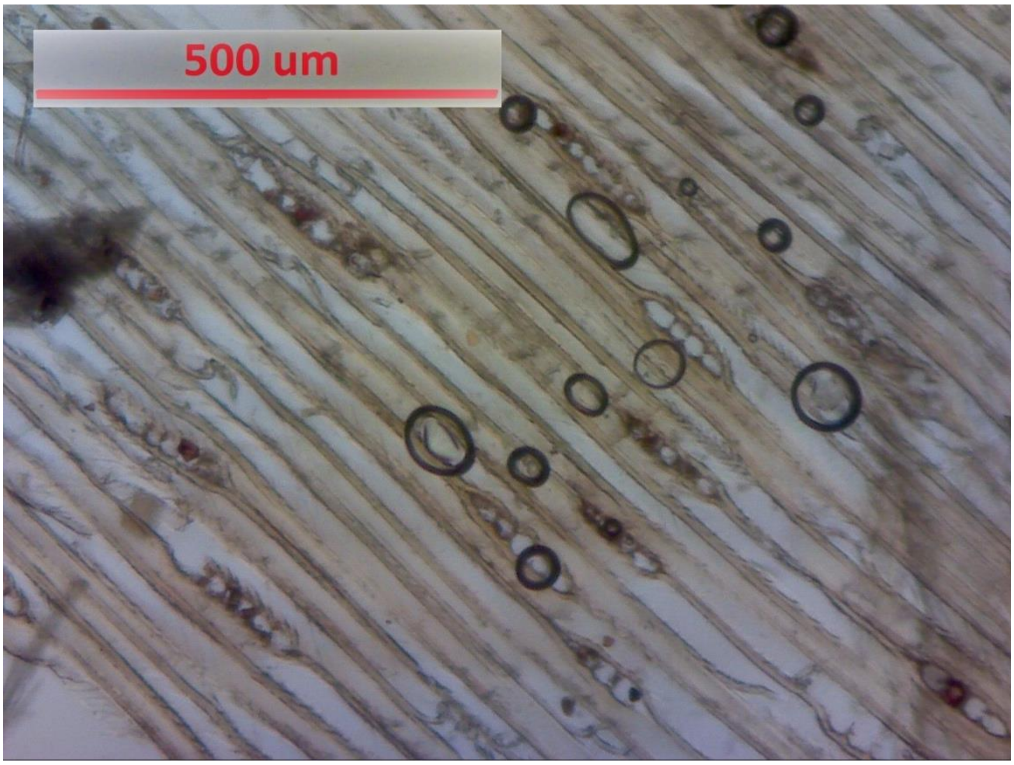
Sample 10. *Agathis sp.* (Kauri). Planking strake 10, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



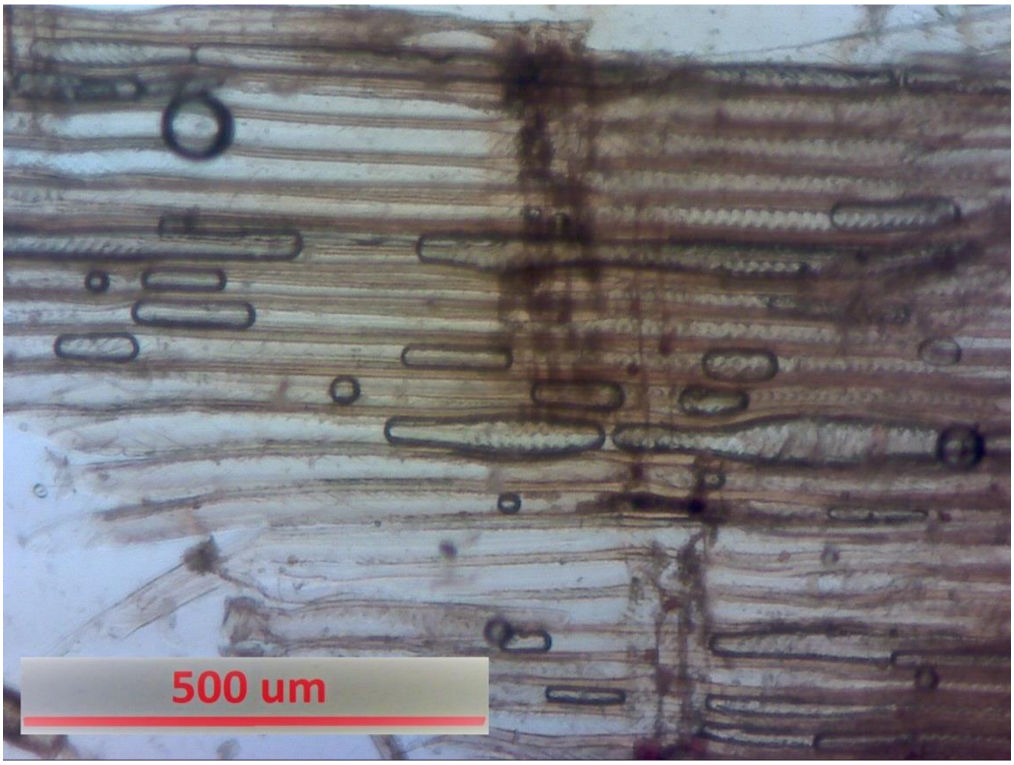
Sample 10. ***Agathis sp.*** **(Kauri). Planking strake 10, portside bow. Sample from hood end of plank. Identified by Jugo Illic.**



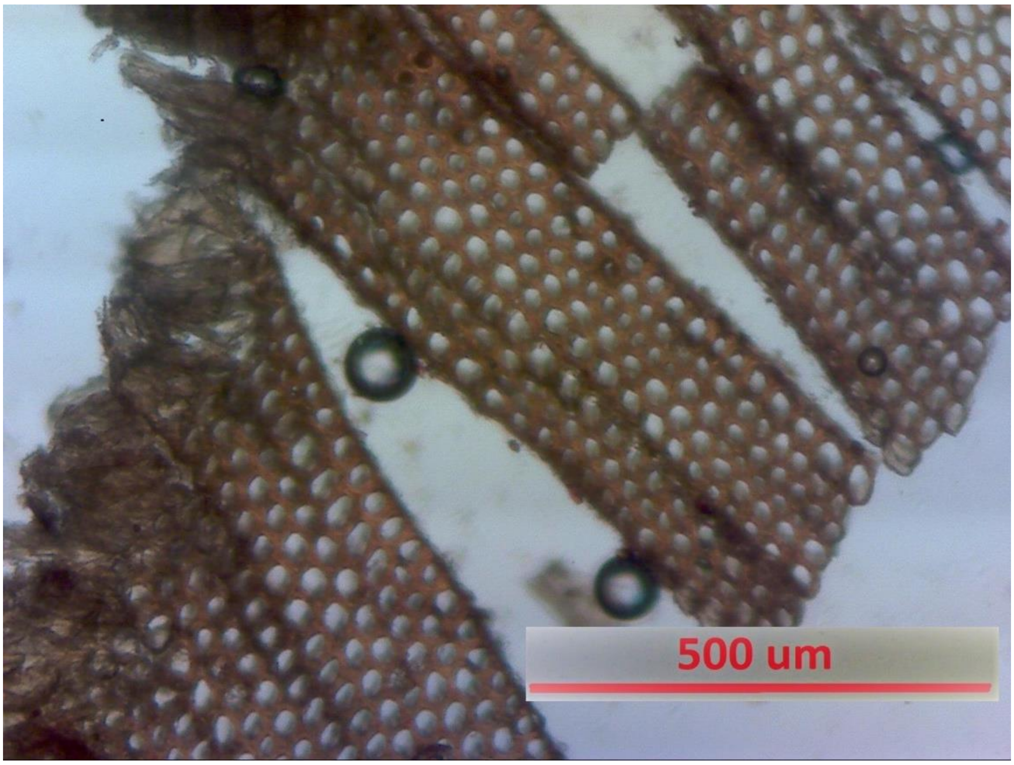
Sample 11. ***Agathis sp.*** **(Kauri). Planking strake 11, portside bow. Sample from hood end of plank. Identified by Jugo Illic.**



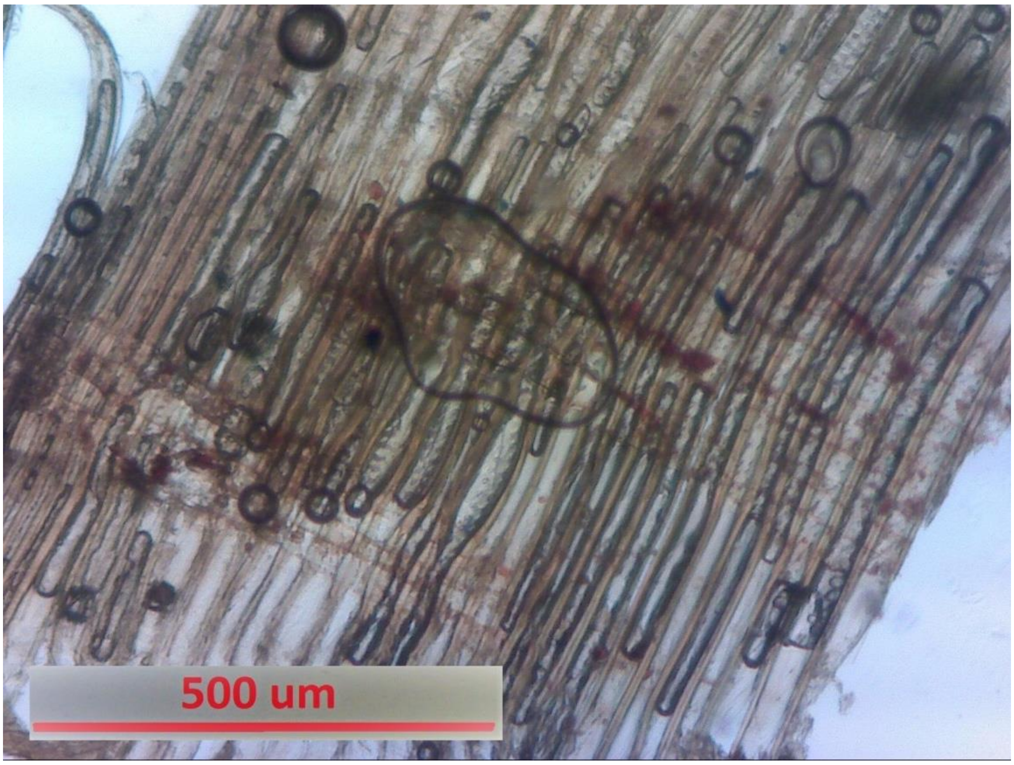
Sample 11. ***Agathis sp.*** (Kauri). Planking strake 11, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



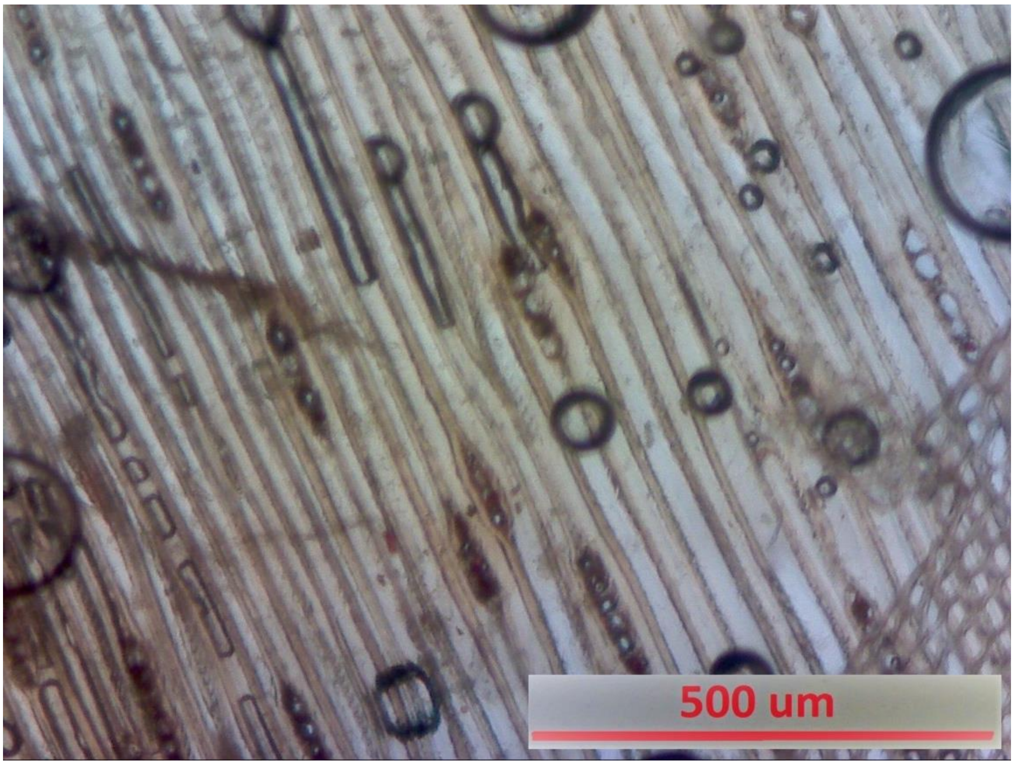
Sample 11. ***Agathis sp.*** (Kauri). Planking strake 11, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



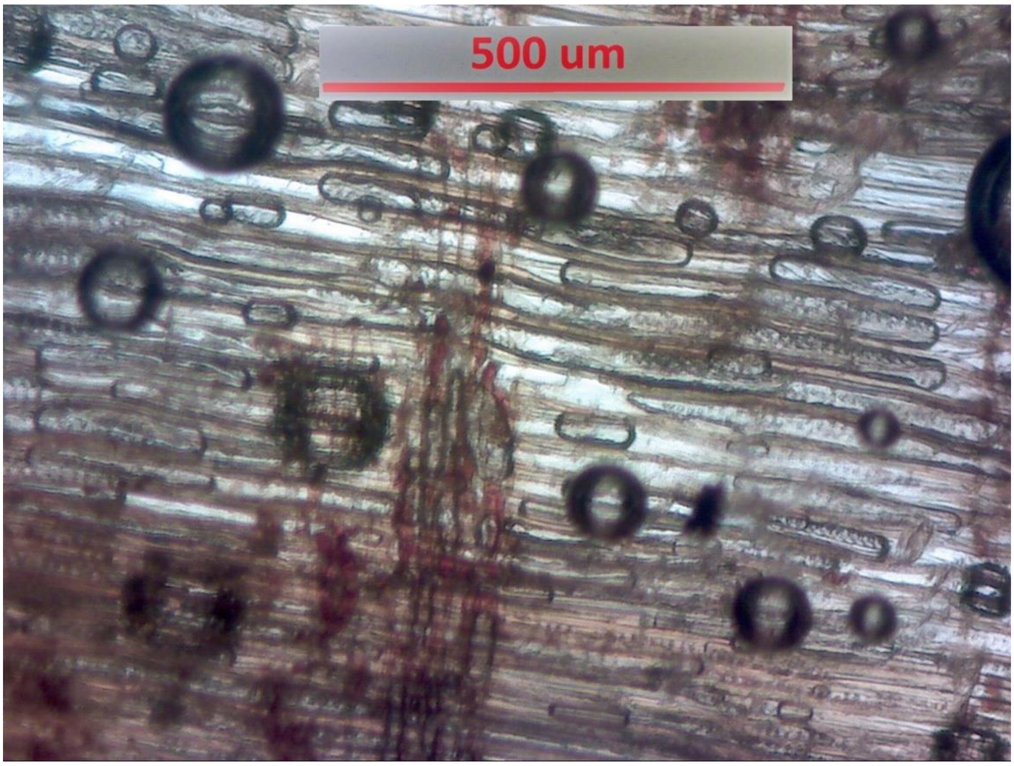
Sample 12. *Agathis sp.* (Kauri). Planking strake 12, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



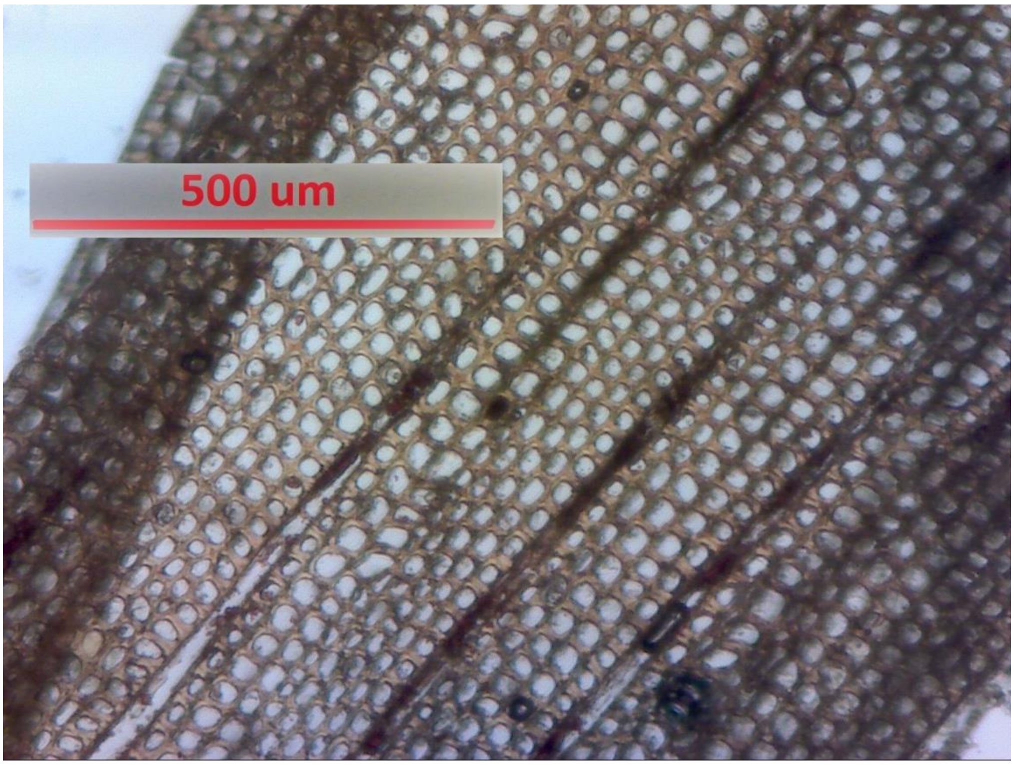
Sample 12. *Agathis sp.* (Kauri). Planking strake 12, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



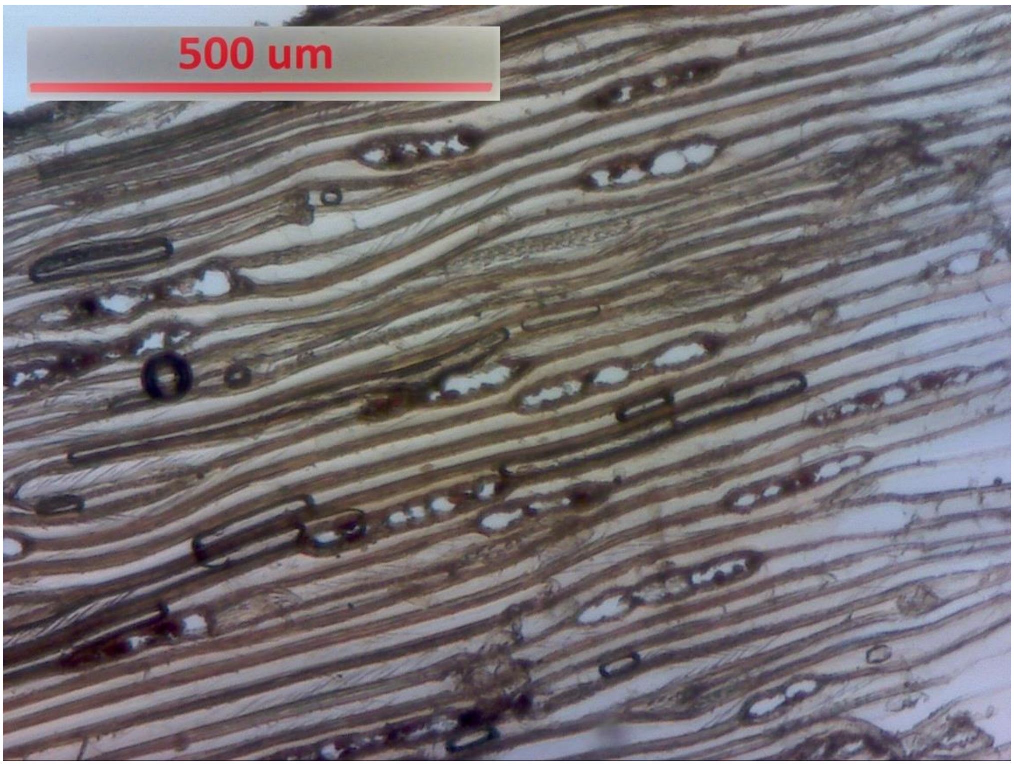
Sample 12. *Agathis sp.* (Kauri). Planking strake 12, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



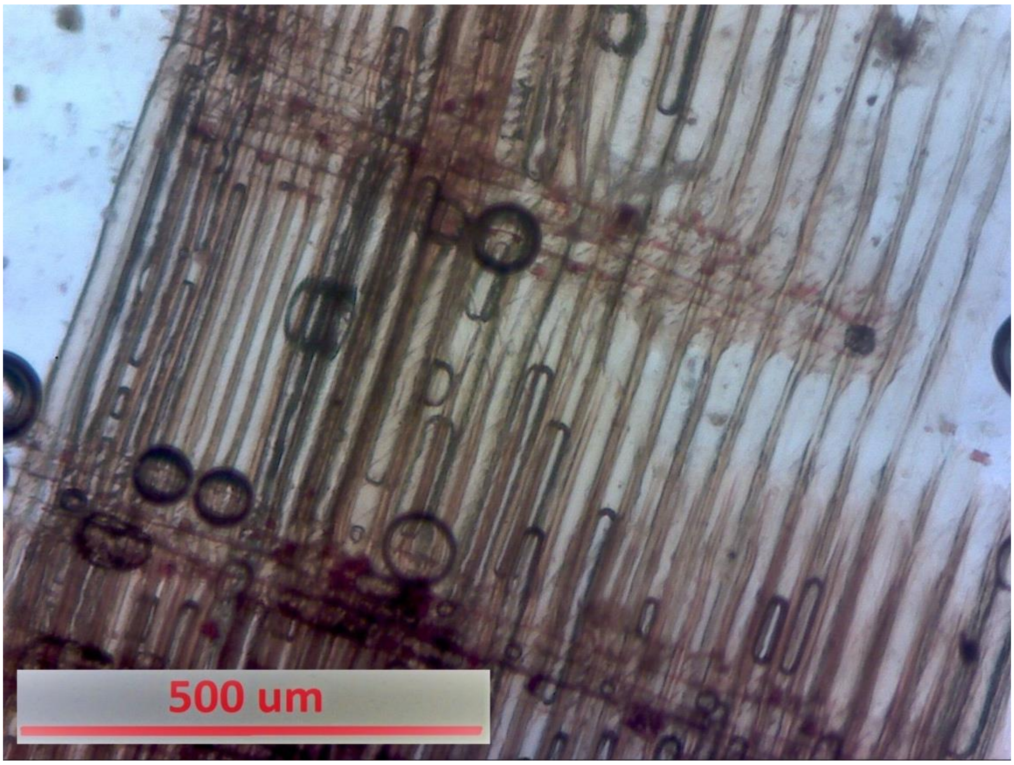
Sample 13. *Agathis sp.* (Kauri). Planking strake 13, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



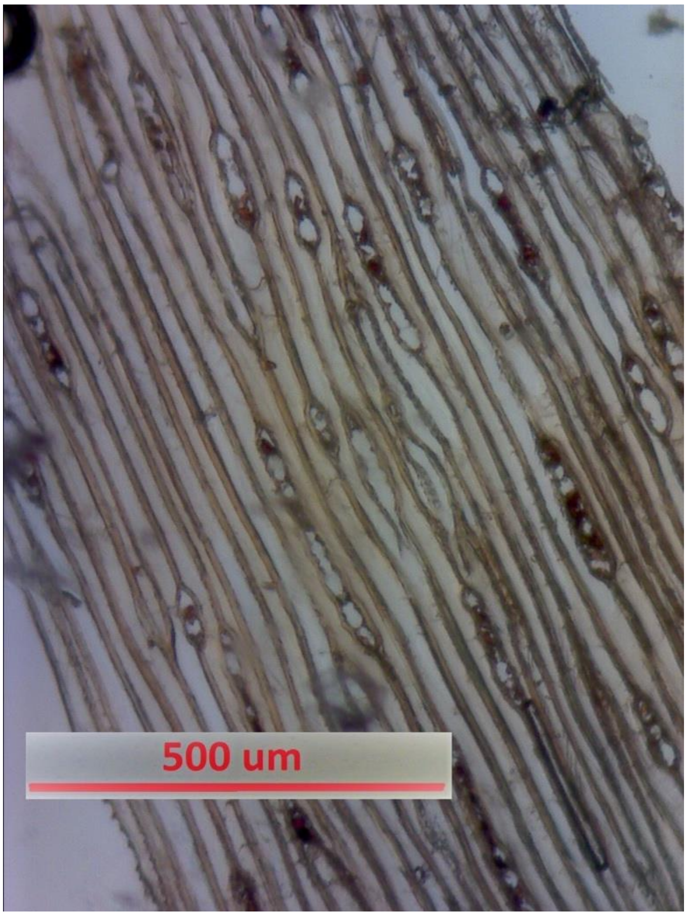
Sample 13. *Agathis sp.* (Kauri). Planking strake 13, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



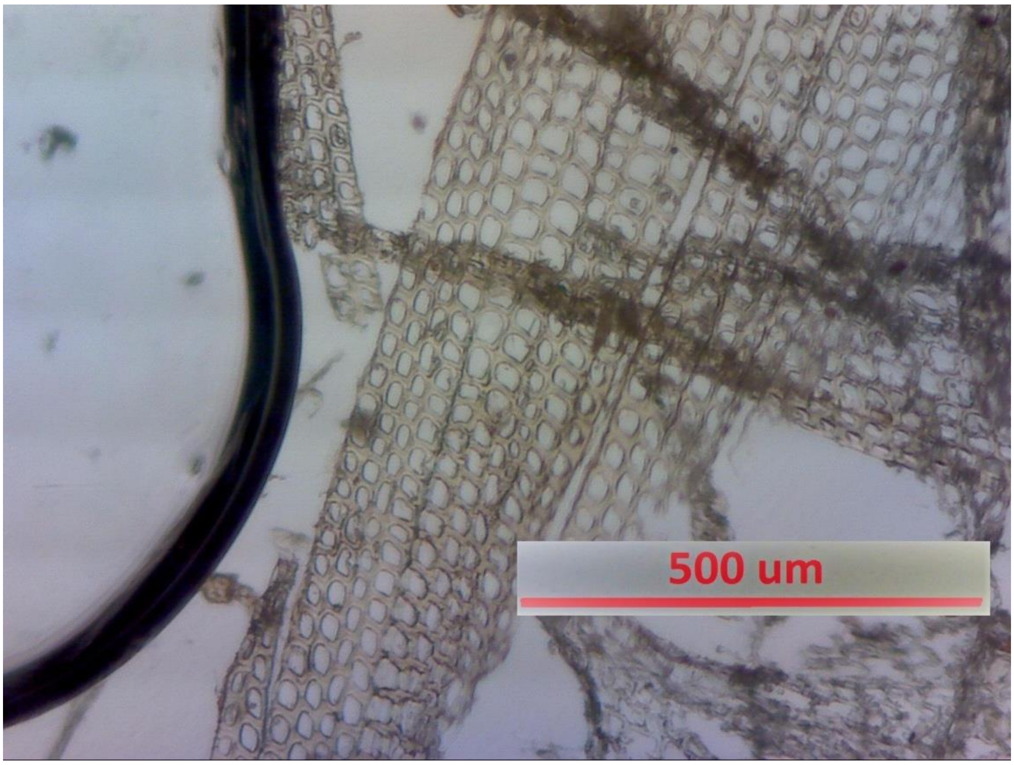
Sample 13. *Agathis sp.* (Kauri). Planking strake 13, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



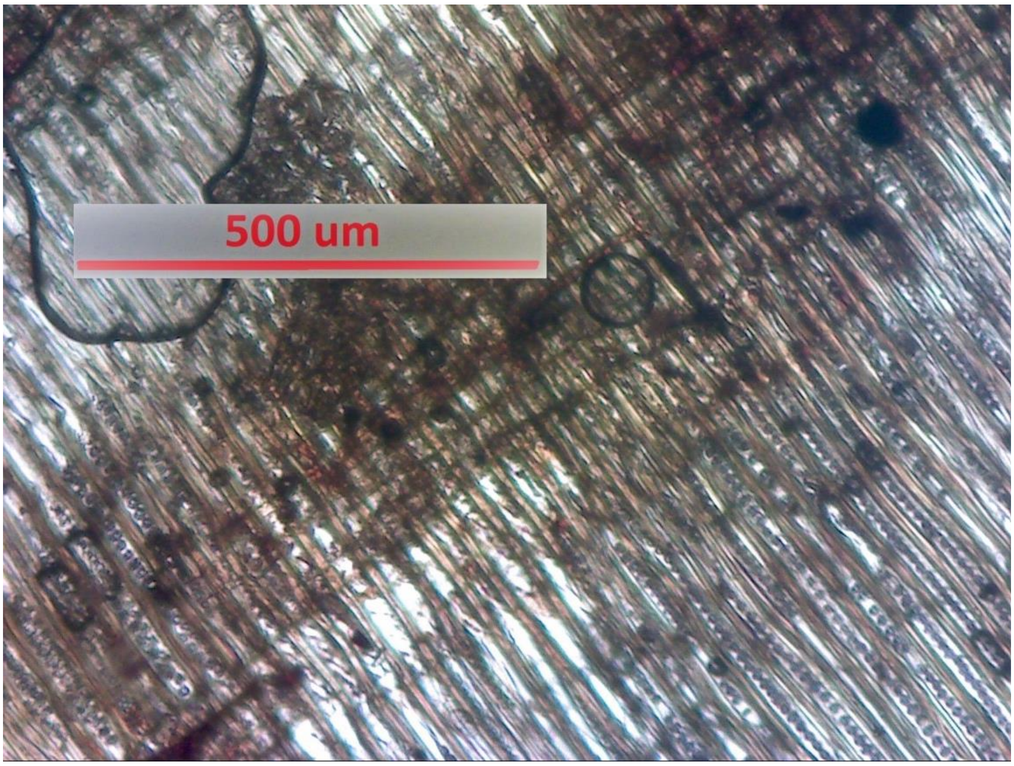
Sample 14. ***Agathis sp.*** **(Kauri). Planking strake 14, portside bow. Sample from hood end of plank. Identified by Jugo Illic.**



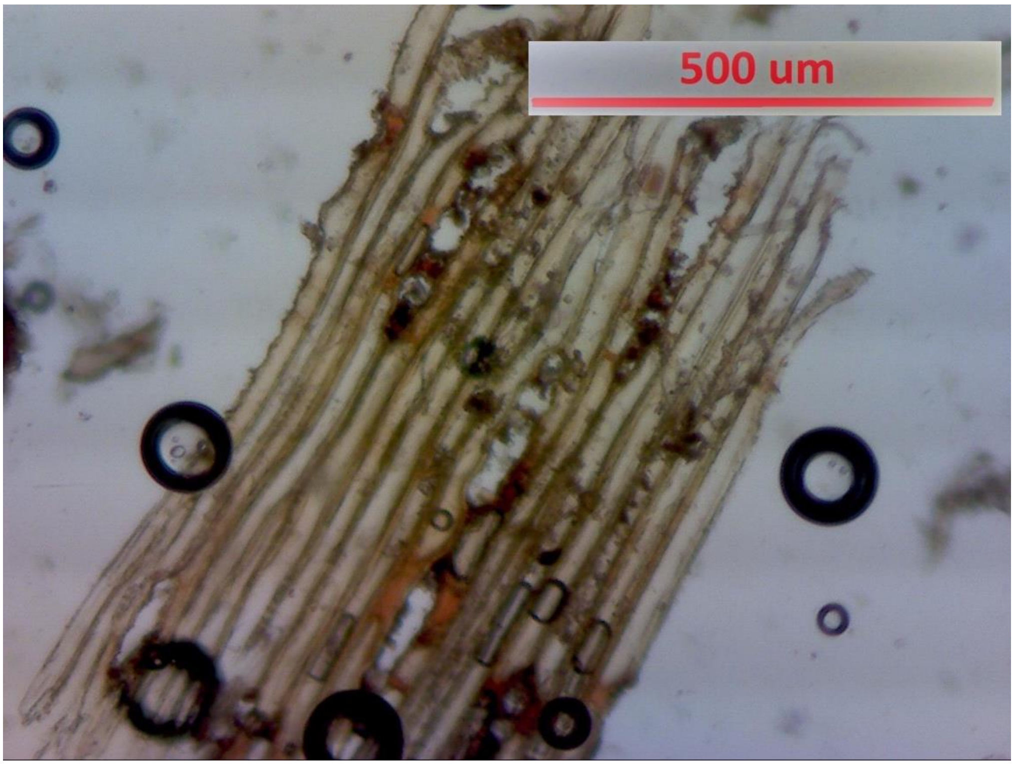
Sample 14. *Agathis sp.* (Kauri). Planking strake 14, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



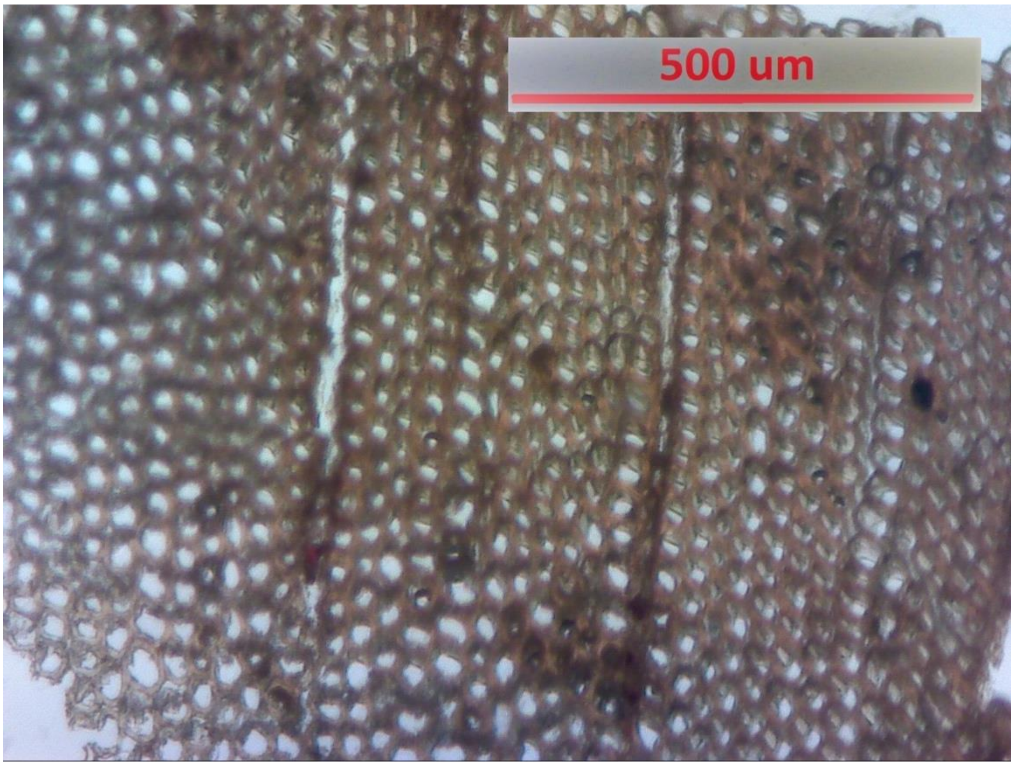
Sample 14. *Agathis sp.* (Kauri). Planking strake 14, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



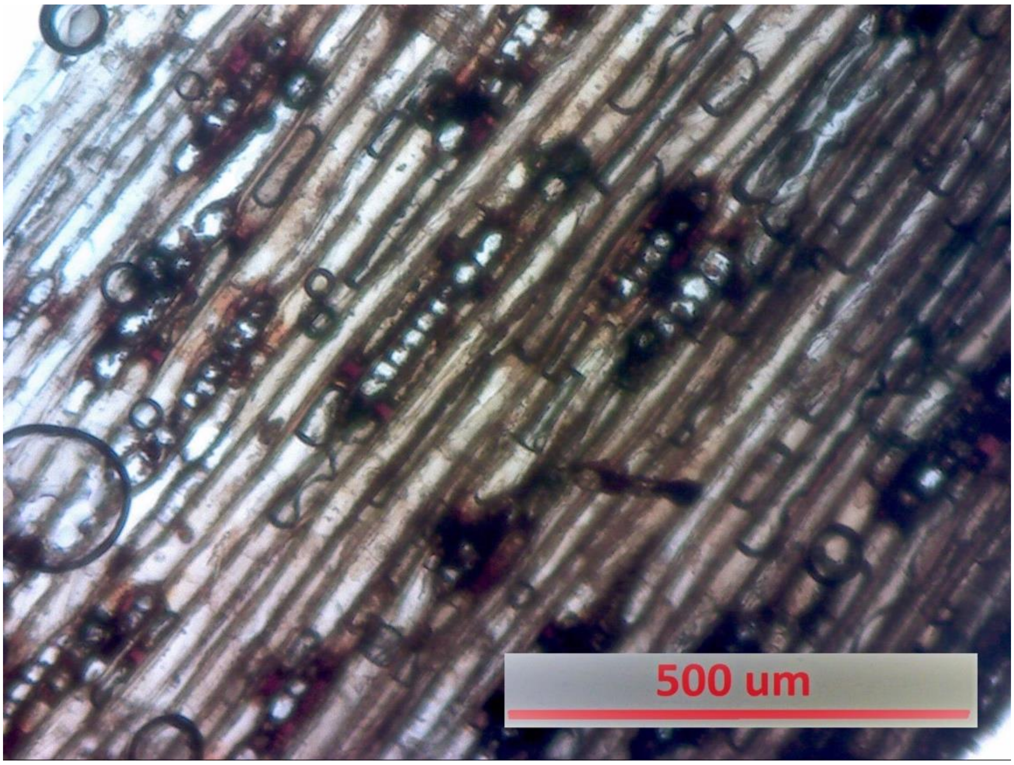
Sample 15. *Agathis sp.* (Kauri). Planking strake 15, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



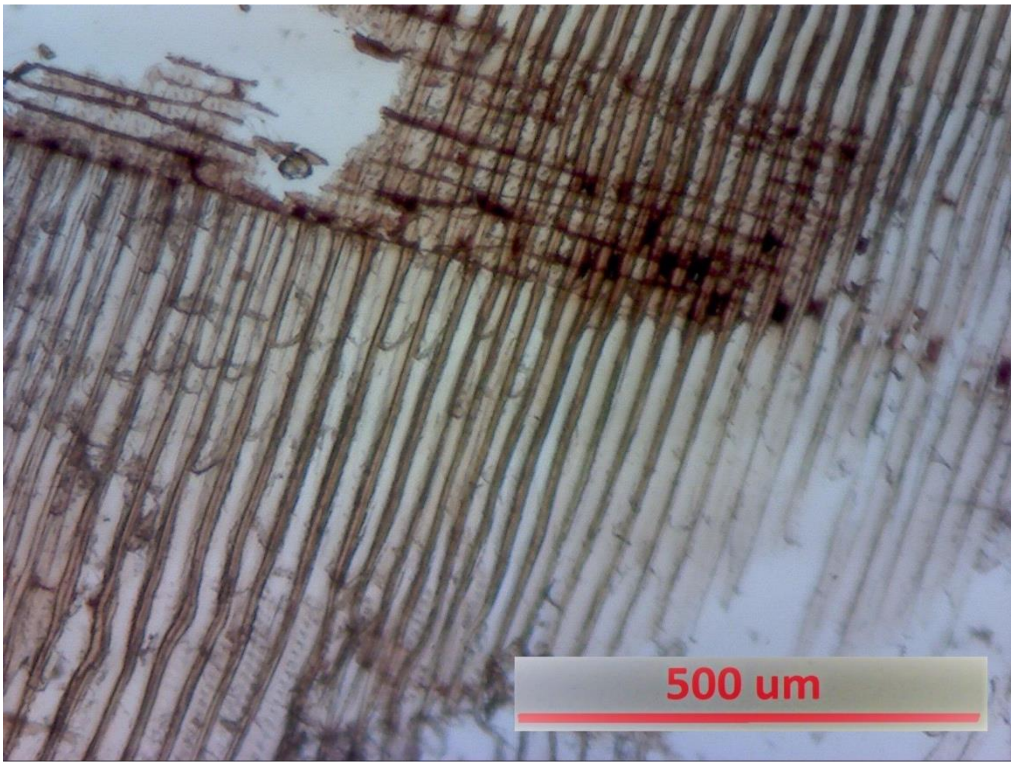
Sample 15. *Agathis sp.* (Kauri). Planking strake 15, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



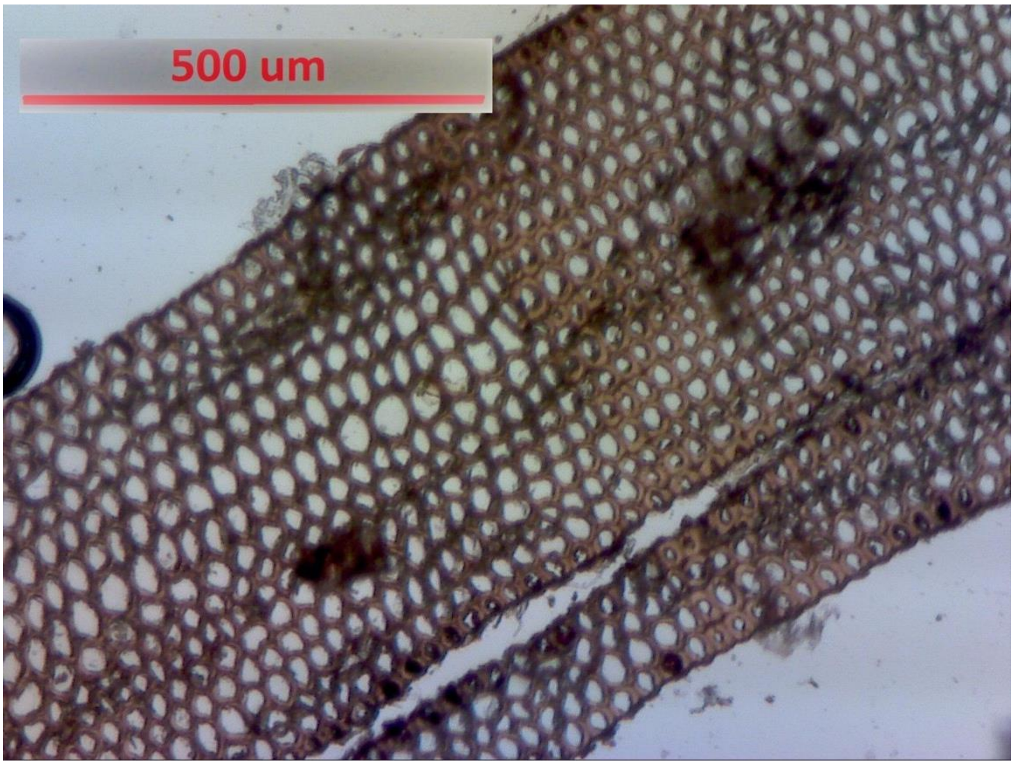
Sample 15. *Agathis sp.* (Kauri). Planking strake 15, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



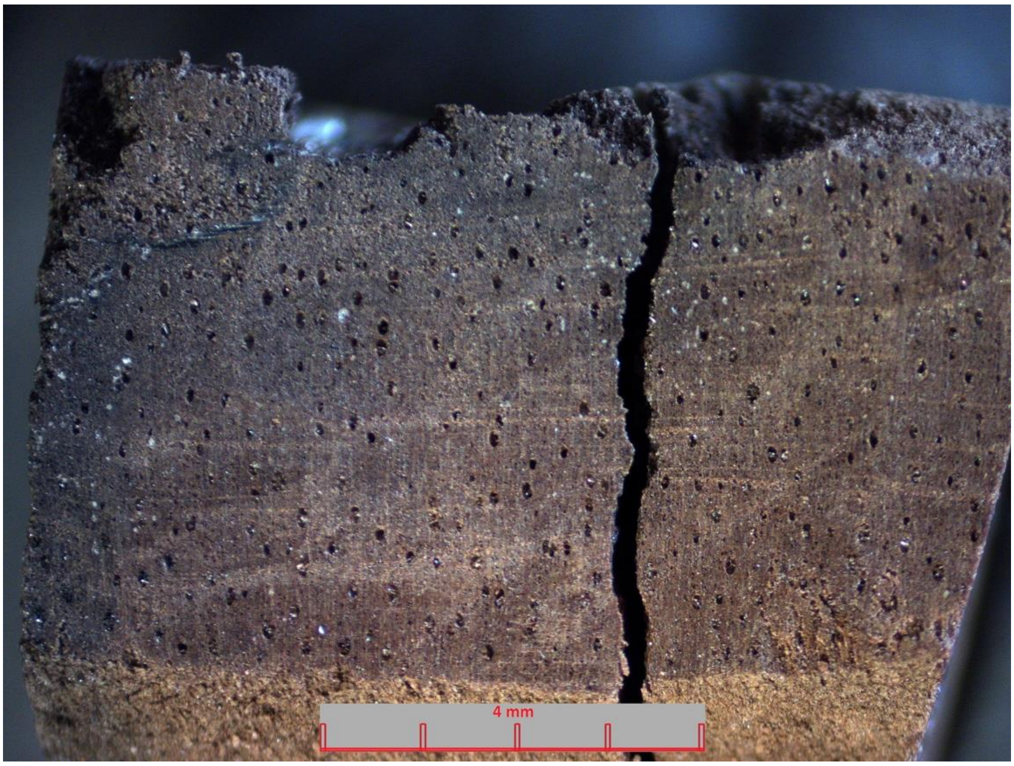
Sample 16. ***Agathis sp.*** **(Kauri). Planking strake 16, portside bow. Sample from hood end of plank. Identified by Jugo Illic.**



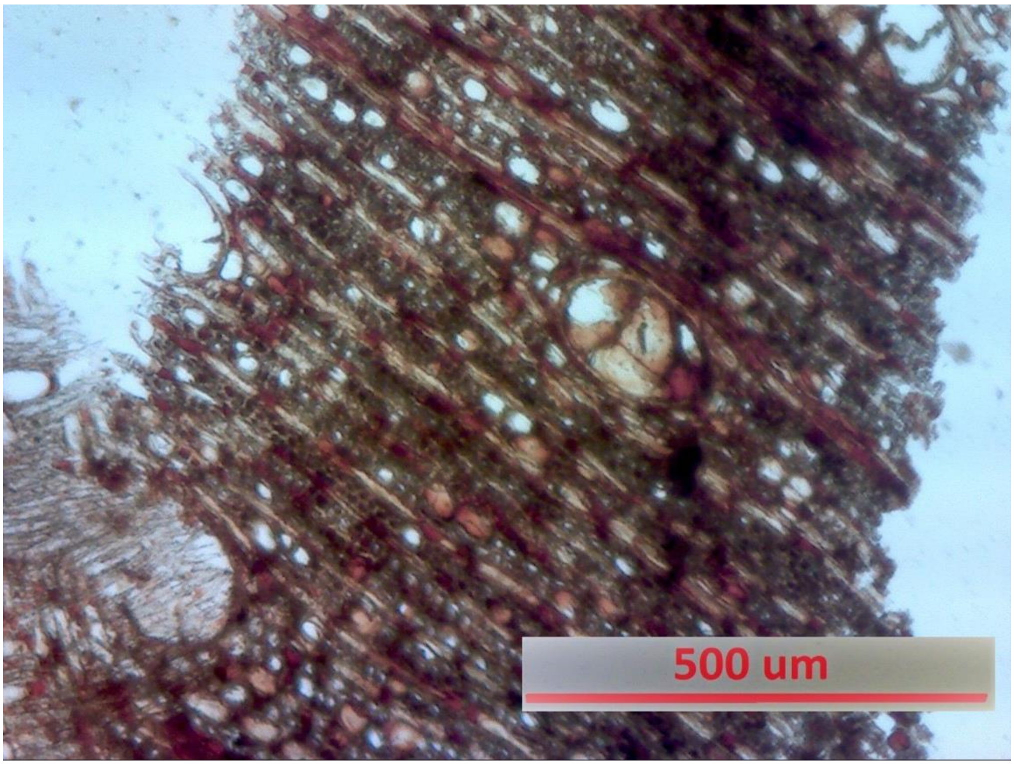
Sample 16. *Agathis sp.* (Kauri). Planking strake 16, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



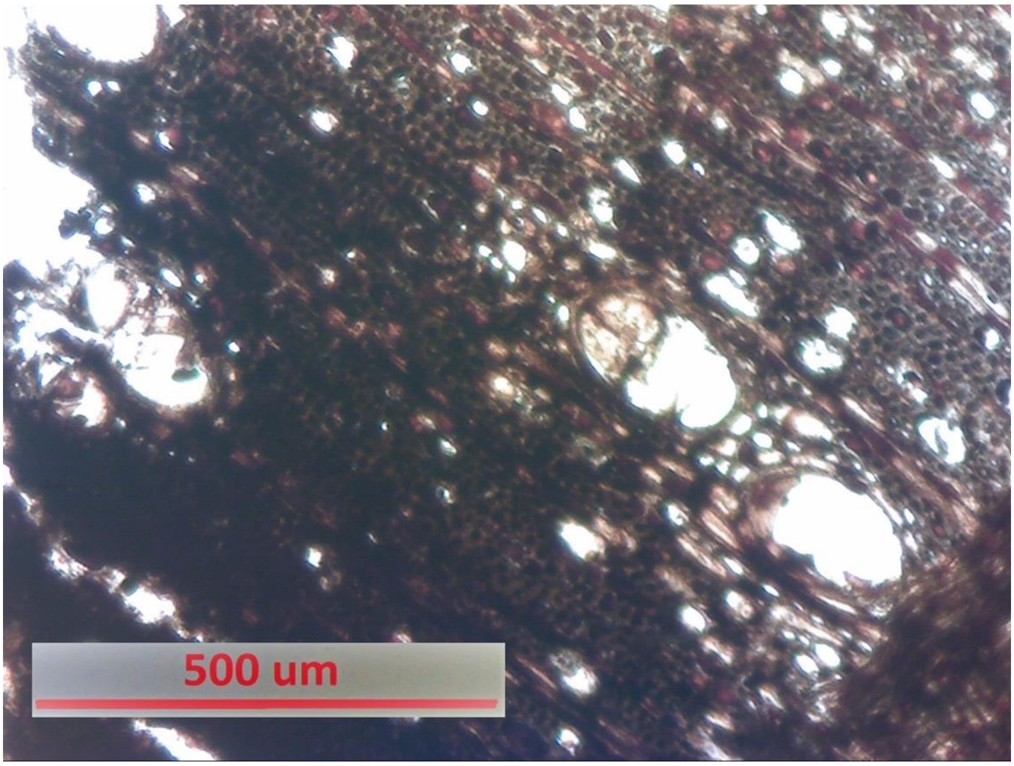
Sample 16. *Agathis sp.* (Kauri). Planking strake 16, portside bow. Sample from hood end of plank. Identified by Jugo Illic.



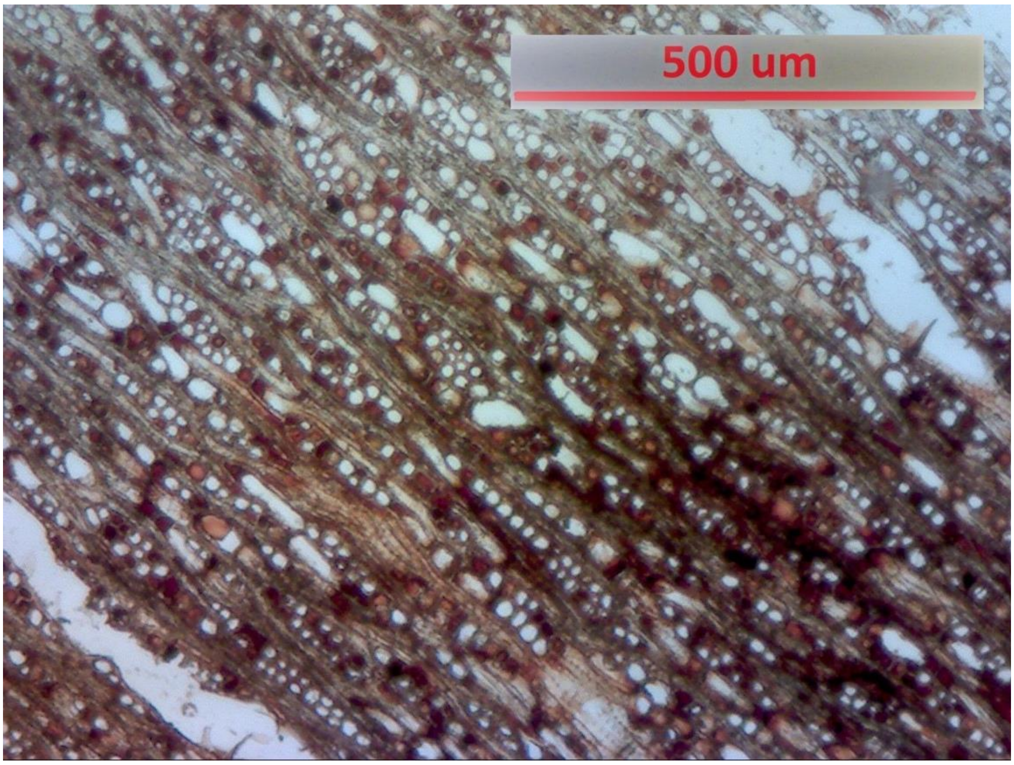
Sample 17. *Eucalyptus camaldulenis.* (Kauri). Stem, lower stem timber, starboard side on-top. Identified by Jugo Illic.



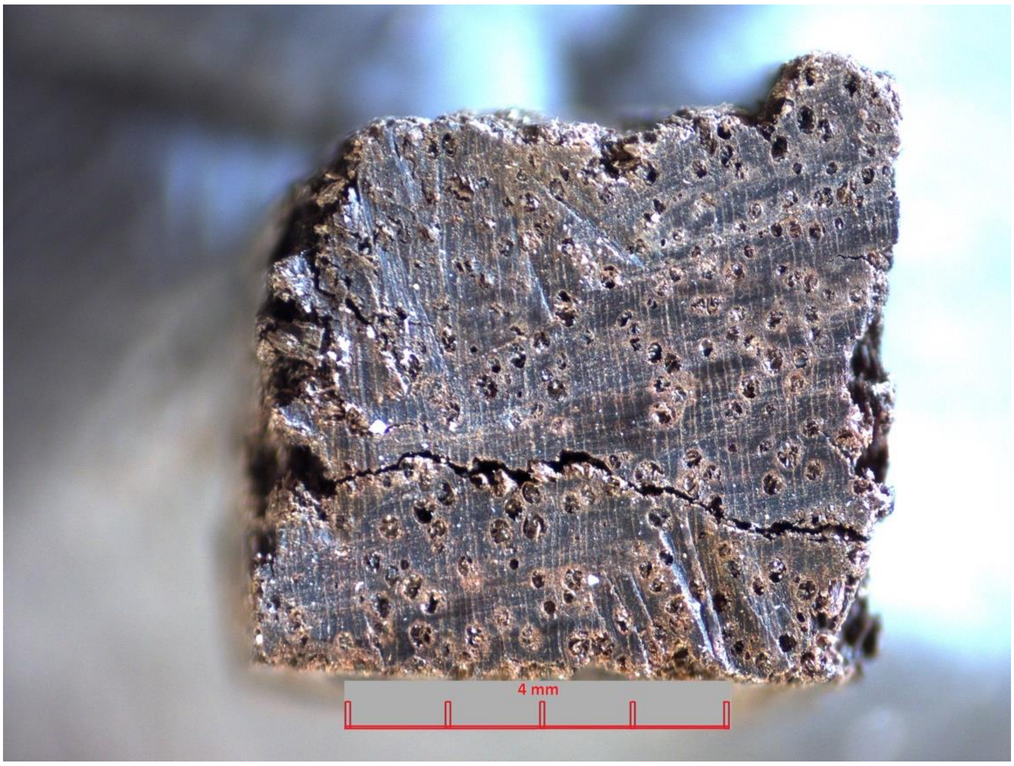
Sample 17. *Eucalyptus camaldulenis.* (Kauri). Stem, lower stem timber, starboard side on-top. Identified by Jugo Illic.



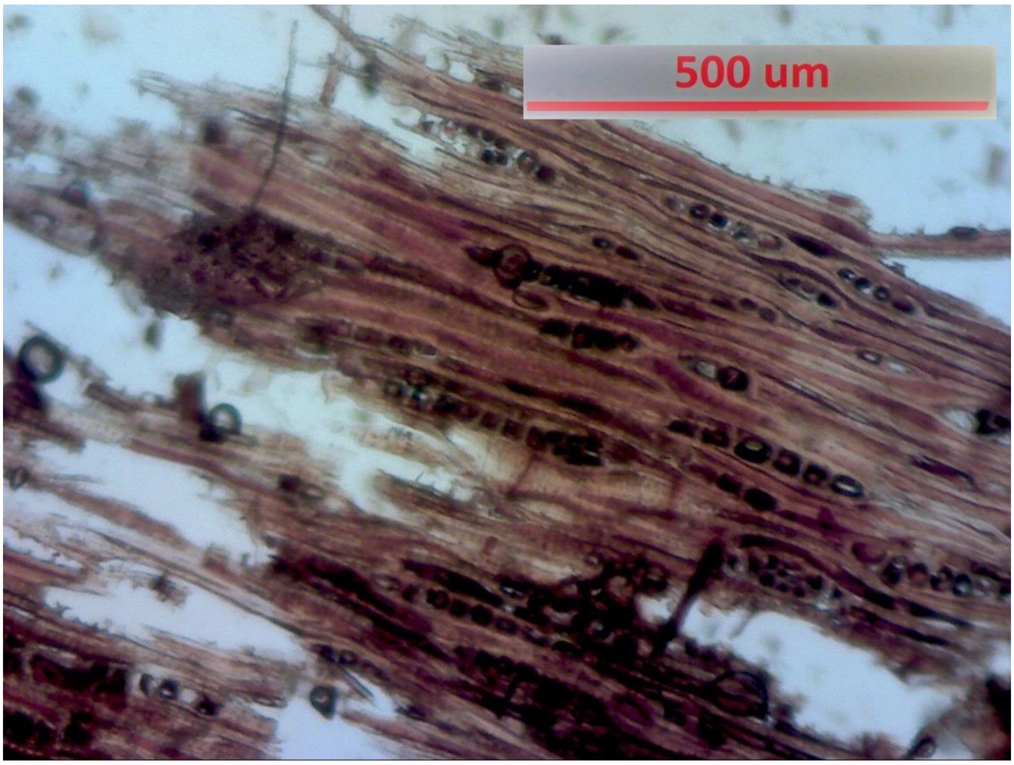
Sample 17. *Eucalyptus camaldulenis.* (Kauri). Stem, lower stem timber, starboard side on-top. Identified by Jugo Illic.



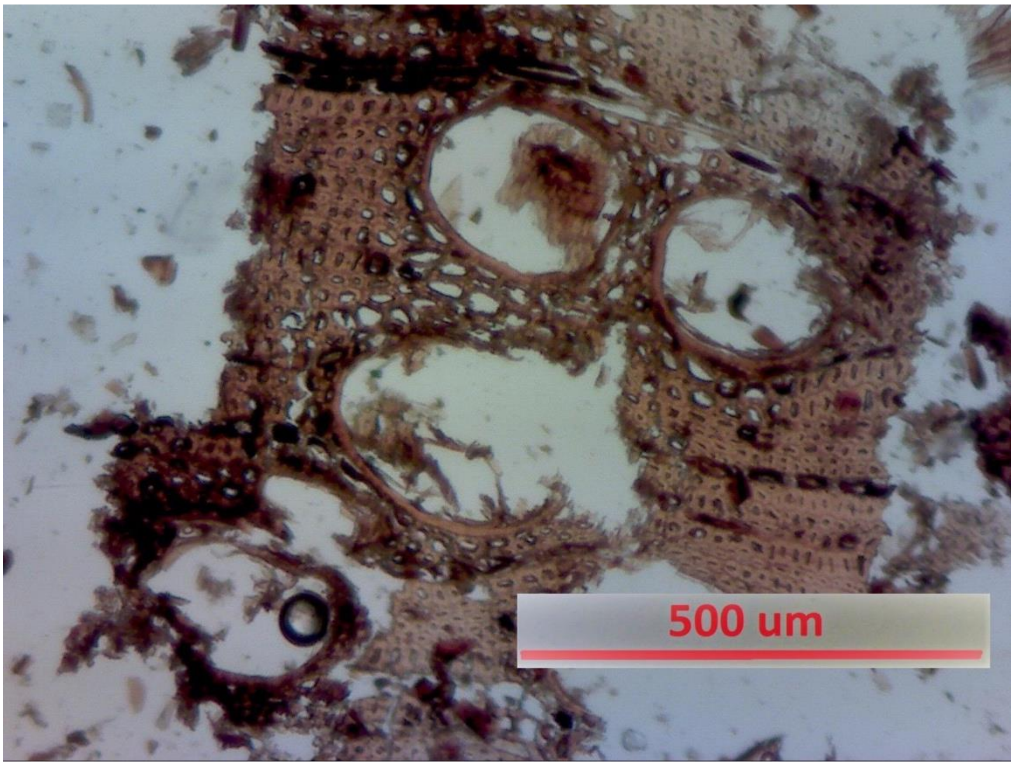
Sample 17. *Eucalyptus camaldulenis.* (Kauri). Stem, lower stem timber, starboard side on-top. Identified by Jugo Illic.



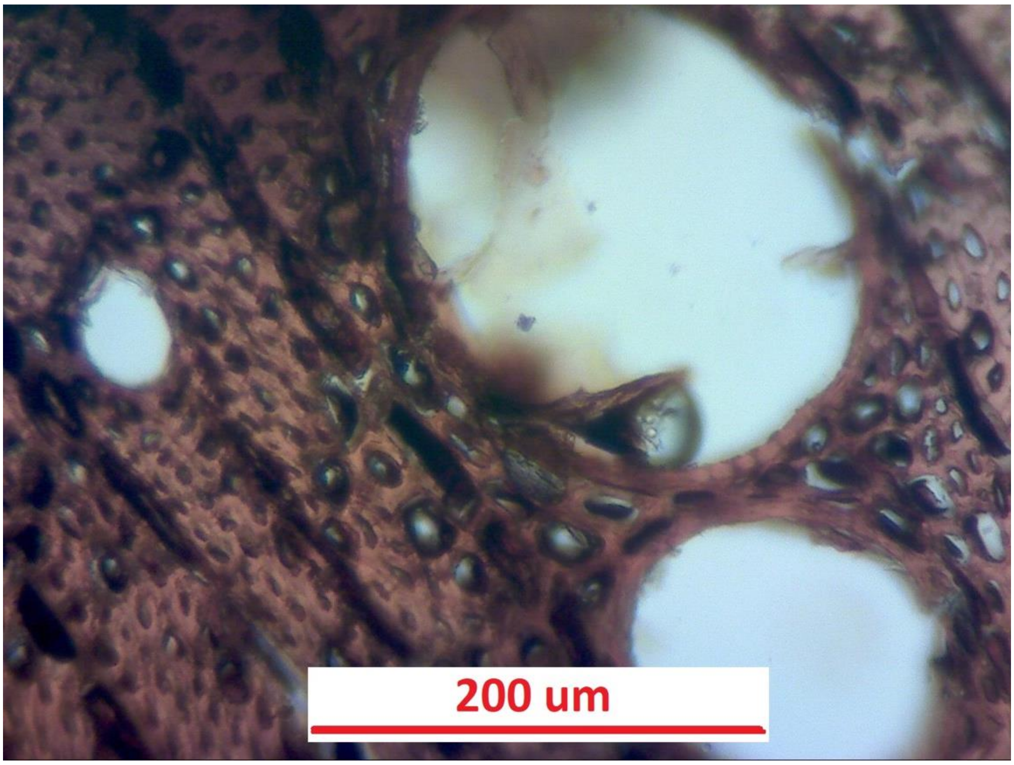
Sample 18. *Eucalyptus marginata* (Jarrah). Keel, front end of keel. Identified by Jugo Illic.



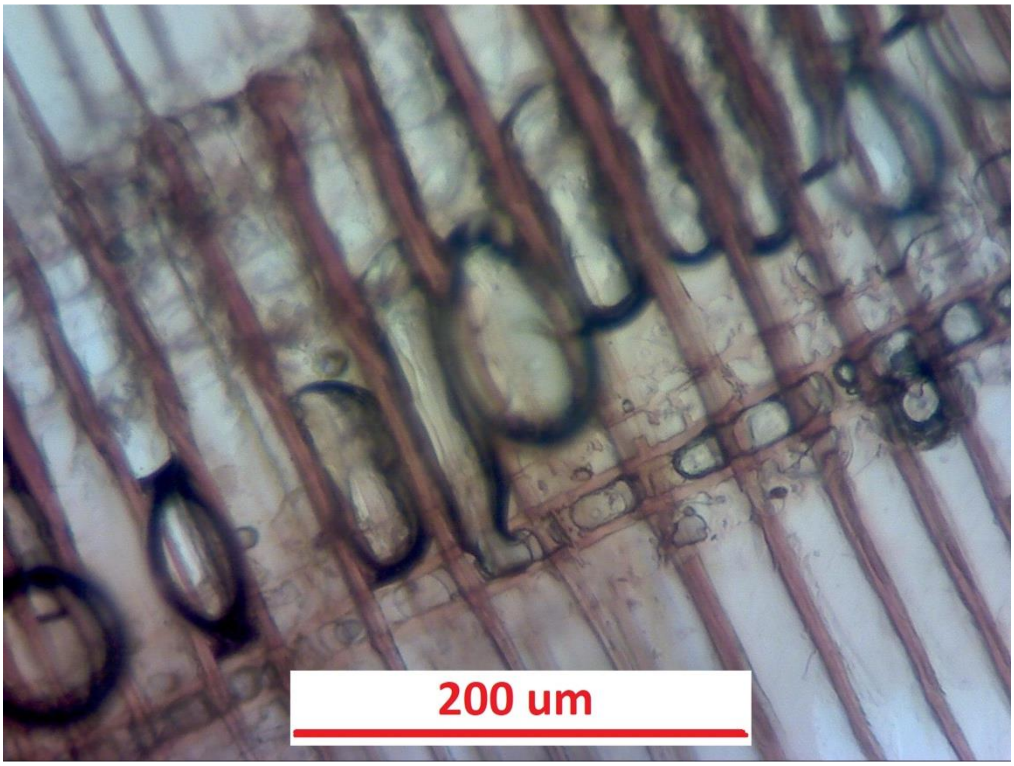
Sample 18. *Eucalyptus marginata* (Jarrah). Keel, front end of keel. Identified by Jugo Illic.



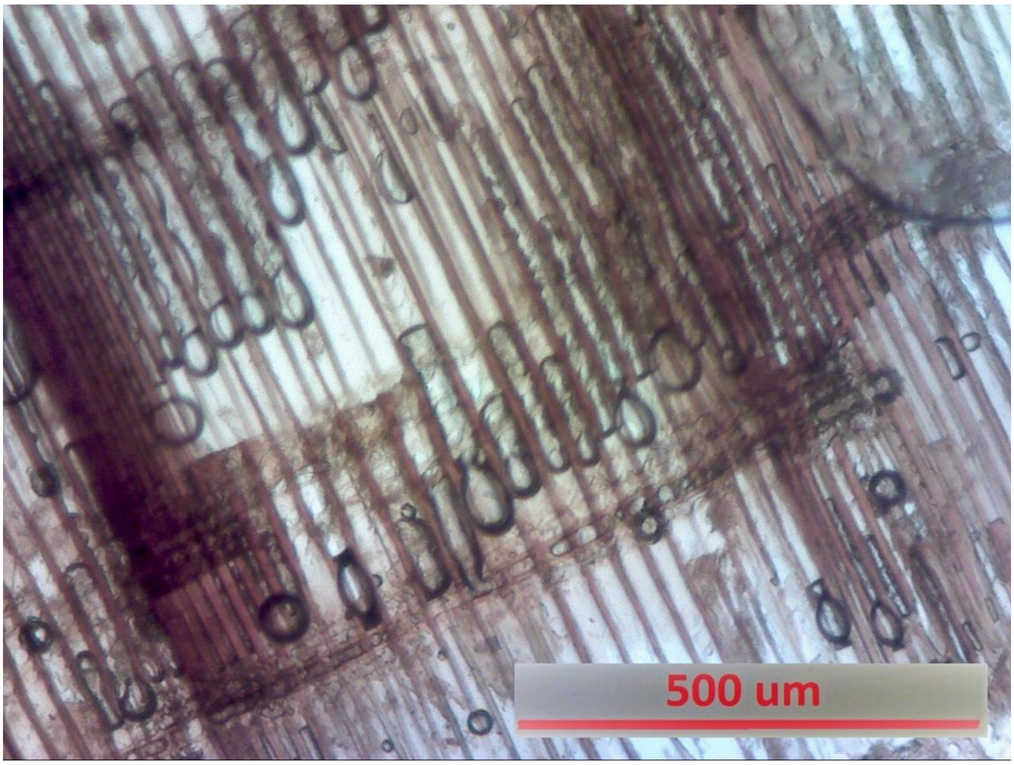
Sample 18. *Eucalyptus marginata* (Jarrah). Keel, front end of keel. Identified by Jugo Illic.



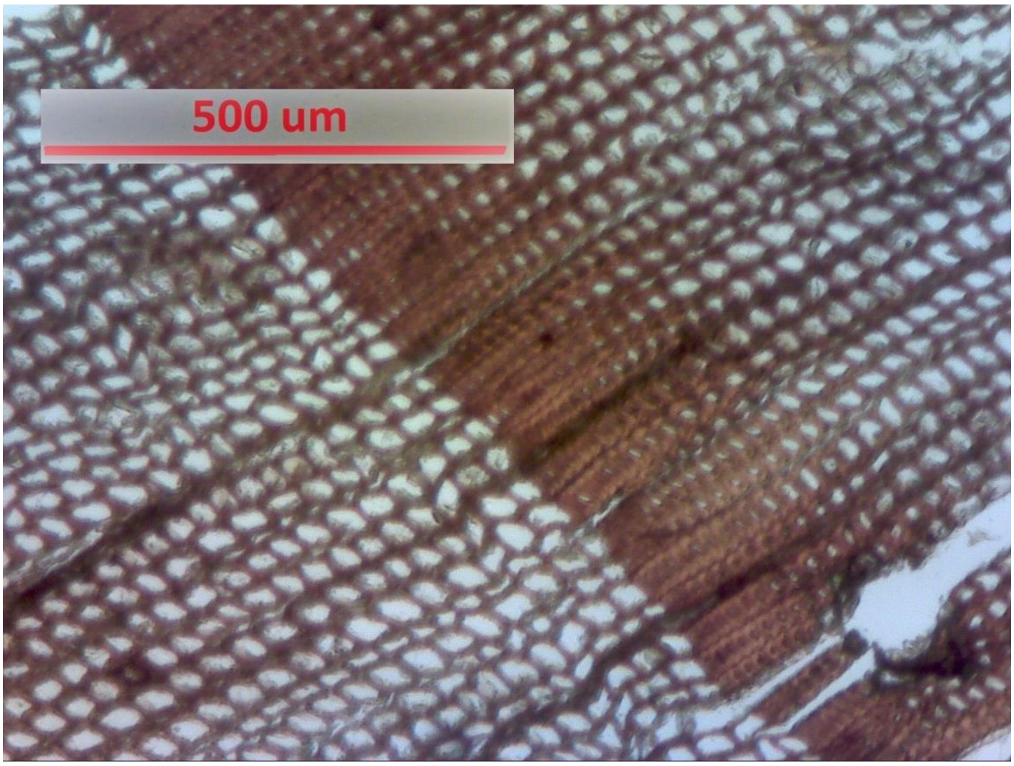
Sample 18. ***Eucalyptus marginata*** **(Jarrah). Keel, front end of keel. Identified by Jugo Illic.**



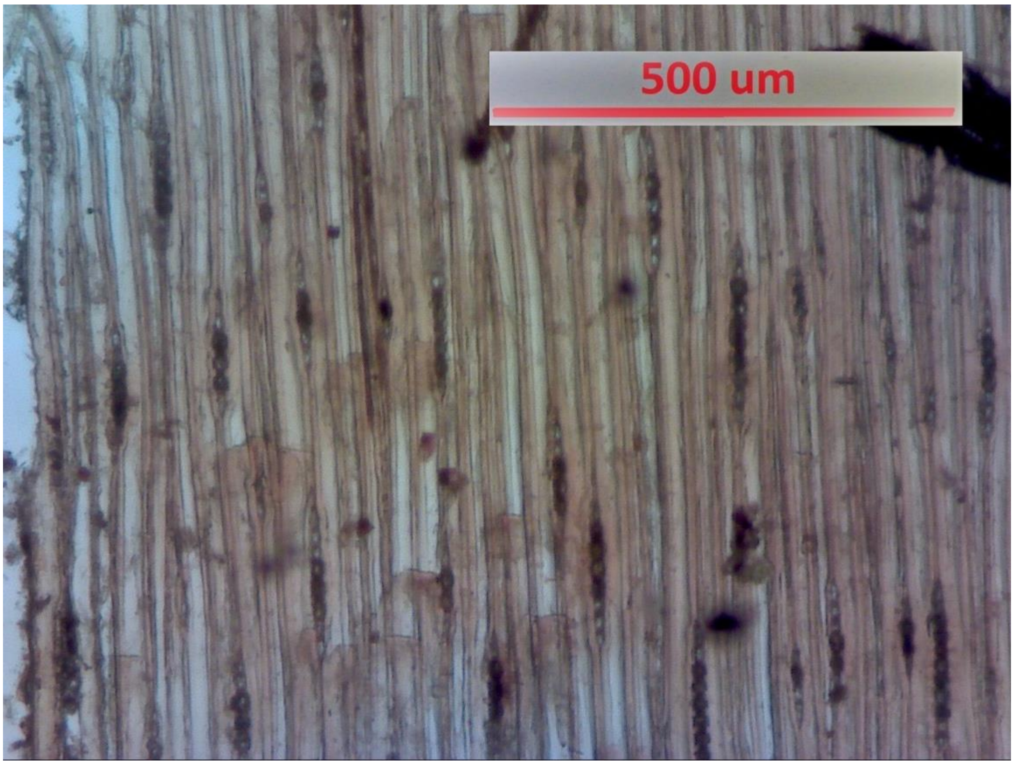
Sample 19. ***Pinus sylvestris*** **(Baltic Pine). Stem, top stem timber (fallen off bow), samples from starboard rabbet. Identified by Jugo Illic.**



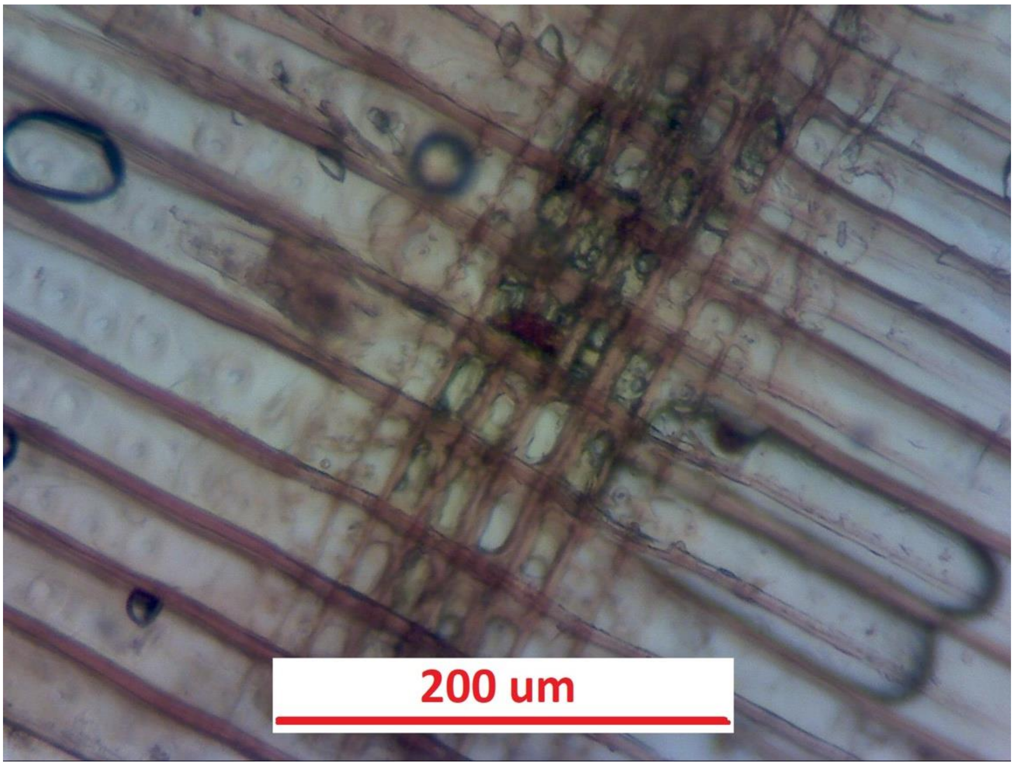
Sample 19. *Pinus sylvestris* (Baltic Pine). Stem, top stem timber (fallen off bow), samples from starboard rabbet. Identified by Jugo Illic.



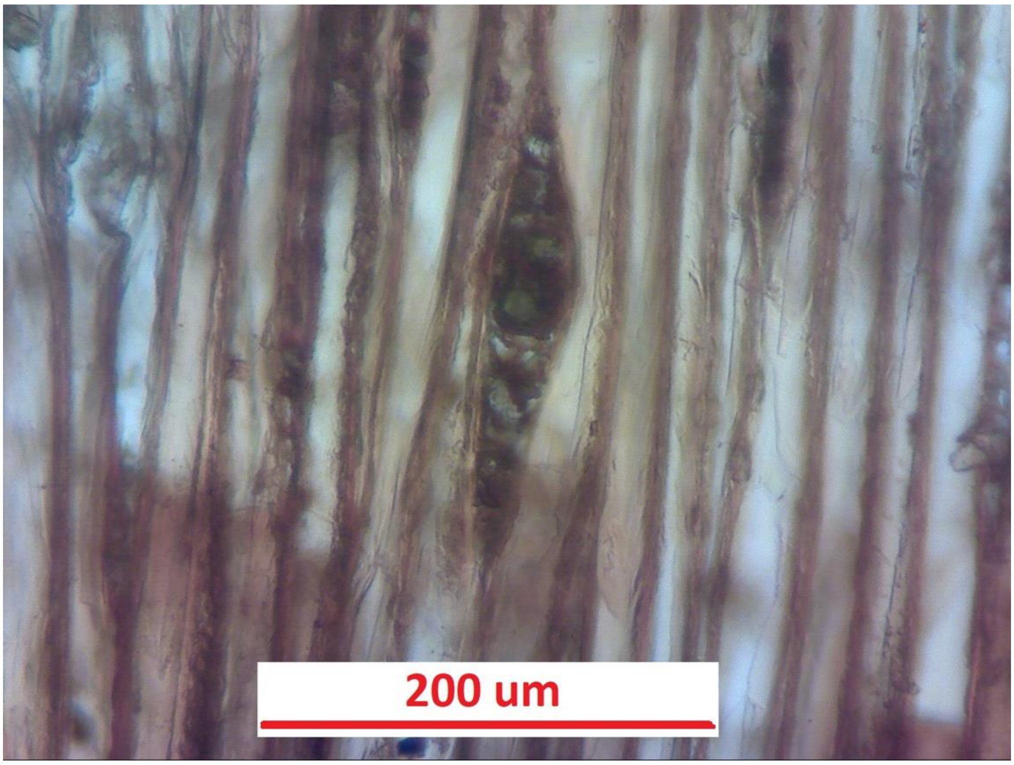
Sample 19. *Pinus sylvestris* (Baltic Pine). Stem, top stem timber (fallen off bow), samples from starboard rabbet. Identified by Jugo Illic.



Sample 19. ***Pinus sylvestris*** **(Baltic Pine). Stem, top stem timber (fallen off bow), samples from starboard rabbet. Identified by Jugo Illic.**

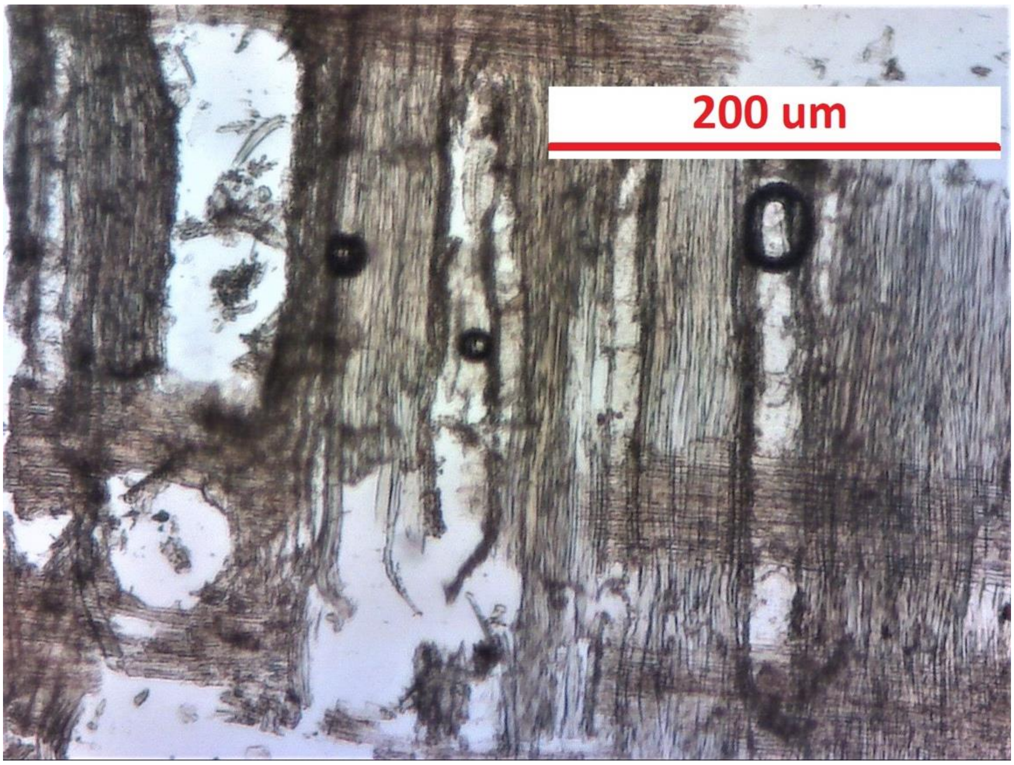


Sample 19. ***Pinus sylvestris*** **(Baltic Pine). Stem, top stem timber (fallen off bow), samples from starboard rabbet. Identified by Jugo Illic.**

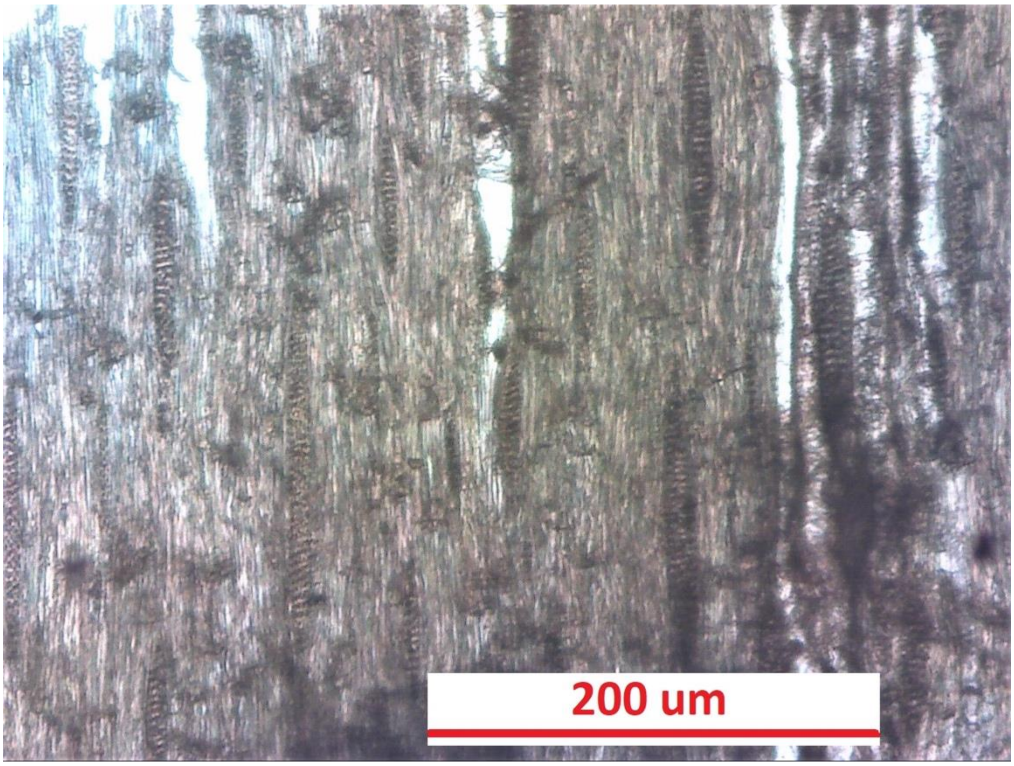


Sample 19. *Pinus sylvestris* (Baltic Pine). Stem, top stem timber (fallen off bow), samples from starboard rabbet. Identified by Jugo Illic.

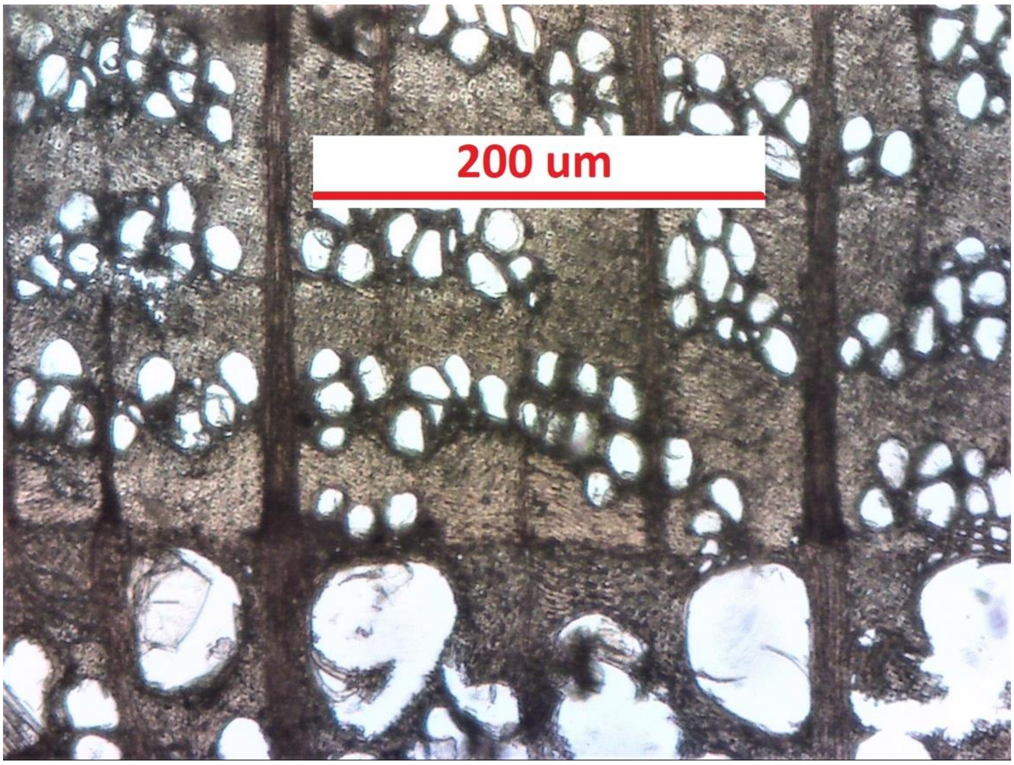
Sample 20. *Ulmus* sp. (Elm). Rib, portside bow, foremost fram timber. Identified by Jugo Illic.



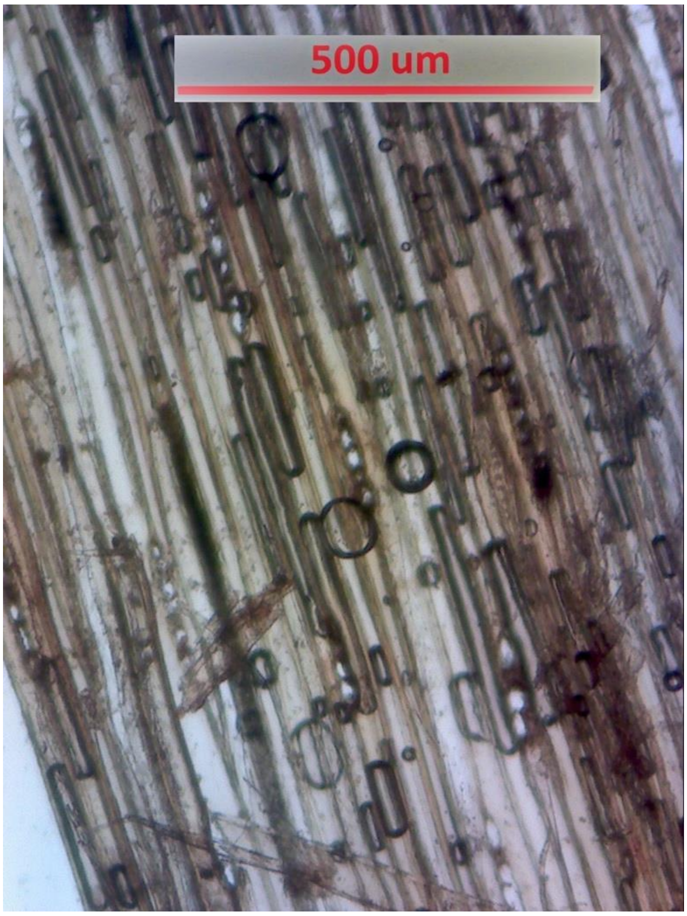
Sample 20. *Ulmus* sp. (Elm). Rib, portside bow, foremost fram timber. Identified by Jugo Illic.



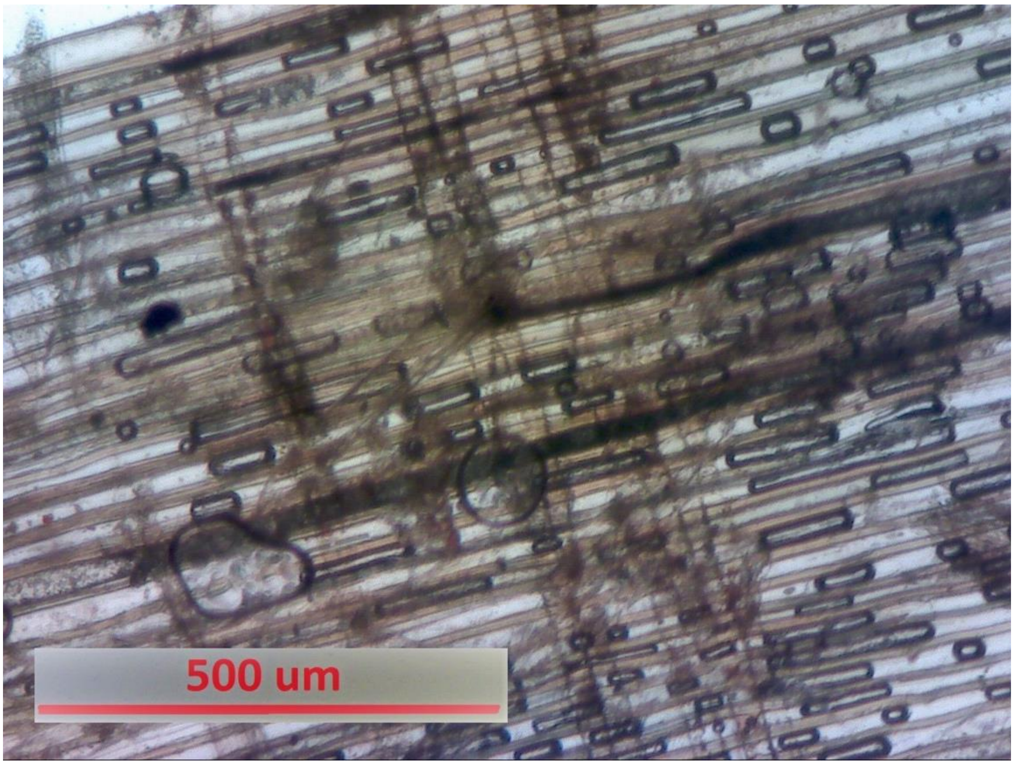
Sample 20. *Ulmus* sp. (Elm). Rib, portside bow, foremost fram timber. Identified by Jugo Illic.



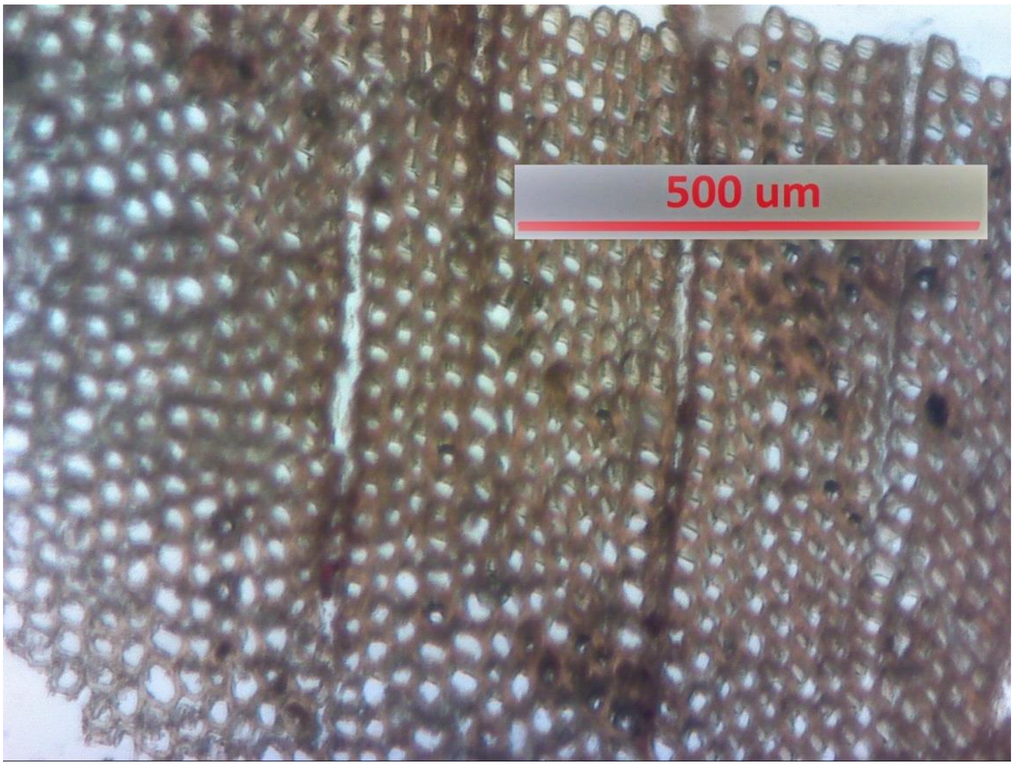
Sample 20. *Ulmus* sp. (Elm). Rib, portside bow, foremost fram timber. Identified by Jugo Illic.



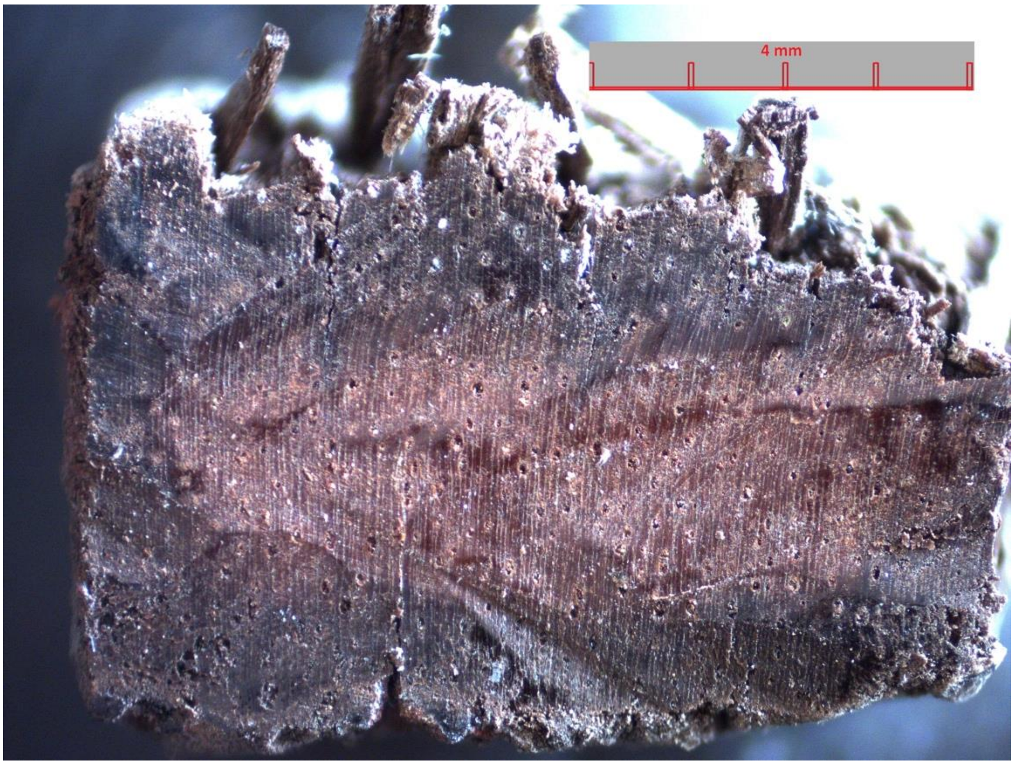
Sample 21. *Agathis* sp. (Kauri). Planking strake 10, starboard stern transom. Sample from aftermost hood end of plank. Identified by Jugo Illic.



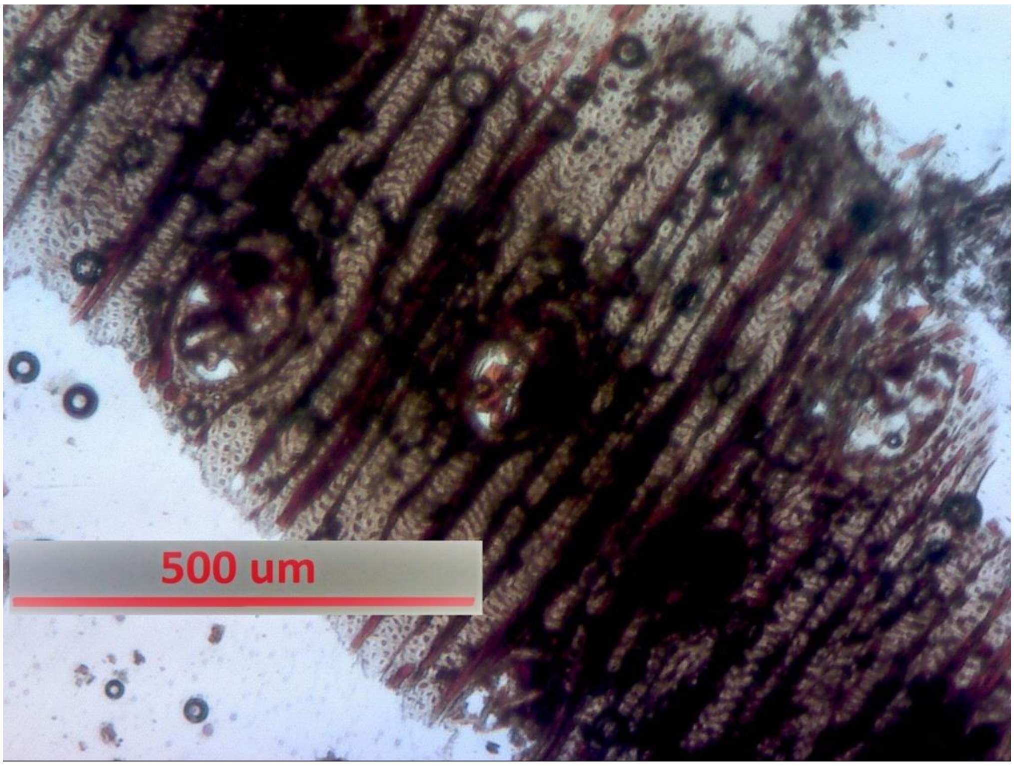
Sample 21. *Agathis* sp. (Kauri). Planking strake 10, starboard stern transom. Sample from aftermost hood end of plank. Identified by Jugo Illic.



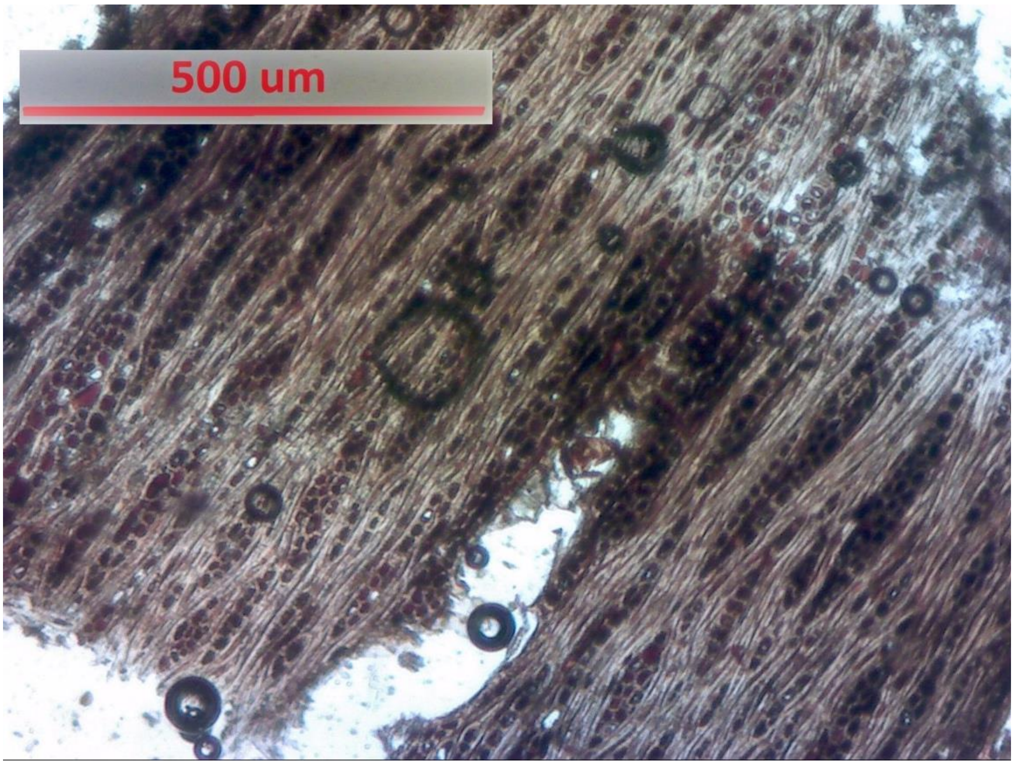
Sample 21. *Agathis* sp. (Kauri). Planking strake 10, starboard stern transom. Sample from aftermost hood end of plank. Identified by Jugo Illic.



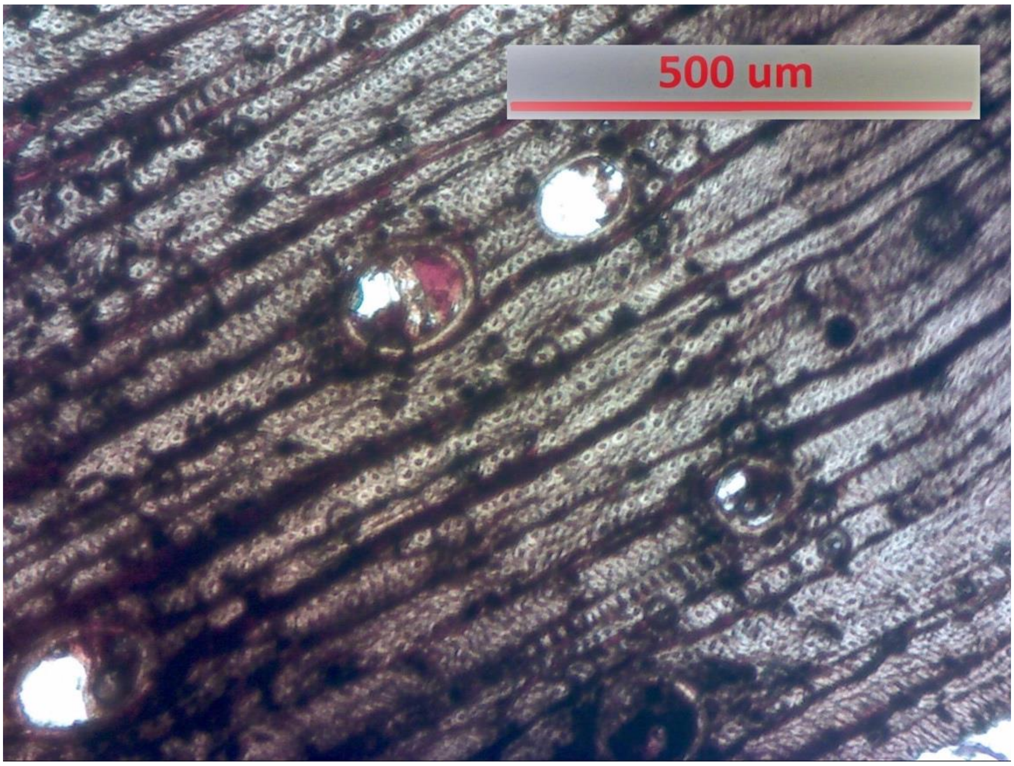
Sample 22. *Eucalyptus camald*ulensis (Red gum). Sternpost, portside. Identified by Jugo Illic.



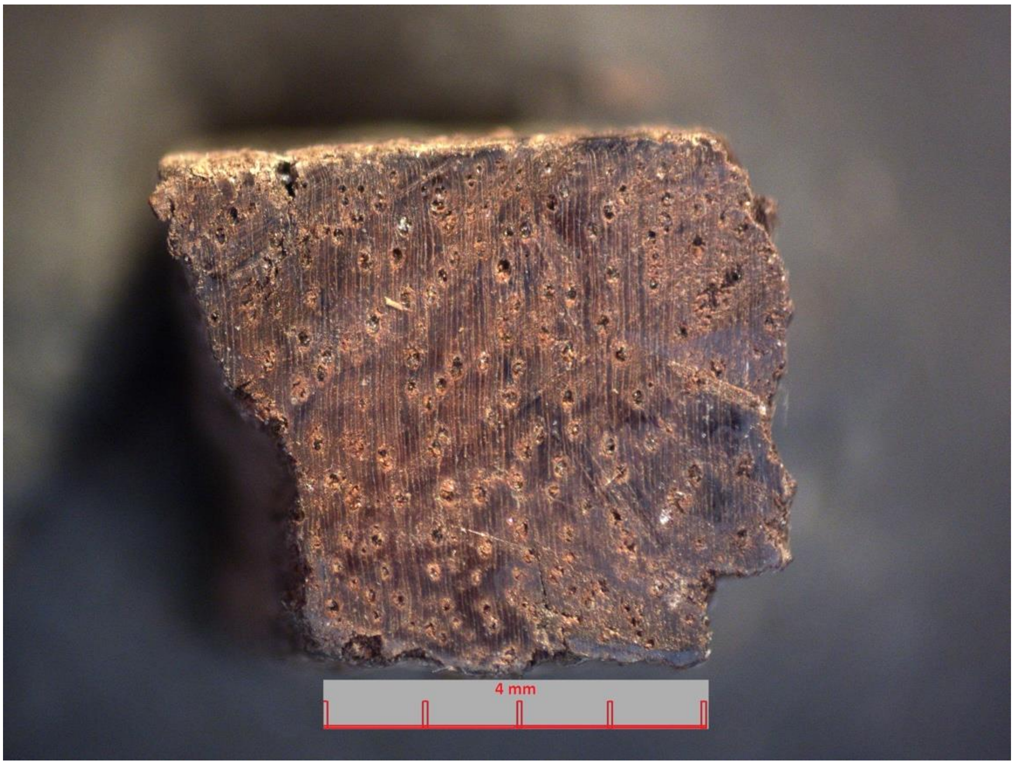
Sample 22. *Eucalyptus camald*ulensis (Red gum). Sternpost, portside. Identified by Jugo Illic.



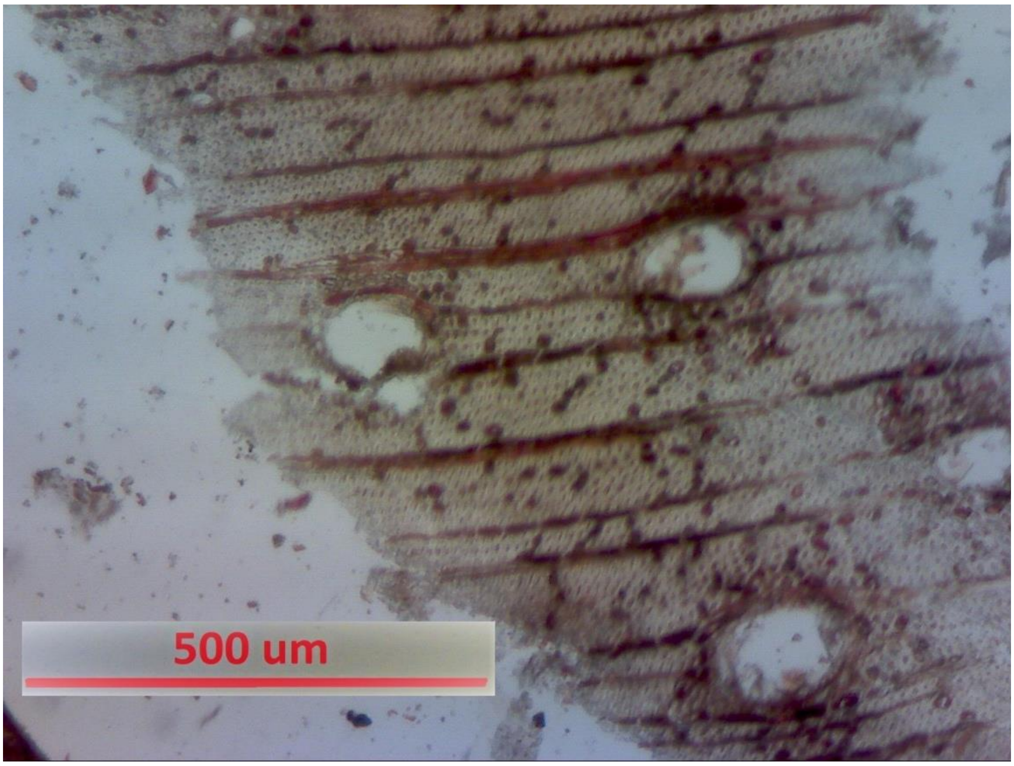
Sample 22. *Eucalyptus camald*ulensis (Red gum). Sternpost, portside. Identified by Jugo Illic.



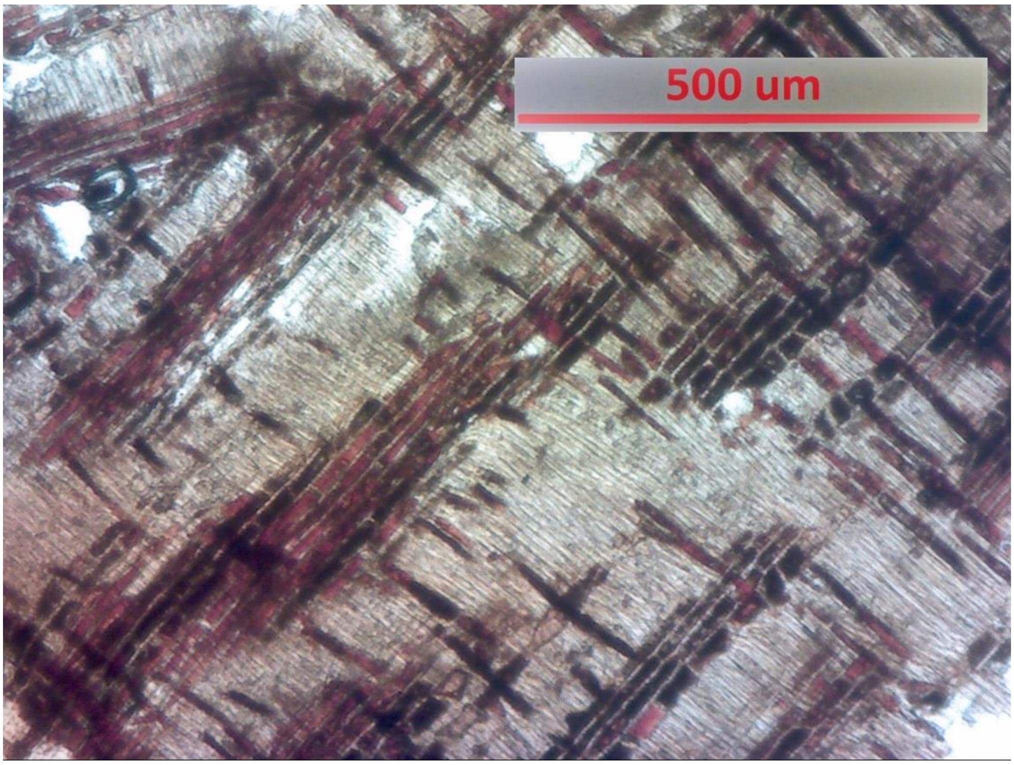
Sample 22. *Eucalyptus camald*ulensis (Red gum). Sternpost, portside. Identified by Jugo Illic.



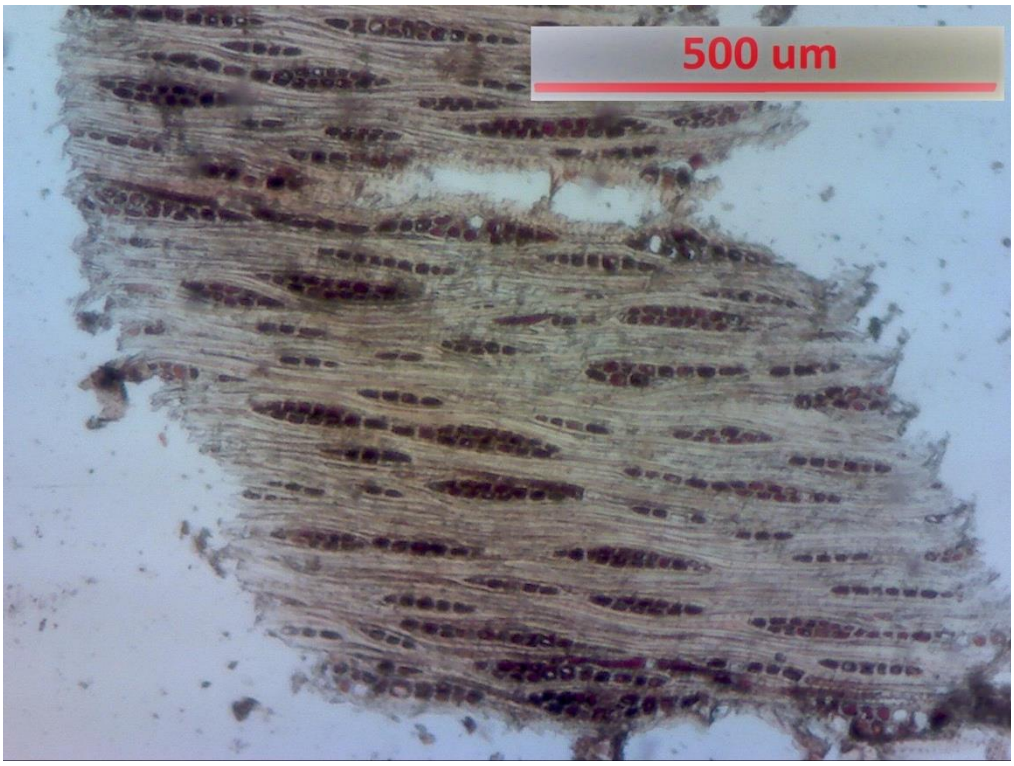
Sample 23. *Eucalyptus camald*ulensis (Red gum). Sternpost, rudder area. Identified by Jugo Illic.



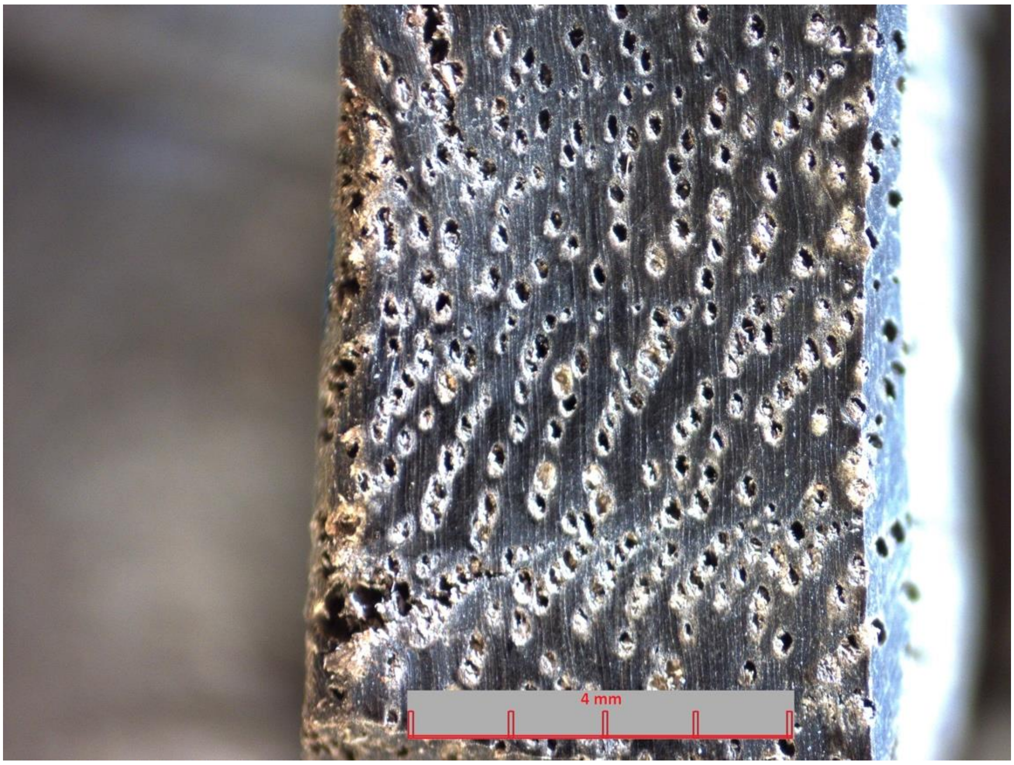
Sample 23. *Eucalyptus camald*ulensis (Red gum). Sternpost, rudder area. Identified by Jugo Illic.



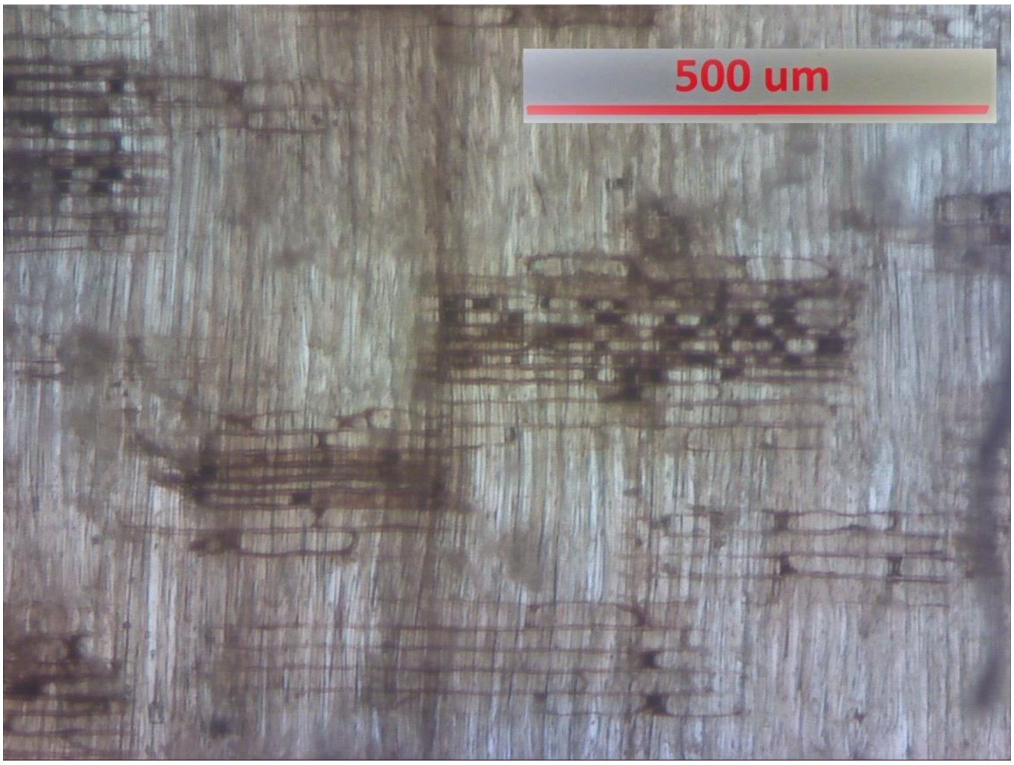
Sample 23. *Eucalyptus camald*ulensis (Red gum). Sternpost, rudder area. Identified by Jugo Illic.



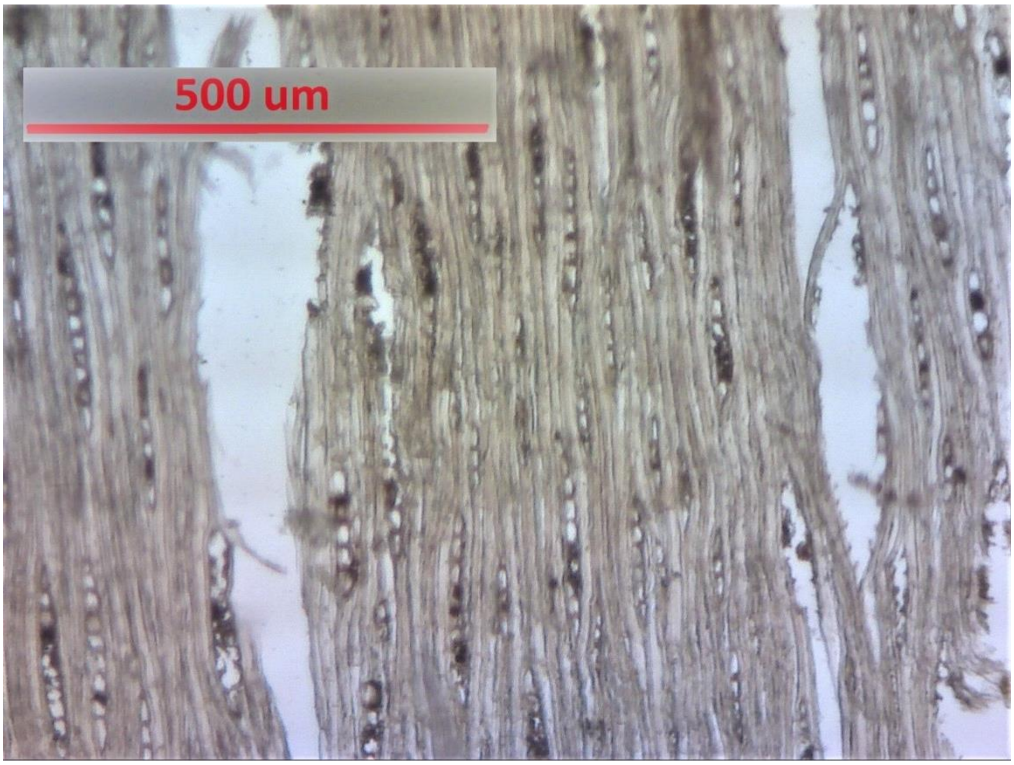
Sample 23. *Eucalyptus camald*ulensis (Red gum). Sternpost, rudder area. Identified by Jugo Illic.



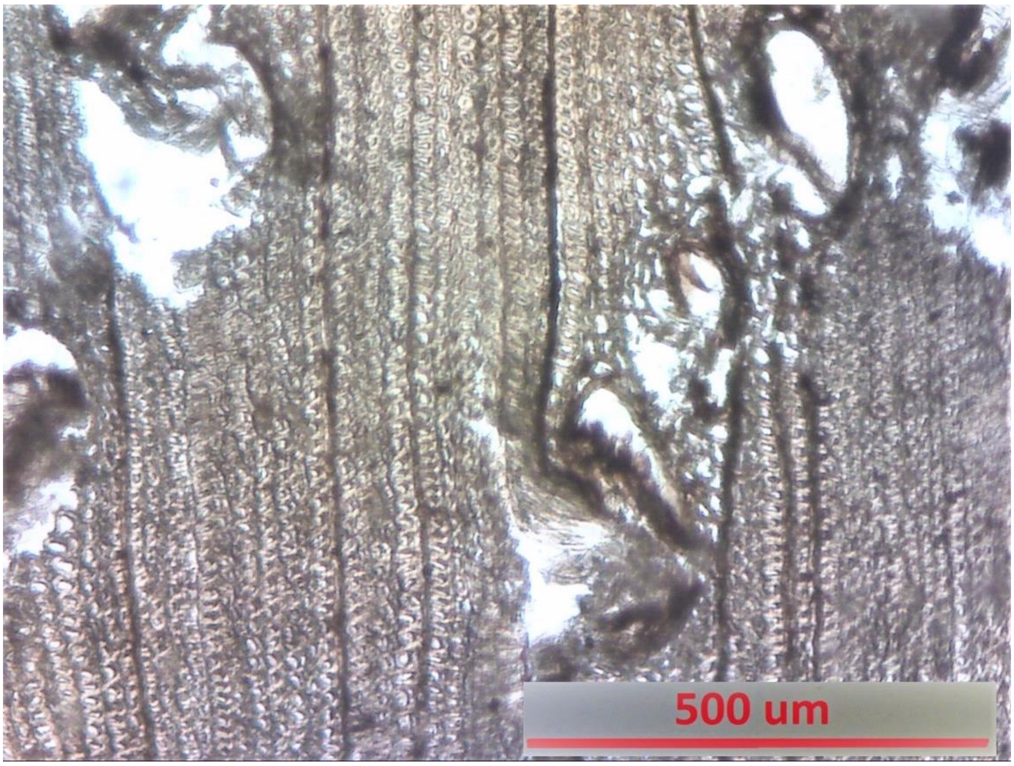
Sample 24. *Eucalyptus* sp. (Stringybark or Blackbutt). Stringer, portside bow, foremost hood area. Identified by Jugo Illic.



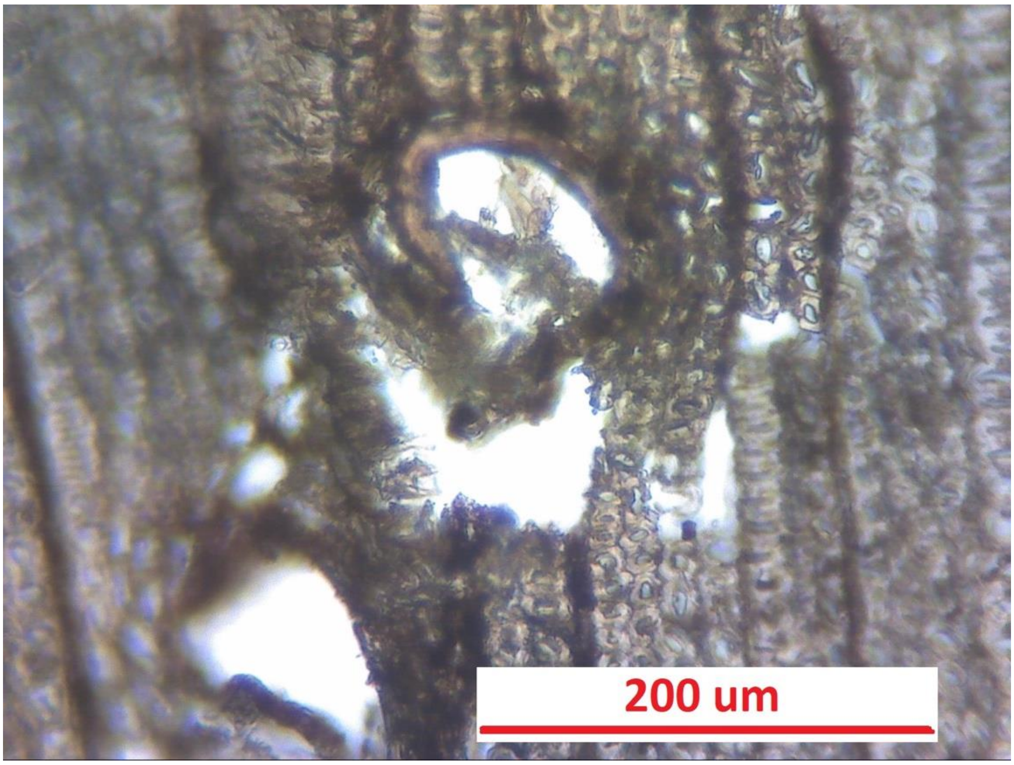
Sample 24. *Eucalyptus* sp. (Stringybark or Blackbutt). Stringer, portside bow, foremost hood area. Identified by Jugo Illic.



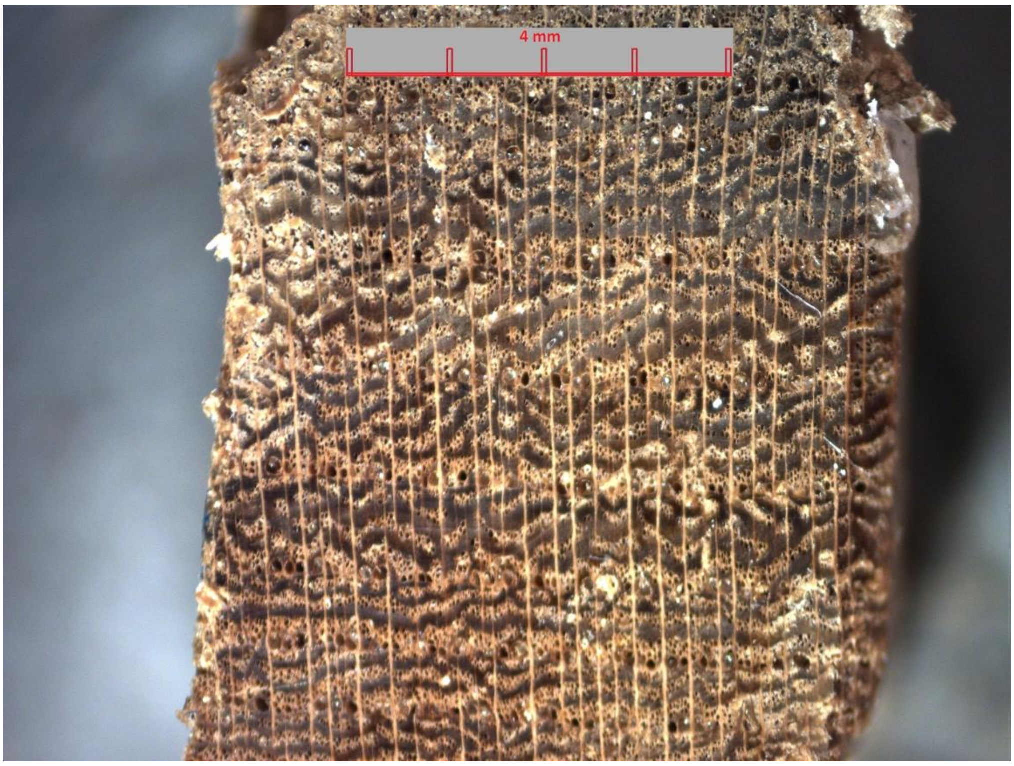
Sample 24. *Eucalyptus* sp. (Stringybark or Blackbutt). Stringer, portside bow, foremost hood area. Identified by Jugo Illic.



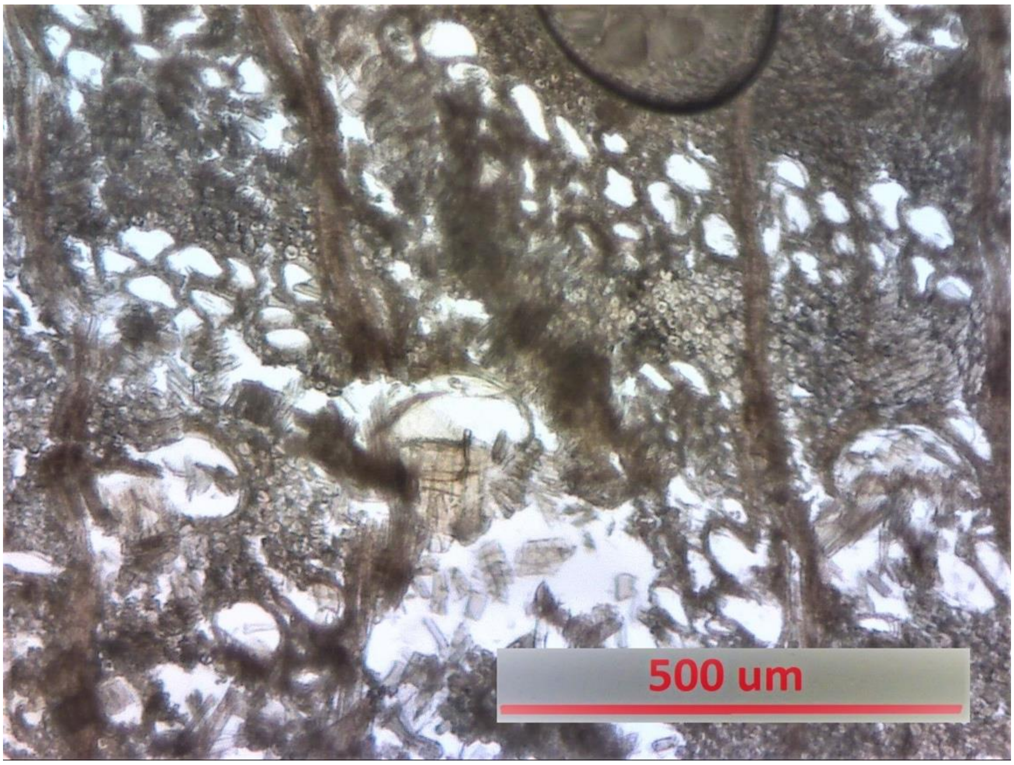
Sample 24. *Eucalyptus* sp. (Stringybark or Blackbutt). Stringer, portside bow, foremost hood area. Identified by Jugo Illic.



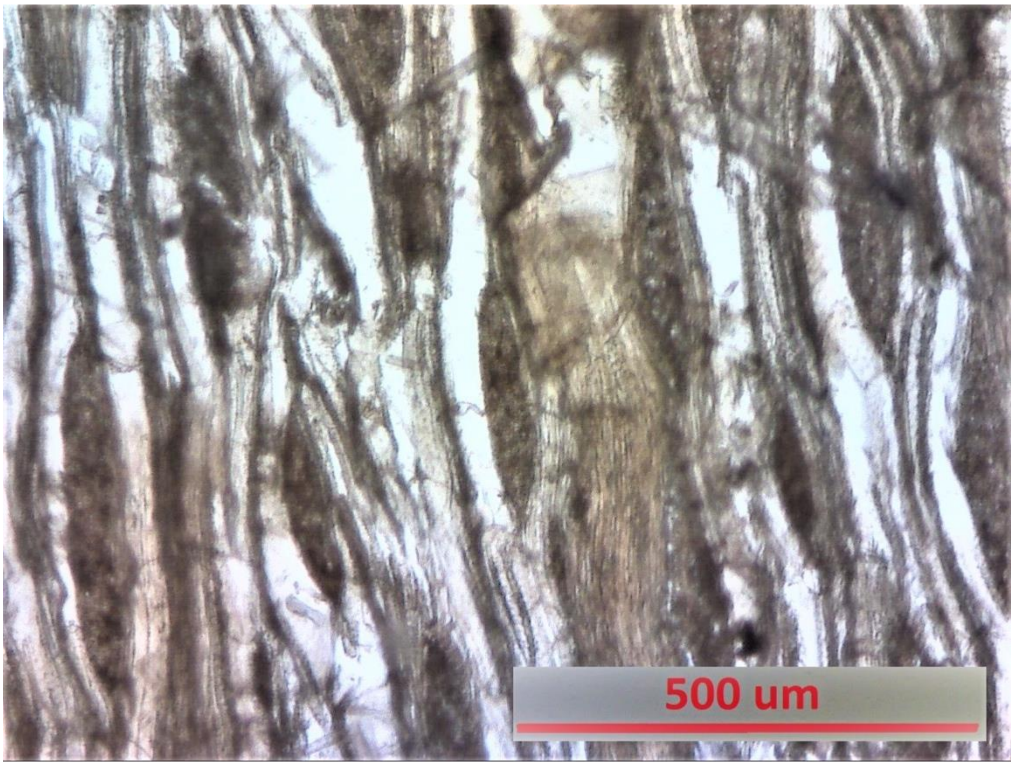
Sample 24. *Eucalyptus* sp. (Stringybark or Blackbutt). Stringer, portside bow, foremost hood area. Identified by Jugo Illic.



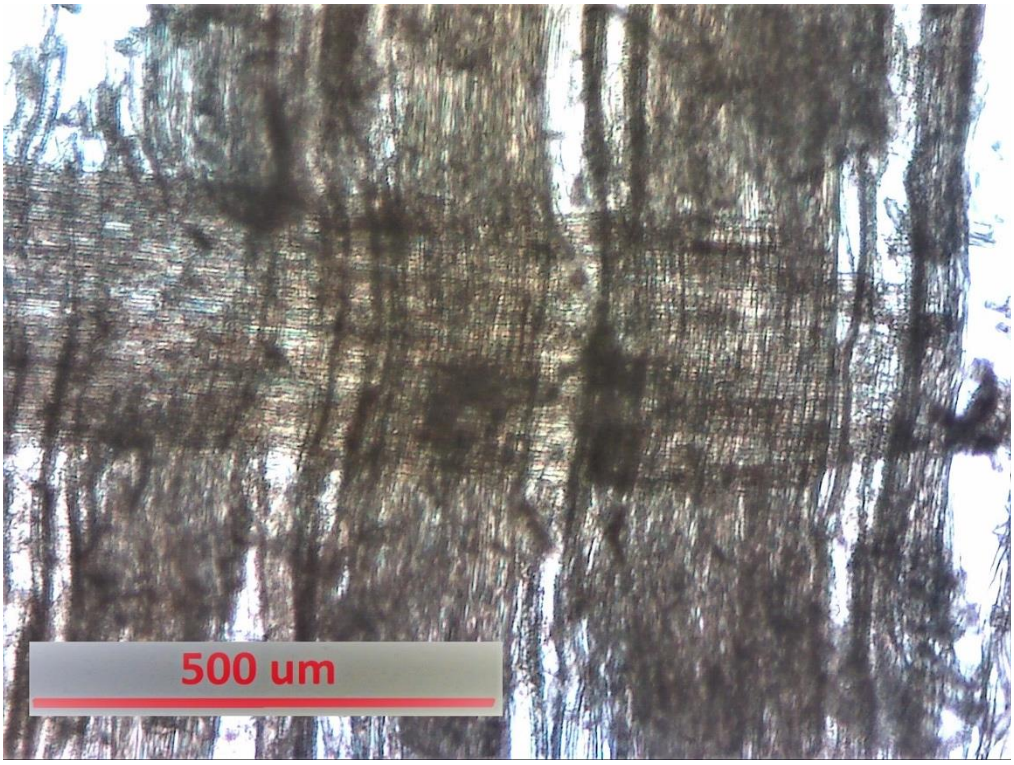
Sample 25. *Ulmus* sp. (Rock Elm). Rib, starboard bow, foremost frame timber. Identified by Jugo Illic.



Sample 25. *Ulmus* sp. (Rock Elm). Rib, starboard bow, foremost frame timber. Identified by Jugo Illic.



Sample 25. *Ulmus* sp. (Rock Elm). Rib, starboard bow, foremost frame timber. Identified by Jugo Illic.



Sample 25. *Ulmus* sp. (Rock Elm). Rib, starboard bow, foremost frame timber. Identified by Jugo Illic.