BLACK RIVER CEMETERY:

An anthropological study of the human remains exhumed from a historic Cape Town burial ground

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DECLARATION

I, ..Christie Pütter......................, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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DEDICATION

To the memories and the lives of every person buried at Black River Cemetery and the family, friends and loved ones who laid them to rest. You were here. You will not be forgotten.

"For this world is not our permanent home;
we are looking forward to a home yet to come."
Hebrews 13:14 (NLT)

"I declare to you, brothers and sisters, that flesh and blood cannot inherit the kingdom of God, nor does the perishable inherit the imperishable."
1 Corinthians 15:50 (NIV)

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The Black River Cemetery, located in modern day Athlone (a suburb of Cape Town), was open for burials from 1867 – 1951, serving three Anglican Churches. The recent (2017) excavation of the historic site allowed for the analysis of the exhumed skeletal remains. The outcome of the skeletal analysis is valuable as the lives documented on the skeleton of a past group of people can write the story of individuals and communities that may have otherwise been omitted from the history books. The aim of this study is to describe demography, lifestyle and disease for a group of people living at the Cape between the 18th and early 20th centuries.

The excavation of the cemetery yielded 1,305 graves of which 1,050 contained skeletal remains. Skeletal preservation was varied due to taphonomic influences, but overall it was poor with high fragmentation and taphonomic loss of skeletal material. The skeletal analysis performed utilised several well-established methodologies used in bioarchaeological and forensic anthropological disciplines and produced a body of information encompassing the demographics for this historic skeletal sample.

Historical research on the Colonial Cape, coupled with the Black River Cemetery history and burial registers was employed to provide the context to the results of the skeletal analysis. The historic research suggests that the community and people buried there were most likely hard-working people of the poorer communities at the Cape in the 18th and 19th century with a division of labour between men and women. In the period of time that the cemetery was receiving burials, multiple social, political and economic changes occurred including; the bubonic (black) plague, Spanish influenza epidemic, the Boer War, the First World War and the Diamond Rush. It also saw the beginnings of racially segregated living and forced relocations. This backdrop provides an interesting landscape on which to view the skeletal analysis.

The data analyses showed that the mortality profiles were skewed from the normal profiles determined by Weiss (1973). The sex ratio was skewed toward males indicating a greater mortality risk for men while the age mortality profiles showed a higher child and juvenile mortality and lower old adult mortality than is typically expected in a cemetery assemblage. This is an indicator of the effects of the epidemics and other factors reducing survivability of individuals. The low frequencies of periosteal reactions also may point to the poor survival capability as individuals

may have succumbed to infections before the effect would be exhibited on the skeletal material. Pathological and stress indicators also show a sexually dimorphic trend with males exhibiting greater frequencies of degenerative joint disease, fractures, osteophytic growths and rates of dental attrition. Stature analysis showed a sexually homogenous group of people suggesting a lower health status and likely malnourishment or undernutrition. The social environment in which people lived likely contributed to a weakened immune system, and the generally poor health status of the people. The experience of the people living in Black River and the surrounding areas appears to be one of hard, repetitive labour and nutritional stress within an everchanging urban setting.

Chapter 1: INTRODUCTION

1.1 Bioarchaeology discipline

Human history is vast and complex, and its' study is for the most part limited to recorded information, oral history and traditions passed from generation to generation. This recorded information, whether in the form of text, images or objects of significance, is frequently limited in portraying the stories of people and this means that our knowledge of past lifestyles and experiences is only a part of the story (Saunders, 1980; Buikstra, 2006). Through the use of biological anthropology and the study of human skeletal remains we are able to add to the knowledge of the past and tell the stories of people or groups of people who would have otherwise been omitted from the history books and thus forgotten (Buzon, 2006). The skeleton can inform a great deal about the individual, from biological descriptors (Buikstra and Ubelaker, 1994) to lifestyles and interactions with the environment (Armelagos and Van Gerven, 2003). When coupled with historical research and a cultural perspective, this biological information can reduce interpretive bias and provide context to historical events (Goodman et al., 1988; Katzenberg and Grauer, 2018). This shows the value of historical skeletal remains and their study to a modern population (Katzenberg and Grauer, 2018). However, frequently, the usefulness of studies of this nature are disputed and comes into conflict with the values of living descendants of the people's skeletal remains in the study samples; many of whom believe their ancestors, and the sacred landscape in which they are interred, should remain undisturbed (Katzenberg and Grauer, 2018).

While value systems surrounding the analysis of human skeletal remains may be polarizing, the resolution does not have to be so. A holistic approach should be taken, considering the ethical responsibility of the skeletal biologist, the dignity of the people whose skeletal remains are being studied and the preservation of cultural heritage for the living ancestors (Katzenberg and Grauer, 2018). Presently, the acquisition of new historical skeletal remains for study is primarily through the excavation of historical burial sites which occur for reasons and motivations outside of the interests of skeletal biologists or the relevant descendant communities (eg. Buzon et al., 2005; Friedling, 2007; Patrick et al., 2019). Frequently, the land that was set aside as a burial ground in the past, once located on the outskirts of the town or community developments, has over time become central property and carries a high value for development (Harvey, 2006; Leuta and Green 2011). The increased urbanisation has resulted in excavations of historical burial grounds in countries around the world with one of the larger excavations being the Spitalfields excavation in London, England (Hilts, 2012) which saw the exhumation of over 10 000 individuals that spanned many years (tDAR, 2011). Another excavation in San Francisco, North America saw the exhumation of around 900 historic burials (Buzon et al., 2005). The African Burial Ground in New York, North America, is yet another example. The burial ground was in use from approximately 1712 to 1795 with an estimated 15,000 individuals interred there and 424 of the graves were excavated due to developments (Frohne, 2015). Urban developments in Cape Town have taken place at both known historic cemeteries as well as uncovering unknown burial grounds resulting in the excavation of historic skeletal remains (Apollonio, 1998; Jonker, 2005). At Prestwich Place in the city, approximately 2,500 burials were exhumed (Finnegan et al., 2011), and at St Stephen's in Paarl, 1,140 historic burials were exhumed (Patrick and Dlamini, 2006).

The history of South Africa and in particular the Cape, is one of a very disparate contribution with colonialism, slavery and segregation being the chief causes (Worden et al., 1998; Bickford Smith et al., 1999). As mentioned before, it is easy for the history to be limited by the dictations of those that had power and resources at the period of time in question (Buzon, 2006). The skeletal study of those that represent and formed a part of the underprivileged and oppressed can provide valuable context to the perspective of history at the Cape that has not typically been recorded in books (Saunders, 1980). Skeletal analysis can provide demographic information including mortality rates, sex, age (Weiss, 1973), ancestry, stature, lifestyles of labour and occupation, diet, habits and the prevalence and consequence of diseases (Larsen, 2002; DiGangi and Moore, 2013; Katzenberg and Grauer, 2018). A skeletal analysis thus provides a window into the history and lived experiences of people in the context of historical events.

1.2 The purpose of the study

The aim of this study is to describe demography, lifestyle and disease for a group of people living at the Cape between the 18th and early 20th centuries.

1.2.1 Objectives

- Reconstruct demographic patterns with regard to sex ratios and age ranges for the site to draw comparisons to other sites and expected patterns.
- Identify the extent of the effect and prevalence of disease on the population through skeletal morphologies, examining the types of pathologies present
- Use the types of trauma and prevalence thereof to examine the lifestyle and stress load on the people also looking at presence of joint disease.
- Identify possible variations on adaptive traits such as stature for a past population using averages for males and females to compare with present populations.
- Examine the impact of the lifestyle on diet and whether this is reflected on the teeth through dental pathologies and wear patterns.

1.2.2 Questions

- Can the death assemblage accumulated over an extended period of time be studied as a homologous group?
- Is there a differential mortality rate between males and females?
- Did the acute epidemic diseases in the period that the Black River Cemetery was operational lead to a higher mortality rate in specific age ranges?
- What may be inferred about the lifestyles and health of those people living at the Cape in the late 19th and early 20th centuries?

Chapter 2 BACKGROUND

2.1 The colonisation of the Cape

The history of South African communities is rich and diverse, filled with challenges ranging from cultural and language barriers to disease and environmental issues. The modern City of Cape Town was built amongst all these changes and challenges that have an integral role in the current physical and social landscape.

The indigenous people to the Cape were the Khoikhoi and the San, who adopted different lifestyles. The Khoikhoi became pastoralists raising cattle and other animals on arable land, the San maintained a hunter gatherer lifestyle, both living off the land in their own respective ways (Smith, 1990). In 1652, after multiple explorative and trade expeditions by the Portuguese, Dutch and Spanish, three Dutch vessels led by the merchant Jan van Riebeeck (Bozarth, 1987), arrived at the Cape with the intention of establishing a settlement that would provide fresh water, produce, and medical care for the Dutch ships travelling around the Cape (Bozarth, 1987). The arrival of these Europeans resulted in tensions arising with the local Khoikhoi people, particularly in 1658 when the Dutch began to cultivate on the land that they had used for grazing, and boundary fencing and outposts were built to restrict, control and monitor the movements of the Khoikhoi and their cattle (Schietecatte and Hart, 2015). With the colonial expansion that followed and the encroachment into the wetlands used by the Khoi for grazing their thousands of cattle, the boundary was only the beginning of the assimilation of the Khoikhoi culture into a new, colonially influenced, way of life (Schietecatte and Hart, 2015).

During the establishment of the colony at the Cape, the Dutch imported slaves from various areas, the first arriving in 1653 (Friedling, 2007). The slaves were imported predominantly from India, Madagascar, the East Indies as well as the East coast of Africa (Reidy, 1997). This brought greater diversity to the Cape colonial landscape that would reshape the community entirely (Shell, 1994; Worden et al., 1998). The slave trade was not the only cause of incoming diversity at the Cape as international immigrants and traders also settled there including Chinese, Jewish and Eastern European Muslims (SAHO, 2015). This would not be the end of colonialism at the Cape, and 163 years after the arrival of the Dutch, the Cape officially fell under British Imperial rule in 1815 and an influx of English-speaking people from Europe and other British colonies around the world ensued (Worden et al., 1998).

2.2 The Cape Colony in the 19th century

2.2.1 Formal end of slavery

Over time, the use of socially constructed racial identities were formed to describe and separate people both socially, economically and politically. Three main race categories were used; Black referring to people of African descent, Coloured referring to people of a diverse ancestry and White referring to those of European descent (Cornwell, 2012). In the early nineteenth century a notable change in society was the decrease in the ownership of slaves (Worden et al., 1998). In 1806 there were 9,367 slaves in the growing, urban Cape and by the time slavery was formally abolished under British rule in December 1834 the number of slaves in the urban area had dropped by almost 50% to 5,550 (Worden et al., 1998). However, the reasons for the drop were two-fold, while the outlaw of external slave trade for British colonies in 1807 prevented a further influx of slaves to the Cape, many were sold to the rural farms and winelands resulting in a decrease in the number of urban slaves (Worden et al., 1998). In the years preceding 1834 and the official emancipation of slaves, a shift toward wage labour had already begun in that owners would hire out slaves to work for wage and require a percentage of the days earnings be returned or, alternately, a slave could be granted permission by the owner to work for others in wage labour positions (Worden et al., 1998). Beyond this, slaves were also permitted to buy their freedom for a price, and while their occupations and lifestyles were not starkly different to free Blacks, there was certainly a psychological significance in being free (Worden et al., 1998). Although the emancipation of slaves occurred legally, most would not truly experience freedom in their lifetime (Worden et al., 1998). The White people of the Cape viewed them as lower class and in need of reform, describing them as “sluggard and vagrant” with “evil disposition and intentions” and police forces were put in place purely to try and control their activity (Worden et al., 1998).

2.2.2 Early industry and development

Under Dutch rule there had been poor legislation in regard to mercantile and company law, which made the Cape colony a poor prospect for overseas investors and the economy was weak (Worden et al., 1998). The main industry at the Cape was formed around agriculture and wine production, and although there was a boost in the mercantile industry in 1846 due to the rise of merino wool sales, it predominated in the Eastern Province of South Africa and thus ports other than the Cape had a higher traffic (Worden et al., 1998). When copper was found in Namaqualand in 1853, the poor legislation proved itself as the collapse of the industry left many, both of limited means and well-off merchants, with nothing (Worden et al., 1998). This proved the need for new legislation for stock companies and reforms that would make the Cape colony a better investment for both locals and those abroad, and resulted in the passing of the Joint Stock Companies Limited Liability Act of 1861 (Worden et al., 1998). The first imperial bank opened in South Africa and The Cape Town Railway and Dock Company were established by 1855 (Meltzer, 1989; Worden et al., 1998). The then predominantly English-speaking town saw growth in the area of education and literacy among residents (Worden et al., 1998). The Cape port had difficulty in ship trade as there was no sufficiently protected bay and ships were often wrecked on the Cape shores (Worden et al., 1998). When steam ships took over, the overseas trade industry increased, necessitating the building of a harbour (Worden et al., 1998). The harbour was officially opened on 17 July 1870, but this was no small undertaking, and resulted in the use of convicts as free labour (Worden et al., 1998).

2.2.3 Health care of the 19th century

In the nineteenth century there was an increase in the research and knowledge surrounding public health and several British colonies had begun implementing policies and structures accordingly, but the Cape lagged behind (Naude, 1987). The South African Medical Society was established in 1827, but its operations included simply a point of reference for doctors at the Cape and retrospective discussion of disease (Naude, 1987). The society ceased to function in 1847 (Naude, 1987). The greatest barrier to the growth of a public health policy at the Cape was a lack of initiative and willingness to fund operations from both the colonial government and the municipality (Naude, 1987) and this resulted in poor public health facilities and knowledge (James, 1978; Naude, 1987; Phillips, 2018). An 1877 committee report on the condition of the city showed that the higher than warranted death rate was due to infant mortality (Naude, 1987). This was attributed to an unsafe water supply, overcrowding, lack of cleanliness and poor drainage, however, insufficient records of birth and death registrations brought uncertainty to this assessment (Naude, 1987).

The city would pay the toll for its poor organization when the smallpox epidemic began in June 1882 and by its end in March 1883 had caused around 4,000 deaths (Naude, 1987; Van Heyningen, 1989; White, 2018). The disease was likely brought to the Cape via the ships from Britain and deaths were concentrated among the poor, spreading rapidly in overcrowded and unsanitary homes (Naude, 1987). This was a wake-up call and in 1882 steps were taken through the use of the district surgeon to improve sanitary conditions and health policies (Van Heyningen, 1989). A professional medical organisation was again implemented in 1883 (Naude, 1987; Van Heyningen, 1989). The need to improve public health in the city was further motivated by the growing mining industry further north during the Capes mineral revolution (Naude, 1987).

2.2.4 The diamond rush and early segregation

In the 20 years preceding the discovery of diamonds, people from the central and northern parts of modern day South Africa would migrate to the Cape Colony for wage labour jobs in farming and public works projects, staying at the job for around four to eight months at a time (Cleveland, 2014). The discovery of diamonds in 1867 transformed the city, as many European foreigners came to the mines via the Cape Colony and the increase in investment interest led to rapid growth and development (Bickford Smith et al., 1999). The diamond mines were north of the colony in what became the city of Kimberley (Fig 2.01). The rush to stake and dig claims saw not only the influx of European foreigners but also thousands of Africans from surrounding areas in Southern Africa (Cleveland, 2014).

For the migrant labourers that would previously work in the Cape Colony, the diamond mines were closer to home and paid a minimum of 50% more in wages than the labour wages offered at the Cape (Cornwell, 2012; Cleveland, 2014). Africans were initially able to own claims and work on them, however, as the competition increased so did racial tensions with the White diggers (Cleveland, 2014). Legislation was passed which allowed entrepreneurs to buy up claims leading to the formation of large mining companies (Cleveland, 2014). This change resulted in the African diggers becoming a migratory labour force rather than claim owners at the mines and subject to racism (Cornwell, 2012; Cleveland, 2014). A local missionary wrote about the black African miners in 1876 saying, ‘Not all blacks on the diamond fields are servants. There are many quite well-educated diggers or merchants. These are mostly from the [Cape] Colony and they are mostly those who tend to remain and build up a nucleus of permanency to which newcomers adhere (Turrell, 1981).’ This indicated that several Blacks from the Cape Colony had also participated in the diamond rush and relocated with a sense of permanence.

The racism was not isolated to the diamond mines in the north. Segregation based on skin tone was found in the Cape at institutions such as hospitals, asylums, schools and prisons by the end of the 19th century (Worden et al., 1998). However, residential segregation had not yet been formally instituted largely due to a lack of willingness of the upper class Whites to invest in new housing and transport had their labour force been required to move a great distance from them (Worden et al., 1998).

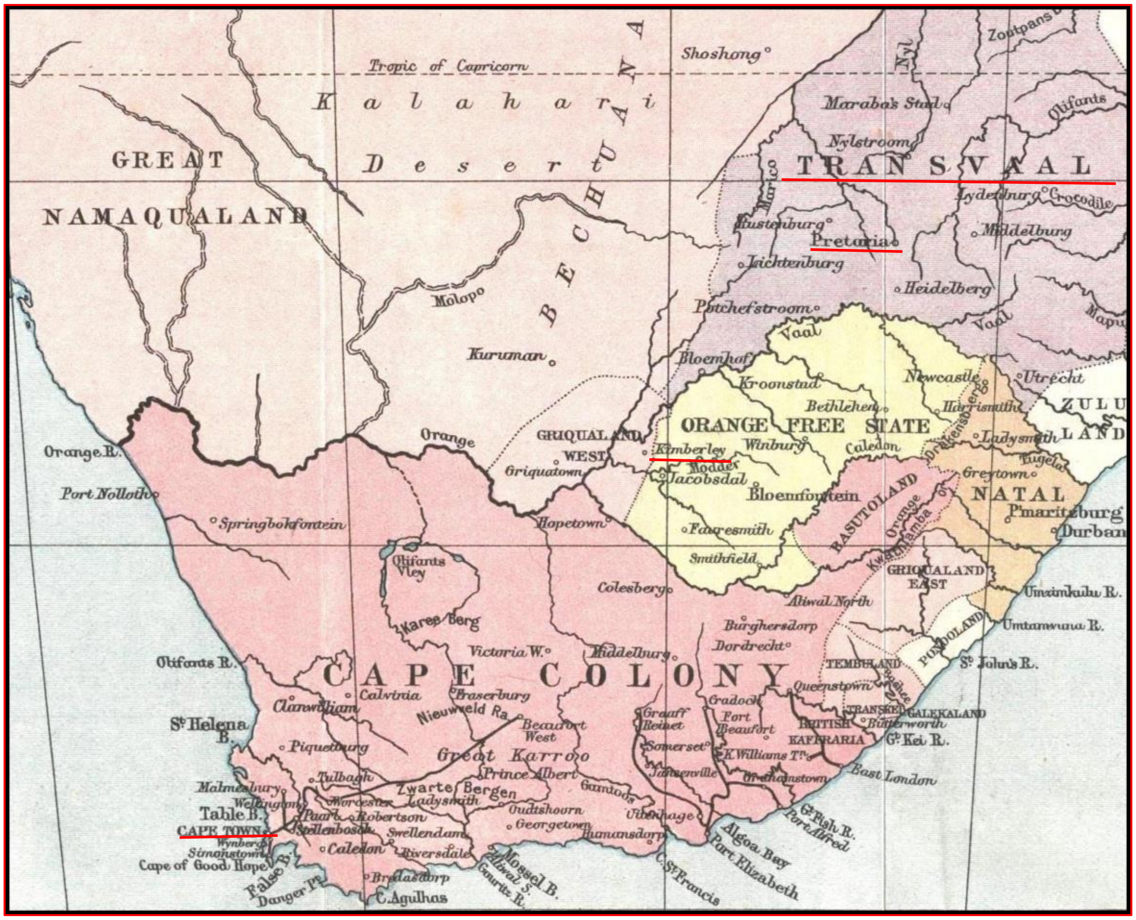


Fig 2.01: A map of the Cape Colony in 1878 obtained from Molteno (1900)

2.2.5 Boer War (1899 – 1902)

The South African War or Boer War broke out between the then Transvaal Republic (Fig 2.01) and the British Empire in 1899 and would continue until 1902 (Bickford Smith et al., 1999). The Cape was under British rule at that time and was somewhat sheltered from the direct effects of the war (Bickford Smith et al., 1999). Refugees flooded to the Cape on the railway lines and cattle trucks from the areas further north and were received by the city, although not all provided for with equal hospitality (Bickford Smith et al., 1999). Coloured and African men did not receive any aid and were assimilated into the poorer communities while Coloured women and children were provided with food and accommodation (Bickford Smith et al., 1999). Indian men were originally set up in tents on Dock Road (in the city) and later moved to Maitland (Fig 2.02) where they were evicted at the first opportunity, being moved into District Six (Fig 2.02) (Bickford Smith et al., 1999). On the other hand, White male refugees were housed in the large Feather Market building and later moved to Dock Road, housed in wood and iron accommodations while the White female refugees were provided for by the elite women of the city (Bickford Smith et al., 1999). This demonstrated the division by race and culture already present in the country, although it had not yet been legalised. Another example of this was in the rejection of Coloured men of the Cape who wished to serve in the British Forces during the war, while White men were received to the volunteer forces (Bickford Smith et al., 1999).

Fig 2.02: A modern map of Cape Town suburbs with locations labelled (Image obtained from Google Maps accessed 10/02/2020 at: https://www.google.co.za/maps/@-33.9367461,18.4380559,9898m/data=!3m1!1e3).

2.2.6 Black Plague (1901)

During the Boer War those living in the Cape were confronted by yet another threat in the form of the deadly and contagious Bubonic, or black plague, that would claim the lives of many in 1901 (James, 1978; SAHO, 2017). The country did have some foresight to the arrival of the plague, it had already been described in several other countries including China, Australia, and Argentina (Bickford Smith et al., 1999). It is evident that there was a concern for the potential arrival of the plague to South Africa as in February 1899 an Inter-State Plague Conference was held in Pretoria (Fig 2.01) to the north of the colony (James, 1978). There had been improvement in public health policy and birth and death registrations since the smallpox epidemic, but at the onset of black plague, sanitary conditions were still a cause for concern (Naude, 1987; Van Heyningen, 1989).

In preparation for the black plague, the government set up a plague hospital in modern day Pinelands (Fig 2.02) and a camp for those who had been in contact with the victims (Bickford Smith et al., 1999). The first identified victim of the plague, a clerk working at the harbour, was sent to the newly opened hospital on 27 January 1901 (James, 1978). This bacterial disease was contracted at much higher rates among the poor who lived in overcrowded and unsanitary conditions of which the predominance were African and Coloured (Simpson, 1901).

To prevent the spread of the disease, hundreds of African people were removed from their homes in District Six (Fig 2.02) and set up, first in temporary tents near the docks, and later to Maitland (Fig 2.02) (Bickford Smith et al., 1999). This marked the beginning of segregated living and the loss of residential freedom for the Africans at the Cape (Bickford Smith et al., 1999; Cornwell, 2012; White, 2018). The plague was at its highest rates for the months February through May, whereafter accounts decreased and had mostly ceased a year after the onset at the Cape (James, 1978). The Acting Chief Medical Officer for the Colony at the time, Dr. Gregory, and his team, acted to prevent the spread of the plague by cleaning outbuildings and disinfecting and fumigating houses, as well as removing the rats and burning their dead bodies (James, 1978). This showed an understanding of the need for ventilation and sanitation, however, an editorial of the Cape Times on 3 October 1901 indicated a reduction in the city council's concern for these issues since the worst of the outbreak had passed (James, 1978).

In total, the plague had claimed the lives of 371 people, a mortality rate of 50% as there were 766 cases reported of people falling ill (Bickford Smith et al., 1999). Those most greatly affected were the Coloured people with a mortality rate of 56.84% followed by the Africans with 44.59% (Bickford Smith et al., 1999). The lower rates of contraction among the African people was due to the forced relocation to an area free of disease (Bickford Smith et al., 1999). In contrast to these numbers, the total number of cases reported in South Africa was 1,694 with 947 deaths (Ole!Media, 2017) and thus the percentage that Cape Town contributed to the total was 41% of cases reported and 39% of deaths in South Africa (Bickford Smith et al., 1999; Ole!Media, 2017).

2.2.7 Employment and census

At the time of the first population census in 1865, the differences in the labour force could be measured and it was ascertained that White laboured and skilled artisans earned more than their Coloured and African counterparts and women had very little job opportunity with low wages (Boddington, 1984; Worden et al., 1998). Coloured woman had great difficulty in the job search and were only able to gain employment in dressmaking, washing and domestic service (Worden et al., 1998). By 1901, the first township (an underdeveloped, racially segregated urban suburb) was formed at 'Uitvlugt' spurred by a racial view of the black plague (Saunders, 1980). The township was later renamed 'Ndabeni' (Fig 2.02) at the original residents request and urban segregation was formalised by parliament in 1902 (Saunders, 1980). The township consisted of large dormitories to house 500 men as well as corrugated iron huts without floors (Bickford Smith et al., 1999). The residents of these townships were outcasts from the city centre, who had been forced to move to reduce the spread of the black plague and the number of people grew, resulting in overcrowding and unsanitary living conditions (Bickford Smith et al., 1999).

Overcrowding and informal and illegal living settlements intensified in the 1920's and attempts were made to control the entry of Africans to the city (Boddington, 1984). By 1904 the population had become male dominated with there being 13,376 more men than women counted (Worden et al., 1998). Following the Boer War, a new era was brought about as the Cape Colony officially joined the Union of South Africa becoming the Cape Province in May 1910 (Bickford Smith et al., 1999). The inter-war years, while seeing a positive increase in industry, also saw a broadening in the gap between the poor and the rich, as well as, black and white residents as national legislation began to discriminate along racial terms (Bickford Smith et al., 1999). The period of time between the First and Second World War (1919 – 1936) saw Southern Africans come to Cape Town in greater numbers (Table 2.01) and the laws set to control the movement of Africans were a prelude to the apartheid legislation that would intensify segregation and the control laws (Boddington, 1984).

Table 2.01: Total population figures in Cape Town 1865-1946 by ancestry from Boddington (1984)

Census	Population	Percentage Composition (%)			
		White	Coloured	African	Asiatic
1865	38,791	54	44	2	00
1875	44,688	56	43	1	0
1891	79,055	52	47	1	0
1904	174,447	60	34	4	2
1911	162,298	53	45	1	1
1921	211,461	54	41	4	1
1936	344,223	50	44	4	1
1946	325,055	51	38	10	1

Source : 1865-1936: reproduced from Batson (1942:12), (References: Reports SS1, SS1)
: 1946: Union of South Africa Census Reports: Vol V, Tables 2, 7, 10, 13

Erica Boddington's (1984) research into the employment of people based on the census reports between 1891 and 1946 showed the following trends:

- Class position based on skin colour was demonstrated, Whites were the most privileged with the broadest range of economic opportunities particularly in commerce and industry.
- The least privileged worked in wage labour in different sectors of the economy including personal service.
- There was a sexual division of labour across all skin colours with women having far less opportunities than men. Whilst White women could gain employment in the industry and commerce sectors, Coloured women were confined to textiles and personal service and African women could only gain employment in domestic service.

2.3 Cape Town in the first half of the 20th century

The earlier half of the 20th century had four major events affecting the social, economic and political environment of Cape Town.

2.3.1 The First World War (1914 – 1918)

The First World War started in 1914, only a short while after the Union of South Africa had been established, and although the epicentres of this war were far from the shores of Cape Town, the city was affected by the conflict (Bickford Smith et al., 1999). The first forces to be called forward were to secure the Union of South Africa against the German South West Africa (present-day Namibia) and shortly thereafter, recruitments were held to send men to Europe, both Coloured and White, although in different contingents (Bickford Smith et al., 1999). This war proved to be significant in the changing of roles for women with both White and Coloured women forced to join the work force to provide for themselves and even the formation of a women's club in District Six that would serve the dual purposes of providing basic education to the women of Colour and recreation in the form of music and dance (Anon, 1916). One of the positive results following the end of the war in 1918 was the formation of a South African identity. However, the poverty gap had widened and the national government was inadequately prepared to combat social, economic and health issues arising thereafter (Bickford Smith et al., 1999).

2.3.2 The Spanish Influenza epidemic (1918)

Between 1910 and 1920, Cape Town developed major issues with overcrowding and lack of accommodations (Phillips, 2018). The population had increased largely due to people from the poorer rural areas seeking work in Cape Town during the war, but also through the presence of First World War servicemen (Phillips, 2018). This resulted in a 30% growth in the population at the Cape within a decade since the formation of the Union of South Africa (Phillips, 2018). These overcrowded living conditions provided a rife environment for the Spanish Influenza virus that was brought to the Cape shores via several ships that arrived at the docks in 1918 (Mendi, 2014; Phillips, 2018).

The onset of the epidemic was so sudden that relief operations were hastily setup involving each Municipal ward opening depots for free medication and food, the streets being disinfected and 6 temporary hospitals formed (Bickford Smith et al., 1999; Phillips, 2018). A call for volunteers saw many people across the colour and class spectrum show up in an honourable effort (Phillips, 2018). Medically, there was very little knowledge of what needed to be done as viruses were not known or understood at the time and treatment was not possible (Bickford Smith et al., 1999). A medical practitioner was quoted stating, ‘We had a rough idea that care was necessary, that fresh air was essential, but as to medical treatment our minds were fogged’ (Phillips, 1984). The city struggled to deal with the level of mass outbreak and churches, social organizations and individuals set up aid stations and temporary medical facilities to assist with the care (Bickford Smith et al., 1999).

The initial infections started in late September and the death toll rose rapidly reaching 442 deaths per day by October 10th which led to the epidemic being referred to as “Black October” (Phillips, 2018). The spread slowed down until two weeks later the number had dropped to 50 per day (Phillips, 2018). The final tally for Spanish Influenza deaths in Cape Town was 4,300 which amounted to 4.2% of the losses across the country in which over 300,000 lives were lost (Phillips, 2018). While the disease itself was unbiased in its selection of victims there was a disproportionately high percentage of deaths within the Coloured and African groups (Tables 2.01 – 2.04) (Phillips, 2018). Possible reasons for this include that they were confined to living in overcrowded camps or districts that allowed for the rapid spread of the disease (Phillips, 2018). People of the poorer communities were unable to afford treatment and could not afford to take time off work to rest, thus having a higher likelihood of succumbing to the disease (Phillips, 2018). Pregnant women were especially vulnerable to the disease as they were at a greater risk of respiratory and cardiovascular stress (Phillips, 2018). The consequence of this was a greatly decreased birth rate between the onset of Black October and the following June, a loss which was noted in 1925 when there was a considerably lower than expected number of children starting school (Phillips, 2018).

Table 2.02: Spanish flu deaths in municipal area of Cape Town by race and sex from Phillips (1990).

	Male	Female	Total
White	660 (15.34%)	450 (10.46%)	1,110 (25.8%)
Coloured, Indian and Black	1,875 (43.58%)	1,317 (30.61%)	3,192 (74.2%)
Total	2,535 (58.93%)	1,767 (41.07%)	4,302

Table 2.03: Spanish flu deaths in municipal area of Cape Town by race and age adapted from Phillips (1990).

	Under 5 years	5-25 years	25-55 years	55-75 years	Over 75 years
White	106 (2.42)	240 (5.47)	712 (16.26)	64 (1.46)	5 (0.11)
Coloured, Indian and Black	657 (15)	890 (20.31)	1,582 (36.11)	95 (2.16)	12 (0.27)
Total	763 (17.42)	1,130 (25.8)	2,294 (52.36)	159 (3.63)	17 (0.39)

Table 2.04: Spanish flu deaths in wards (suburb) by race adapted from Phillips (1990).

	Rondebosch ward (% of total Cape Town deaths)	Maitland ward (% of total Cape Town deaths)
White	61 (1.42%)	104 (2.42%)
Coloured, Indian and Black	317 (7.37%)	281 (6.53%)
Total	378 (8.78%)	383 (8.95%)

The number and rate of deaths over this short period completely overwhelmed the city's cemeteries; with the largest, Maitland Cemetery (Fig 2.02), unable to accommodate everyone, smaller church and local cemeteries would open their gates too (Patrick et al., 2019). At Maitland Cemetery the number of burials per day rose from 10 to 60 and peaked at a staggering 250 per day during the third week of the epidemic (Bickford Smith et al., 1999). The streets became silent as stores were closed and standard operations stopped, the dead would lay uncovered on the sidewalks for hours before being tended to, (Bickford Smith et al., 1999) and the city was left in shock and grief. The response following the epidemic to the issue of housing and overcrowding, was to build a township, called Langa, which was deliberately built even further from the city centre (Fig 2.02) and acted in increasing the racial segregation (Phillips, 2018).

2.3.3 The Great Depression (1929 – 1934)

The period of time between the First and Second World War saw the city grow in terms of industry and manufacture as well as other modern amenities such as electricity, the cinema and motorised vehicles (Bickford Smith et al., 1999). That time also saw the difficult period known as the Great Depression, which was spurred by the collapse of the American stock market in October 1929 (Sebree and Ruggiero, 2020). The Great Depression was experienced globally and was characterized by the poor economy, high prices for living expenses, high unemployment rates and reduced accessibility to products (Minnaar, 1990; Sebree and Ruggiero, 2020). Prices began to improve in 1933 but only recovered to the levels prior to the collapse in the late 1930's and early 1940's preceding the Second World War (Minnaar, 1990). The consequences of the Great Depression extended beyond industry and economy having a social and political impact too (Sebree and Ruggiero, 2020).

2.3.4 The Second World War (1939 – 1945)

The Second World War, while still affecting the city, was a lot less dramatic to the changes it incurred. South African forces were recruited and participated in the war in Africa and Europe (SAHO, 2011) and civilian reserve and protection services were established in Cape Town (Bickford Smith et al., 1999). However, the Cape Town community's experience of the war was the unsure threat of air and sea raids, with ill-prepared precautions set in place such as the instalment of air-raid sirens and the institution of a nightly black out in which all electrical, motor vehicle and other lights had to be turned off (Bickford Smith et al., 1999). Social constructs were not greatly changed as a result of this war, however, a boost in industry did occur as South Africa had to rely on their own resources after the German invasion of Scandinavia and the Netherlands in 1940 (Bickford Smith et al., 1999). In the four years after this, the canned food industry had grown its output from 96 million pounds to 196 million pounds and the docks were reconstructed and enlarged (Bickford Smith et al., 1999). This effort saw new Black and White labourers immigrate to Cape Town and the employment boost included White Afrikaners, African migrants and women (Bickford Smith et al., 1999).

2.4 Historical burial grounds at the Cape (17^{th} – 19^{th} centuries)

Historically, cemeteries were setup on the outskirts of the city, and in the 17^{th} century, the outskirts and periphery of the Cape settlement was the sand dunes and wetlands that today is Green Point (Finnegan et al., 2011). Along with the needs of the colony to provide burial space, churches and religious burial practice also influenced the cemetery composition of the Cape (Friedling, 2007). The 'Green Point' area was divided into a formal and informal burial ground and were populated according to religious and class distinctions with the Dutch Reformed Church predominating in the early colonial years (Finnegan et al., 2011). Europeans and slaves were initially buried in the same cemetery, however, separate burial grounds were later used with the Europeans being buried in formal, walled cemeteries and slaves in the informal, unwalled burial grounds (Bozarth, 1987; Friedling, 2007).

In 1755, the cemetery belonging to the Dutch Reformed Church was declared full following a smallpox epidemic and lead to the establishment of two cemeteries between present day Signal Hill and the shoreline of Table Bay (Finnegan et al., 2011). The Dutch Reformed Church was the most influential during the building of the colony (Davids, 1992), but after the British occupation, several other denominations of Christianity grew (Table 2.05) and with that the number of cemeteries increased as churches were built (Friedling, 2007). In the early decades of the 19th century, Somerset Road (within the city) became the new site for cemeteries belonging to several religious affiliations including, Anglican, Lutheran, Catholic and Episcopalians (Finnegan et al., 2011). These were placed amidst residential and commercial buildings and by the end of the century were in a poor state resulting in their closure as a part of the push for better public health initiated in 1883 (Finnegan et al., 2011). The government then granted land to the city in the modern-day Maitland (Fig 2.02) to be dedicated burial ground (Finnegan et al., 2011).

2.5 Anglican Church and Black River Cemetery

Religion played a strong role in the politics at the Cape and with the arrival of the British in the early 19th century, the number and diversity of religious affiliations increased and the previously dominant Dutch Reformed Church was no longer enforced as the only religious affiliation at the colony (Table 2.05) (Worden et al., 1998).

Table 2.05: Religious affiliations at the Cape by numbers of people in 1841 (Anon, 1842 in Worden et al., 1998).

Religious Affiliation	Number of people
Dutch Reformed	15,000
English Episcopalians	4,200
Scottish Presbyterians	750
Lutherans	1,800
Roman Catholics	676
Protestant Dissenters	2,069
Muslim	6,492
No affiliations	1,541

One of the Christian denominations added to the city's religious community was the Anglican Church which by the late 1800's had become well established with several churches, mission stations and smaller chapels formed as the city grew (Bester, 2014). Historically, it was the people living along Black River in the late 1800's that decided to build a church, made from wattle and daub, and began the work of doing so, mixing clay and throwing it on to bushes to erect the walls of what would be the church building (Patrick et al., 2019). The landowner, Mr. William Schierhout, was pleased to see the desire of the people wanting to build a church and donated land for this purpose as early as 1850 which would become the location of the St. James Anglican Church (Bester, 2011; Patrick et al., 2019). The adjacent Black River Cemetery was formed following the donation of land by Mr Thomas Tregidga to the Anglican Diocese of Cape Town in 1880 for the purpose of developing a burial ground (Patrick et al., 2019). The title deed (Erf 3303 TD 557) and Surveyors diagram (Erf 41605) locate the land at the Camp Ground near the Kromboom River, Athlone (Fig's 2.02 and 2.03), in the Western Cape (Patrick et al., 2019).

Fig 2.03: A modern map of Cape Town suburbs with church locations labelled (Image obtained from Google Maps accessed 10/02/2020 at: https://www.google.co.za/maps/@-33.9694977,18.4991526,1749m/data=!3m1!1e3).

The burial registers for the Black River Cemetery are maintained at St Pauls church in Rondebosch (Fig 2.03) and have been catalogued and published by Bester (2011 and 2014). While the deed of transfer is dated 1880, a burial dated March 1867 appears in the St Pauls Burial Registers, indicating that the land was already in use as a burial ground by the Church prior to their acquisition of the land (Patrick et al., 2019). The cemetery served the Anglican communities of three churches, St Georges (Silvertown), St Marks (Athlone) and St James (Black River) (Fig 2.03) (Patrick et al., 2019). The burial registers indicate that the cemetery took burials of people from the surrounding suburbs (Patrick et al., 2019). According to Bester (2011), despite the wider geographical area, all the burials during the Spanish Influenza epidemic of October 1918 were Christian. There was such a demand for the purchase of graves that the grieving took hours to reach the offices at Maitland Cemetery (Fig 2.02) to purchase a grave, and then waited to be shown to the correct grave to inter their family members (Patrick et al., 2019). This resulted in over 150 burials at the small Black River Cemetery in a space of three weeks (Patrick et al., 2019).

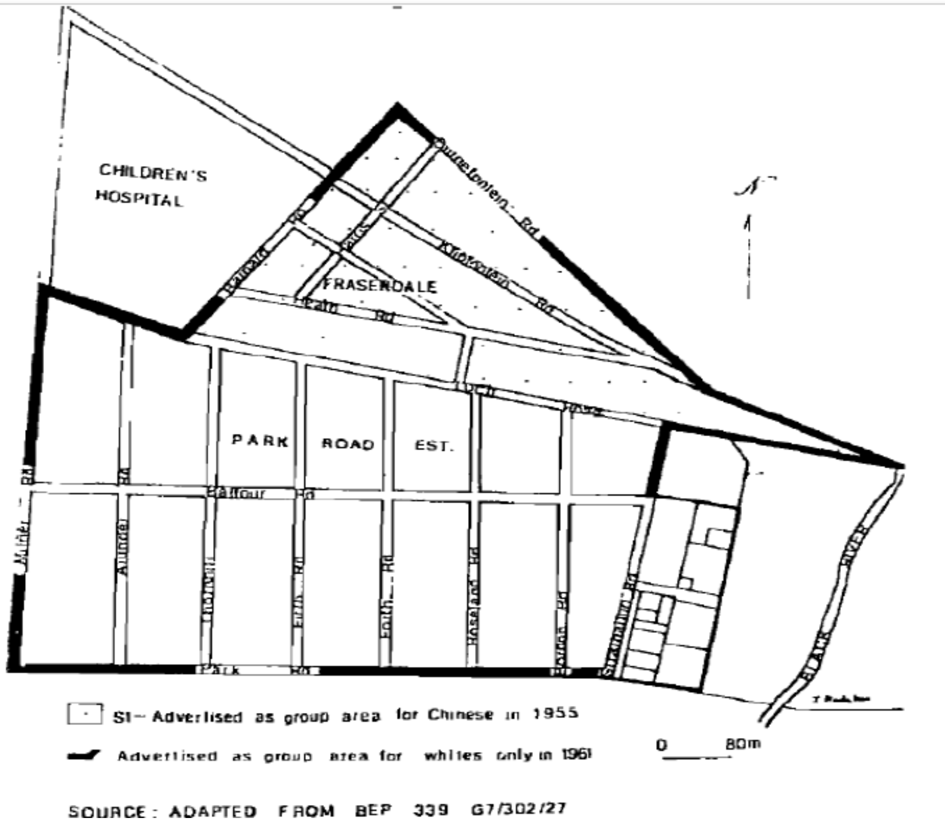


Fig 2.04: A map of the Black River community streets including the area between Loch, Duinefontein and Roseland Roads (Sourced from Dhupelia-Mesthrie 1996:218, as adapted from the Secretary for Planning File (BEP), National Archives of South Africa 339 G7/302/2) obtained from Patrick et al. (2019).

The Black River community took pride and ownership of the burial ground and ensured it was maintained, kept neat and protected through members working at the cemetery in their free time and later it was decided to raise funds to employ someone to maintain the cemetery (Bester, 2011). It became customary for relatives and friends of those buried at the Black River Cemetery to gather there on the morning of Easter Day to celebrate the resurrection of Christ and the hope found therein for their loved ones (Bester, 2011). In this special service, the names of those that had been added to the cemetery in the preceding year were read aloud in memory and thanksgiving (Bester, 2011). The Easter service in 1919, months after the devastating Spanish Influenza epidemic saw over 1,000 people in attendance and similarly, a memorial service held on 26 October 1919, a year after the epidemic saw about 1,200 people gather from Black River and nearby Rylands (Fig 2.02), Rondebosch (Fig's 2.02 and 2.03) and other areas (Bester, 2011). By 1966, the Black River community (Fig 2.04) was made up of 300 families, totalling just below 2,000 individuals classified as Coloured, Malay and Indian (Dhupelia - Mesthried, 2006).

2.6 The excavation of Black River Cemetery

2.6.1 Reasons for cemetery excavations

As urbanisation continues, the cemeteries that were once on the periphery of the city became prime land earmarked for new developments and this often leads to the excavation of historic cemeteries as the value of the land is very high. An example of this was the excavation of a First African Baptist Church Cemetery in Philadelphia, which was a historical site used as a burial ground in the 19th century by a then marginalised group of people (Parrington and Wideman 1986). The site was initially granted legal protection, but proposed improvements to infrastructure and a building proposal in 1982 necessitated its excavation to prevent the destruction of the burial ground (Parrington and Wideman 1986).

The exhumation of cemeteries has been a part of Cape Town's history with the most recent being the excavation of the Prestwich Street burials (Friedling, 2007; Finnegan et al., 2011). This excavation incidentally links back to the 19th century excavations in which all the official cemeteries in Green Point were excavated and exhumed remains were reburied in the demarcated Maitland burial grounds (Finnegan et al., 2011). It was later discovered that only the graves with burial stones or those that were found in church records had been exhumed and urban developments since the 1990's have been uncovering the graves of the thousands of informal burials that were never recorded (Finnegan et al., 2011).

The last burial at Black River Cemetery was reported to be in 1952 (Patrick et al., 2019) and with the loss of the St James Church in the 1970's the onus of the maintenance of the property then fell to the nearby (Fig 2.03) St Marks Church in Athlone (Patrick et al., 2019). The Parish council of St Marks did not have the financial, administrative or material means to maintain the property and by 2011 the land was barely recognizable as a burial ground (Patrick et al., 2019). In response to the degraded state of the burial site, the complaints of nearby residents and the inability to protect the graves at the burial site, a decision was made by the Anglican Church to investigate the possibility of the site being excavated (Patrick et al., 2019).

2.6.2 Process for the excavation and exhumation of historical sites

In order for any grave or burial ground to be exhumed a permit granted by the South African Heritage Resources Agency (SAHRA) and Heritage Western Cape (HWC) must be obtained. The requirements for the permission to exhume a grave are found in the National Heritage Resources Act, 25 of 1999 (Section 36) and include a stipulation that there should be a concerted effort through a 60 day public participation made by the applicants to communicate with any people, individuals or communities, that may have an interest in the grave or burials through their history. In meeting this requirement, three public consultations were held from 2012 – 2013 with the third and final one taking place on June 3rd 2013 (Patrick et al., 2019). In addition to these, the Anglican Diocese also communicated the project to their congregants and communities requesting that anyone with a vested interest should come forward and register their interest (Patrick et al., 2019).

The permit for the exhumation of the burial ground was granted and the excavation was allowed to proceed. Additional permits for the exhumation and handling of human remains are required and permitted by the Social Service Directorate and the Provincial Inspector of Anatomy for the Environmental Health Department. These permits were granted with guidelines regarding regulation of on-site work as well as the treatment of the exhumed human remains, as defined in the Environmental Management Act of 1998 (Act 107 of 1998) and the National Health Act of 2003 (Act 61 of 2003) respectively (Patrick et al., 2019).

2.6.3 Protest to excavation and exhumation

Despite the permitting requirements being met, including community engagement, the excavation and exhumation process met with opposition once fieldwork commenced, primarily spearheaded by the owners of three properties bordering the burial site (Patrick et al., 2019). The unrest caused by this led to a high media coverage including radio, newspaper, social media and caused false perceptions of the reasons for excavations as well as the people who were buried there (Patrick et al., 2019). The actions of the protestors included online petitions, site invasions, removal of the site boundary fence, physical and verbal abuse of the archaeological team members, desecration of the graves, banners painted on the boundary fence and complaints filed to the SAHRA, HWC, the City of Cape Town Heritage Unit and the Commissioner of Culture, Religion, and Language portfolio for the South African Parliament (Patrick et al., 2019).

At every stage of the protest, appropriate communications occurred between the legal team for the project; the heritage authorities SAHRA, HWC and the Cape High Court. The excavation permit remained valid and the excavation and exhumation was completed in December 2017 within the timeline stipulated by the permit (Patrick et al., 2019). The protests are ongoing beyond the completion of the excavation and an interest group wish to lay claim to the land. The group would like a garden of remembrance built on the Black River Cemetery site to commemorate their ancestors and feel that the Anglican Church should not benefit from the commercial development of the land (Patrick et al., 2019).

Chapter 3 MATERIALS and METHODS

3.1 Materials

3.1.1 Black River Cemetery location and people

Black River Cemetery is located in Athlone, Cape Town (GPS co-ordinates: 33º 57' 38. 58" S - 18º 29' 52. 42" E) and measures 6,600m^2. It is bordered by Klipfontein Road to the North, The M5 highway to the West, residential homes to the East and a secondary school to the South (Patrick et al., 2019) (Fig 3.01). The cemetery is under the administration of the Council of St Marks Church and is owned by the Anglican Diocese of Cape Town (Patrick et al., 2019). The name of the cemetery arises from the Black River which originates at Ardene Gardens in Claremont and initially flows underground, then as a canal and eventually uncanalised until it joins with the Salt River beyond Maitland (Patrick et al., 2019).

The cemetery initially served three Anglican churches; St James in Black River, St Marks in Athlone and St Georges in Silvertown all of which were under the oversight of St Pauls in Rondebosch (Fig 2.03) (Patrick et al., 2019). The Black River community and congregation of the St James church maintained the cemetery (Patrick et al., 2019). The land on which the small St James church was located was sold in 1965 to the government and was situated where the on ramp to the M5 now is (Fig 3.01) (Patrick et al., 2019). Although the cemetery was consecrated to serve these three Anglican churches, the Spanish Influenza epidemic of 1918 led to the cemetery receiving people from several surrounding suburbs and the high internment rate resulted in multiple burials, a lack of coffins and a higher than normal juvenile death rate (Patrick et al., 2019).

3.1.2 Black River Cemetery excavation

The skeletal material used for this study came from a historic burial ground in Cape Town. The burial ground was open for burials between the years 1867 and 1951 when the last burial took place (Patrick et al., 2019). The Trustees of the Anglican Church of South Africa with the input and approval of the community and government heritage agencies decided to excavate the site and exhume all the human remains and grave materials associated with the cemetery (Patrick et al., 2019). The remains were cremated following exhumation and reinterned in a purpose-built columbarium (Fig 3.02) at the premises of the St Marks church in Athlone (Fig 2.03) (Patrick et al., 2019). This process began in 2012, and the excavation was completed in 2017 (Patrick et al., 2019). There were no comprehensive burial records kept specifically for the cemetery and the reconstructed register does not provide information on grave locations. It may not be possible to match the skeletal material with an individual using the historic information. A memorial service to commemorate those buried at Black River Cemetery was held prior to initiating the excavation (Patrick et al., 2019). For the excavation, the site was divided into 4 arbitrary working quadrants (A, B, C, D) (Fig 3.03 – 3.05) using a methodological framework developed by Patrick and Dlamini (2006) in conjunction with a demolition-earth moving contractor, Steven Harsmen (Patrick et al., 2019).

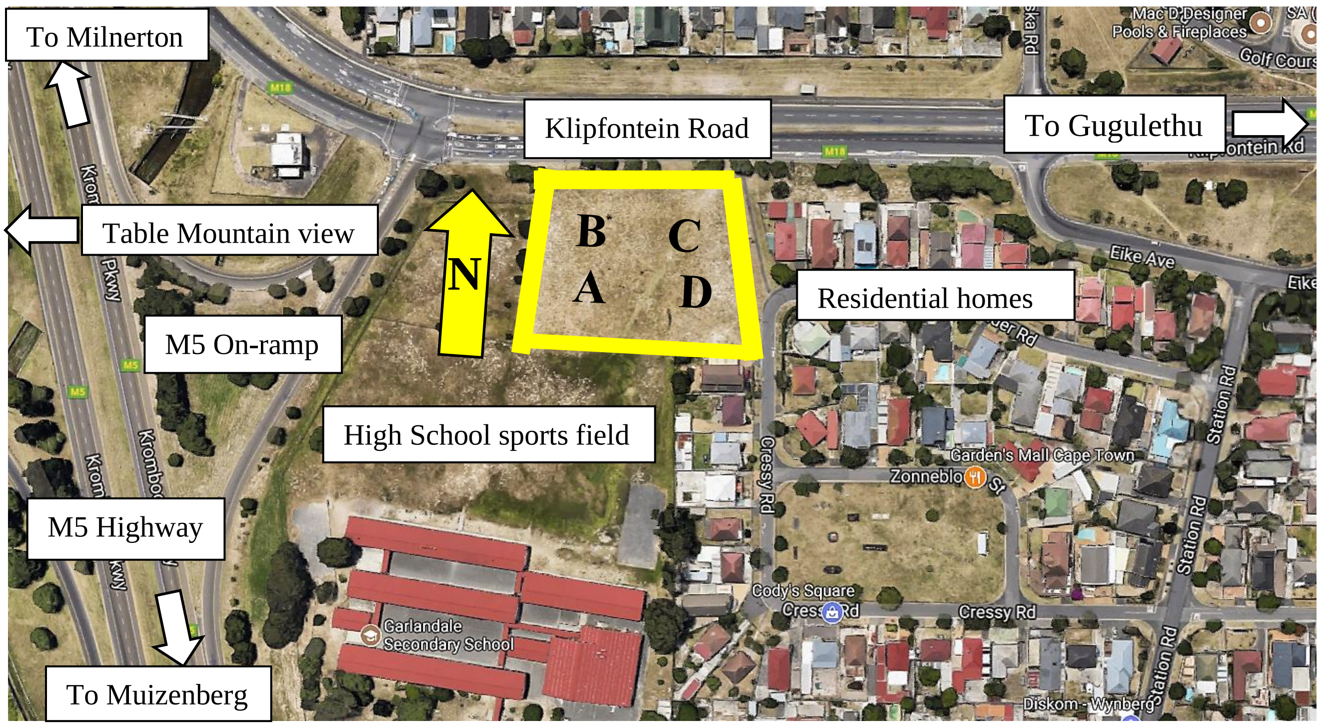


Fig 3.01: Aerial photograph of the site, the arrow indicating north and the quadrants indicated (Image obtained from Google Maps accessed 22/10/2017 at: https://www.google.co.za/maps/@33.9611391,18.4984528,370m/data=!3m1!1e3).

Fig 3.02: The inside of the pupose-built Columbarium at St Marks church in Athlone containing the remains and grave goods recovered by CAS during fieldwork in 2017 (Photographic Source: M Bester 2018).

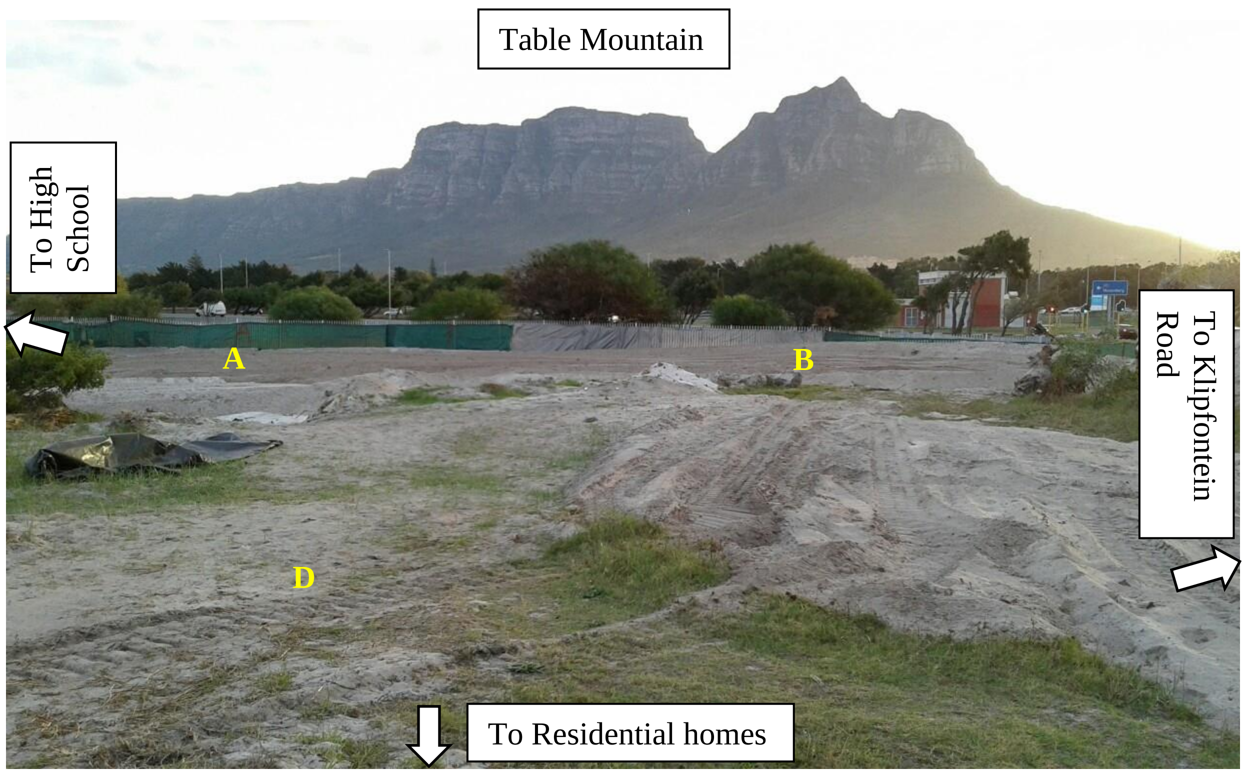


Fig 3.03: An eastward view of the site, standing in quadrant D, taken after quadrants A and B excavations were complete (Photographic Source: This Study).

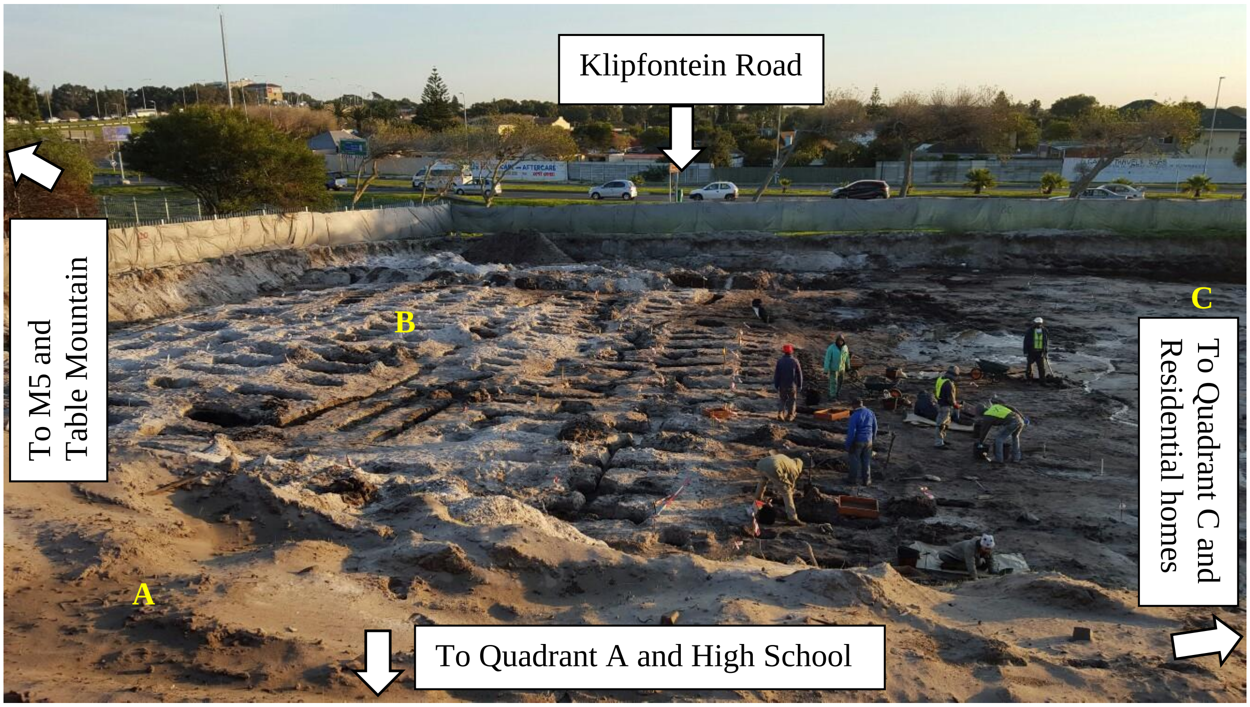


Fig 3.04: A northward view of quadrant B during excavations (Photographic Source: This Study).

3.1.3 Burial numbers

A total of 1305 graves were exhumed, however, not all the graves contained skeletal remains due to taphonomic loss (Fig 3.05). Thus, a total of 1050 burials containing skeletal remains were analysed and a minimum number of individuals (MNI) of 1342 (Fig 3.06) was determined. The burials were numbered first by the letter of the quadrant, then a number starting from 1 in each quadrant. In cases of multiple burials, often one on top of the other, the burials were further identified by an a, b, c etc indicating their position or order of excavation. In quadrant A, the burials were further separated by two taphonomic areas, the wet section and the drier, sandy section dubbed the 'Island' as burials in this section were shallower. Thus, in quadrant A, burials on the Island were also named with an 'I' at the end of the number. Quadrant C also presented with the two taphonomic areas (Fig 3.05), however, the numbering system was not adjusted for the taphonomy in Quadrant C. In quadrant D, a small number of burials at the beginning of its excavation were numbered with an 'X' to indicate that the excavation was performed as a rescue archaeology due to uncontrollable external factors.

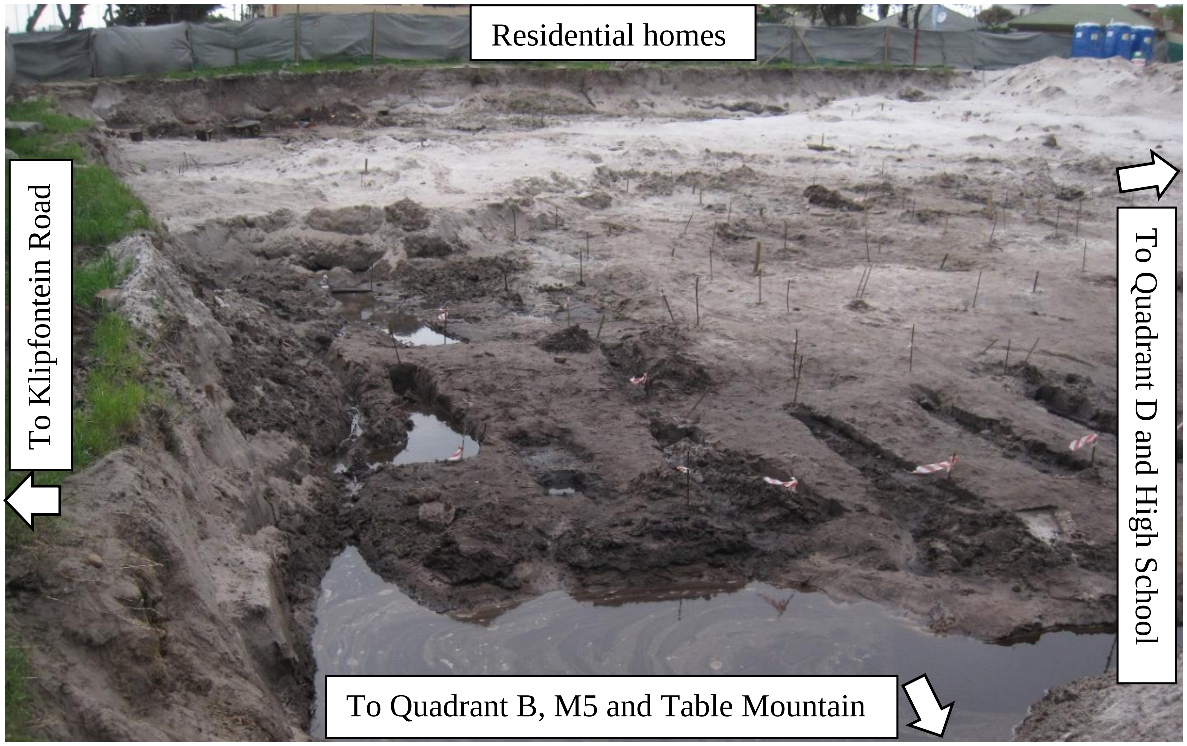


Fig 3.05: A westward view of quadrant C during excavations. Note the different taphonomic areas, the raised sandy area was named the island and presented with several multiple internments and improved preservation of skeletal material while the waterlogged area had poor preservation with single burials more likely (Photographic Source: This Study).

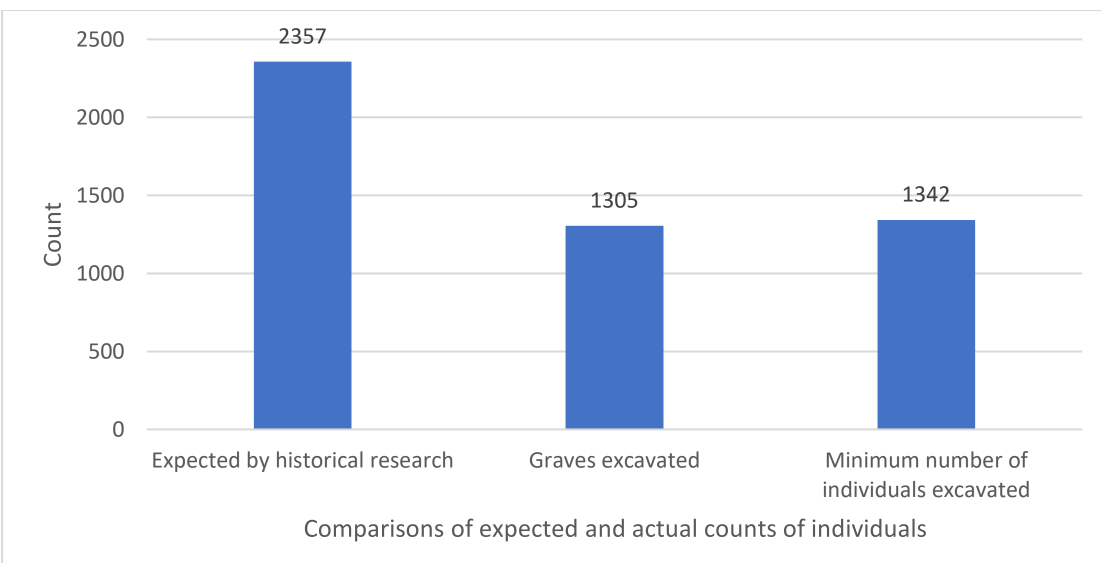


Fig 3.06: A visual representation of the count of individuals that were expected to be present by historic report, the number of graves excavated (Patrick et al., 2019) and the calculated minimum number of individuals (MNI) excavated.

3.1.4 Grave numbers and context

There was discrepancy noted between the number of burials recorded in the historic burial register and the number of burials excavated in 2017 (Fig 3.06) (Patrick et al., 2019). The Black River Cemetery was at working capacity during 1948-1951, and this section of the register accounts for about 614 burials (Patrick et al., 2019).

3.1.5 Data collection process

Data was collected by both the archaeological team and the biological anthropologists through a variety of methods at different stages of the exhumation. Photographs were taken of each burial with the grave and skeletal remains in-situ ensuring the grave number, date of excavation, site name and a scale were visible in each photo. Data sheets were used to record the skeletal inventory at this point as well as grave/coffin size, body position and any notable conditions of the burial/excavation. The biological/forensic anthropologists then performed the skeletal analysis, confirming the skeletal inventory and completing the data sheet as well as photographing the skeletal remains, once again ensuring all relevant data were visible. Notable skeletal features, markers or variations were additionally photographed during analysis.

The site supervisor maintained a daily site plan recording the location and numbers of burials excavated. Upon completion of each quadrant, a land surveyor recorded the geographical position of each burial to produce a site map. The burial data was captured using all the above resources to obtain the most complete data set possible and to ensure inconsistencies were cross referenced and either removed or explained. The site map produced by the land surveyor (Fig 3.07) shows the positions of each burial as well as the borders of the quadrants. The map was produced, one quadrant at a time (Fig 3.08 – 3.11) at the end of each quadrants' excavation and published at the end of the excavation (Patrick et al., 2019). The site map is colour coded by age estimation, with adult burials in white, juvenile in blue and baby burials in orange (Fig 3.07). There was a discrepancy as the age estimations depicted on the site map are the preliminary age estimations that were made before the skeletal analysis and are based on the grave or coffin size and teeth or teeth roots when no other skeletal elements were complete enough to examine.

3.1.6 Data collection limitations

A site invasion by protestors who destroyed graves and a landslide, caused by continuous heavy rain and strong winds, during the excavation of quadrants C and D, resulted in several rescue excavations being performed. The priority of these was to preserve and exhume the skeletal remains but the location pegs for these burials were lost and thus not recorded onto the site map (Fig 3.07). During this time, it was also not possible to photograph the rescue excavations and so the data for these burials was recorded only on the data sheet during retrospective analysis. Furthermore, the site map produced by the land surveyors contains errors in the numbering in that there are several cases in each quadrant where two burials are incorrectly allocated the same burial number producing doubles on the map (Fig 3.07). This does account for some of the burials with distinct numbers and data that do not appear on the site map.

3.1.7 Preservation of skeletal remains

Preservation refers to the quantity and quality of skeletal materials that remains in-situ to be excavated after the passing of years and taphonomic influence since the burial took place (Marden et al., 2013). Preservation is controlled by a number of factors, some are intrinsic, such as; body size, robusticity of the skeleton and open wounds present at the time of death (Lewis, 2007). Other factors are extrinsic, such as; moisture, temperature and the acidity of the soil (Lewis, 2007). Thus, the influence of taphonomy on a study of this size and nature is profound as the preservation of the remains determines the level of meaningful data that can be collected (Cox, 1999; Bowen, 2003; Milner and Boldsen, 2012).

The quadrants had generally varying levels of preservation, mostly due to their proximity to the Black River and the underground water table. The majority of skeletal data was recorded from burials in quadrants A, C, and D; the depth of the burials and location of quadrant B was closer to the water table and had a higher taphonomic loss of skeletal material (Patrick et al., 2019). Similarly, sections of the site with a high density of baby burials also had high taphonomic loss of skeletal material. This is in line with other studies where poor preservation has hindered the sample size of children (Buikstra and Cook, 1980) and is due to the smaller size and gracility of child remains (Morton and Lord, 2002). When burials occurred where no skeletal remains were found, age was determined by coffin size, namely, adults, juveniles and/or baby burials.

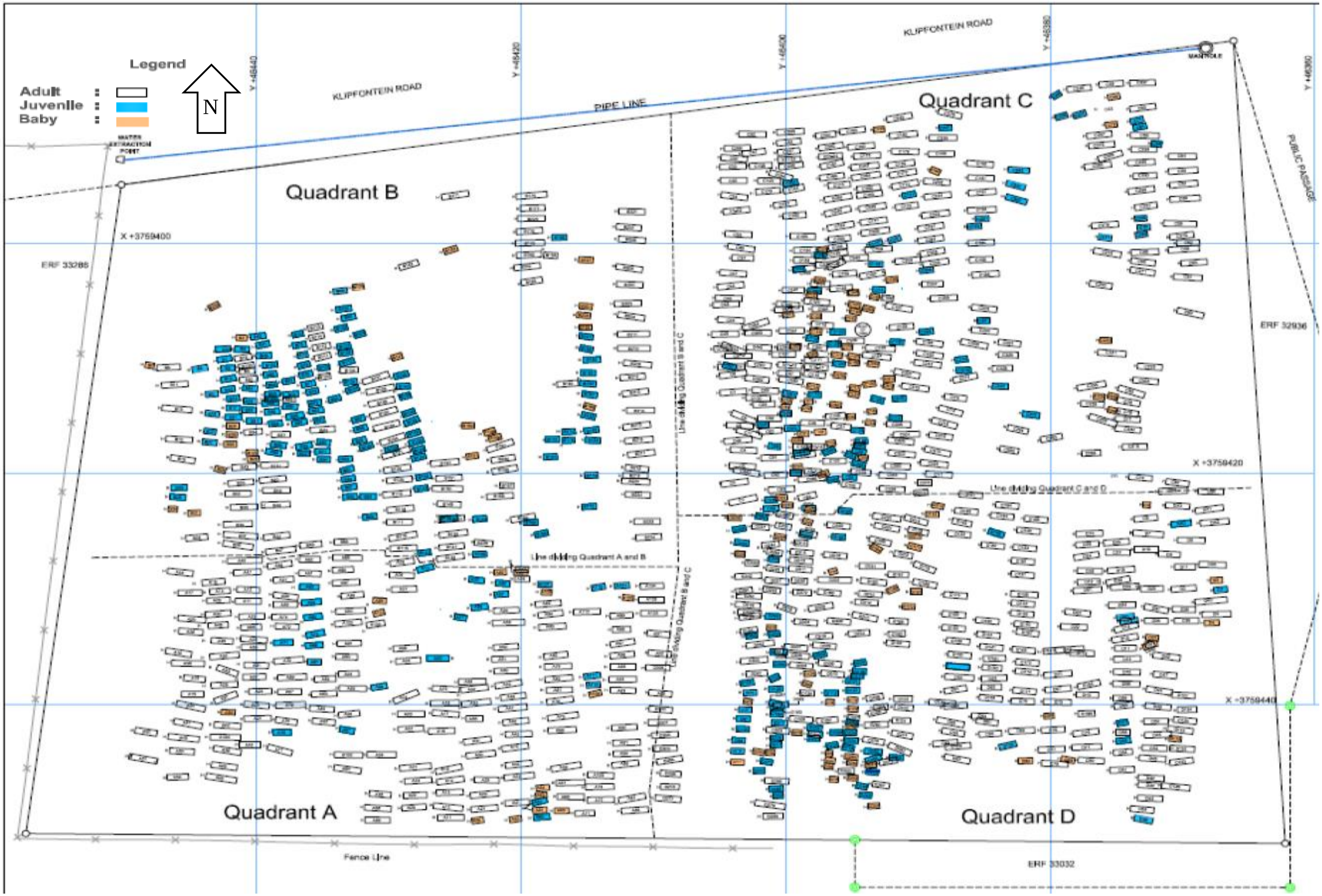


Fig 3.07: Map of the burials for Black River Cemetery. [Reference: Lloyd & Hill Revised Plan No 115 (ABCD-2018) in Patrick et al., (2019)].

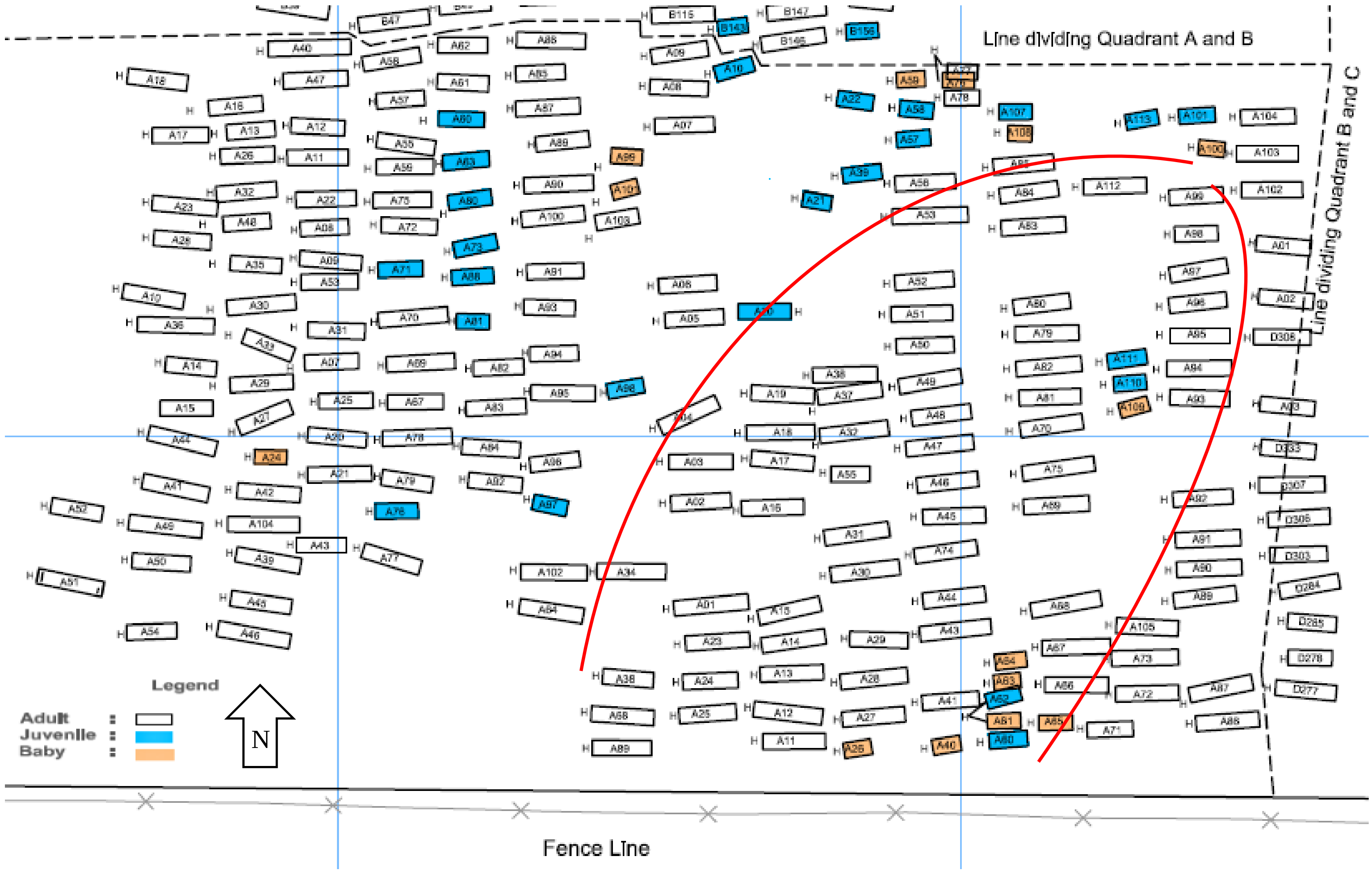


Fig 3.08: Map of the burials for quadrant A of Black River Cemetery. [Reference: Lloyd & Hill Revised Plan No 115 (ABCD-2018) in Patrick et al., (2019)]. The area between the red arcs demarcates the 'Island' area.

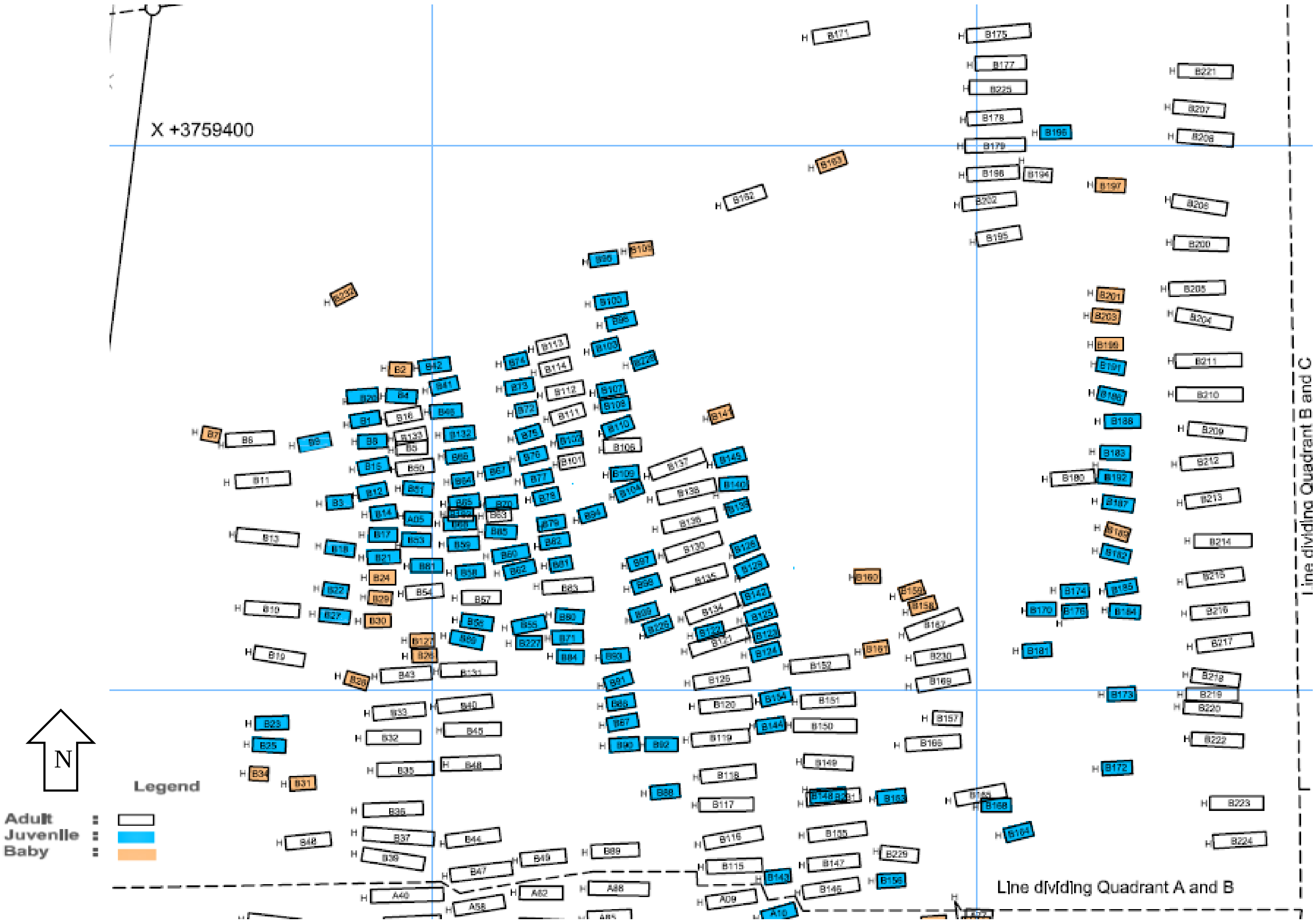


Fig 3.09: Map of the burials for quadrant B of Black River Cemetery. [Reference: Lloyd & Hill Revised Plan No 115 (ABCD-2018) in Patrick et al., (2019)].

Fig 3.10: Map of the burials for quadrant C of Black River Cemetery. [Reference: Lloyd & Hill Revised Plan No 115 (ABCD-2018) in Patrick et al., (2019)].

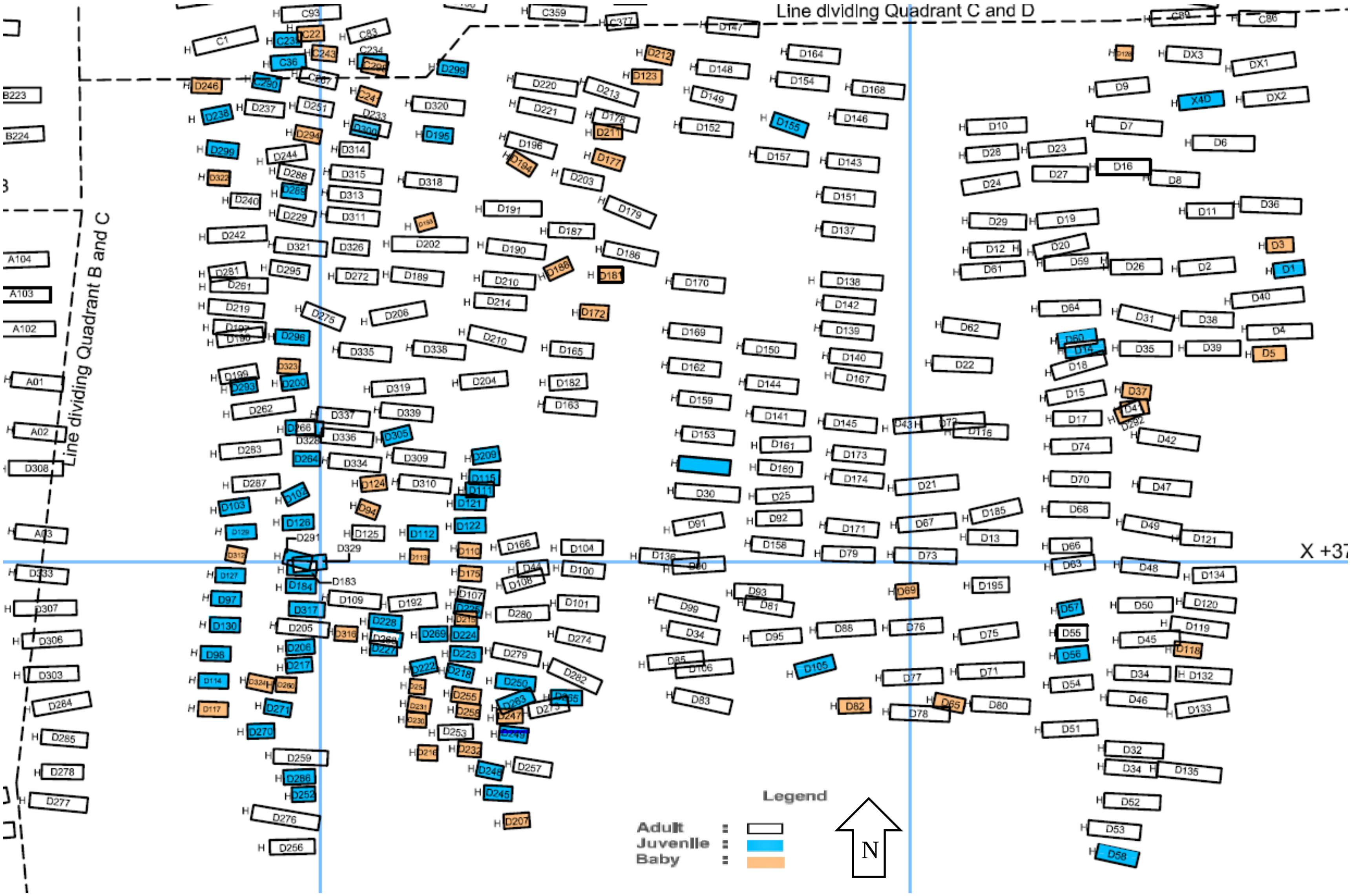


Fig 3.11: Map of the burials for quadrant D of Black River Cemetery. [Reference: Lloyd & Hill Revised Plan No 115 (ABCD-2018) in Patrick et al., (2019)].

3.1.8 Scoring for preservation

In this study two sets of data scoring checks were done for preservation, the completeness of the skeleton and the quantity of skeletal remains present for each burial. A burial was scored as complete if approximately 85% of the skeleton was present and, incomplete if less than 85% of the skeleton was present and there were both cranial and post-cranial remains present. Other scores included, no remains present, only post-cranial remains present, and only cranial/mandibular remains present (see Appendix 1). This included burials where only teeth were recovered. The second set of scores was done for the quality of the skeletal remains present and a good score was granted if 85% of the skeletal remains present were in tact where as a fair score was allocated if less than 50% of the remains were intact and finally a burial was scored as highly fragmented when the majority of the skeletal remains were fragmented.

The differences in the preservation can be seen in a burial in quadrant A that was excavated from the dry 'Island' taphonomic area and appears articulated in-situ (Fig 3.12), but is still incomplete containing both cranial and post-cranial skeletal elements and is highly fragmented when exhumed (Fig 3.13). Contrastingly, a burial from the waterlogged area in Quadrant B (Fig 3.14) is less articulated and has a poorer preservation of skeletal elements (Fig 3.15). Many burials, particularly the smaller graves, had complete taphonomic loss and no skeletal remains were recovered (Fig 3.16).

Fig 3.12: In-situ photograph of the excavation of an adult buried in the sand (A69I) in a drier taphonomic area (Photographic Source: This Study).

Fig 3.13: Lab photograph of the analysis of A69I which would receive a preservation score of incomplete with cranial and post-cranial skeletal elements and is highly fragmented (Photographic Source: This Study).

Fig 3.14: In-situ photograph of the excavation of a water-logged grave (B223) (Photographic Source: This Study).

Fig 3.15: Lab photograph of the analysis of remains recovered from a water-logged grave (B223) which was scored as post cranial skeletal elements only and highly fragmented (Photographic Source: This Study).

Fig 3.16: In-situ photograph for a baby burial (B185) where no skeletal remains were recovered (Photographic Source: This Study).

3.2 Methods

3.2.1. Excavation

Trial excavations took place in the April 2017 field session in which a team of professional archaeologists worked from the South West corner to the North West corner of the site to expose the contents of individual graves and to determine the depth of the bulk excavation. In quadrants A, B, and D this was recorded as 1 meter and 70cm in quadrant C (Patrick et al., 2019). In collaboration with an earthmoving contractor a timeline and excavation plan were devised to calculate the duration of the project. The earth was moved first from Quadrant A and stockpiled on B while the exhumation process was underway, and then B stockpiled on A and C on D, and finally D on C (Patrick et al., 2019). Bulk excavation was done per quadrant using a mechanical digger to remove the sub surface deposits determined in April trial excavations. This was closely monitored by field assistants to avoid damage to grave contents.

Following the bulk excavation, hand excavation using spades was used to reach the coffin depth allowing for each of the burials to be pegged, flagged, allocated a burial number, and marked on a site plan (Patrick et al., 2019). An archaeological team would then remove the coffin lids and soil to expose the skeletal remains at which point a biological anthropologist would record the presence or absence of skeletal elements as well as note gross pathologies on the developed data sheet (Patrick et al., 2019). Before continuing the earth-moving between quadrants, a land surveyor would record the positions of each grave post exhumation (Patrick et al., 2019). The burial positions were additionally recorded daily using a CAS score sheet maintained in the site office and made available to the Inspector of Anatomy, and the Department of Health (Patrick et al., 2019).

The excavation was performed during the winter months of the year, while this was not ideal, the process had to be complete within the timeframe allowed by the client and provided by the excavation permit. The location of the burial site is in a wetlands area alongside the Black River and quadrants of the site are perennially waterlogged; this was discussed in Church minutes from the early 1900's (Patrick et al., 2019). This, combined with the winter rains of the Cape resulted in three of the quadrants (B, C, D) being waterlogged for large sections and required a sludge and water pump to continuously drain them in order to proceed with the excavation (Patrick et al., 2019). The exhumed remains were placed in a box labelled with the burial number and date of exhumation and taken to the on-site lab for analysis, after which they were removed from the site for cremation and internment in the purpose-built columbarium (Patrick et al., 2019).

3.2.2 Skeletal data collection

The standards for data collection set out by Buikstra and Ubelaker (1994), while having been published for an American context, provide a thorough guideline of the peer-reviewed methods of data collection and analysis for skeletal samples such as the Black River sample. The context in any study differs and every sample has its own challenges and as such, the standards were used as a guideline, not in complete isolation and were adapted where necessary for the data collection. The analysis was conducted by postgraduate students registered in Biological Anthropology under the supervision of a senior forensic anthropologist. The skeletal analysis occurred at an on-site laboratory. Data sheets (see Appendix 2) were provided for the recording of data and included the following sections:

3.2.2.1 Skeletal inventory

Recording and compiling a skeletal inventory is important as the frequencies of bones present will affect the analysis of skeletal markers and anomalies that will provide information about health and lifestyle (Buikstra and Ubelaker, 1994). Visual recording forms of the anterior views for an adult and juvenile skeleton were present on the data collection sheet obtained from Buikstra and Ubelaker (1994). Visual recording forms were also used for the vertebral column and primary and secondary dentition. A data table was used in addition to the visual recording form for dentition (see Appendix 2). The initial data sheet did not include the visual recording form for dentition, and it was added early in the data collection phase. The photography also ensured a record of the skeletal inventory for each burial.

3.2.2.2 Sex estimation

Several well-established methods were utilised for the sex estimation which was only performed on the adult skeletal remains as the sexual dimorphism only becomes significant on the skeleton after adolescence (Saunders, 1992). The scoring for the features were done as follows:

1 = probable female

2 = unclear

3 = probable male

The scoring suggested in the standards of Buikstra and Ubelaker (1994) were adapted for the context of the data collection constraints and feasibility in this study. The diagrams (Fig 3.17 – 3.23) provided a guideline on the skeletal element being assessed and the degrees of the outermost scores that allowed for the adaptation to a three point score description where the outermost scores matched that of the diagrams and the in-between score was within the scale or not applicable for certain elements (Table 3.01-3.02).

For the pelvic analysis, known to have a greater reliability for sex estimation than the cranium (Bruzek, 2002; Walrath et al., 2004; Williams and Rogers, 2006), four elements were examined (Table 3.01):

- Shape of the greater sciatic notch (Fig 3.17)
- Pre-auricular sulcus (Fig 3.18)
- Sub-pubic angle (Washburn, 1948)
- Sub-pubic concavity (Fig 3.19) (Phenice, 1969)

Table 3.01: Scoring of pelvic features for sex estimation adapted from the scoring of Buikstra and Ubelaker (1994).

Score		1	2	3
Pelvic Features	Greater sciatic notch	Wide	Medium	Narrow
	Sub-pubic angle	Wide	-	Narrow
	Sub-pubic concavity	Absent	-	Present
	Pre-auricular sulcus	Absent	Slight	Marked

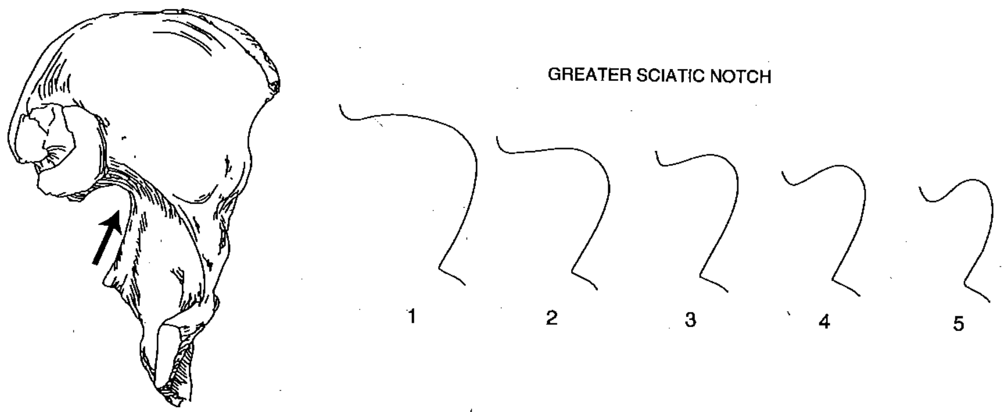


Fig 3.17: The scoring of sexual dimorphism in the greater sciatic notch. Drawing by P. Walker. (Buikstra and Ubelaker, 1994).

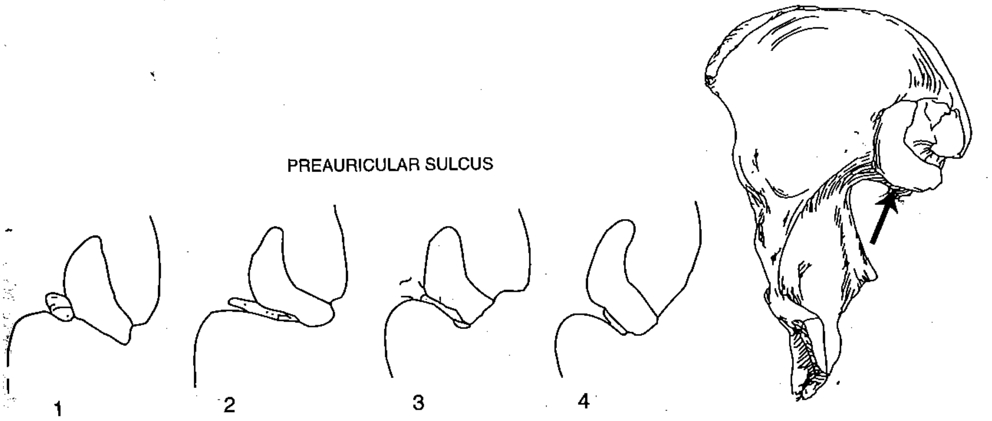


Fig 3.18: The scoring of sexual dimorphism of the pre-auricular sulcus. Drawing by P. Walker after Milner (1992) obtained from Buikstra and Ubelaker (1994).

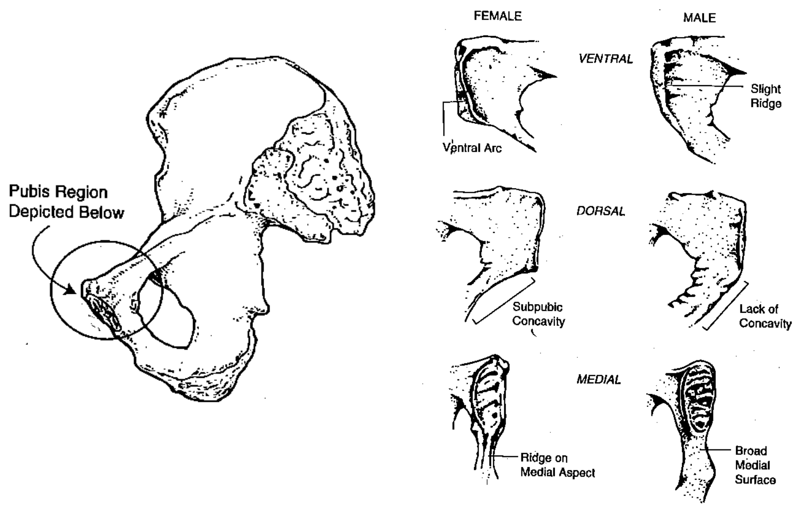


Fig 3.19: Phenice technique for sex estimation from the sub-pubic region. Drawing by P. Walker after Buikstra and Mielke (1985) and Phenice (1969) obtained from Buikstra and Ubelaker (1994).

Table 3.02: Scoring of cranial features for sex estimation.

Score		**1**	**2**	**3**
Cranial Features	Supra-orbital development	Slight	Moderate	Marked
	Supra-mastoid development			
	Nuchal crest			
	Mastoid size	Small	Medium	Large
	Supra-orbital margin	Sharp	-	Smooth
	Gonial eversion	Straight/ inverted	Slightly everted	Markedly everted
	Chin shape	Pointed	Round	Square

For the cranial features examined in sex estimations, four out of the five features outlined by Buikstra and Ubelaker (1994) were employed in this study namely, the nuchal crest, mastoid process, supra-orbital margin and supra-orbital ridge (Fig 3.20). However, the Buikstra and

Ubelaker (1994) method uses a five-point scale for scoring the features (Fig 3.20) and this was adapted to a three-point scale for data collection (Table 3.02). Further, the gonial eversion and chin shape were examined on a three-point scale (Table 3.02), these features have been shown to express sexual dimorphism (Rickets, 1975; Weijs and Hillen, 1986).

3.2.2.3 Age estimation

Age estimations were divided into 6 categories viz. baby (under 25 months), child (3 to 8 years), juvenile (8 to 17 years), young adult (18 to 25 years), adult (over 30 years) and old adult (over 40 years). These estimations were defined following the guidelines of Buikstra and Ubelaker (1994).

3.2.2.3.1 Sub-adult aging

For this study, two methods were implemented for sub-adult aging. Dental eruption was scored for both primary and secondary dentition (Table 3.03) this combined with the dental inventory information was used to estimate age (Fig 3.21) according to the standard set out by Buikstra and Ubelaker (1994). In the cases where the maxilla and/or mandible were not present in order to determine eruption, the morphology of the loose teeth and the dental inventory were used to determine the eruption score (Table 3.03). A deciduous tooth crown that is present but unerupted does not have any root formation, or evidence of occlusal wear while a deciduous tooth that has erupted may have some occlusal wear and potentially root resorption and the presence of the mineralisation of the crown of the underlying permanent tooth (Hillson, 1996; Scheuer and Black, 2004). Thus, root formation and resorption, occlusal surface wear, and dual presence of deciduous and permanent dentition were all factors in determining the eruption scores.

Table 3.03: Scoring of eruption level for deciduous and permanent dentition.

Score	Deciduous Dentition (erupted)	Permanent Dentition
0	No milk teeth	-
1	Upper/lower central incisors only	M1 erupted
2	Incisors and canines only	Incisors erupted
3	Incisors, canines and deciduous molar 1 only	Pre-molars / canines erupted
4	All milk teeth	M2 erupted
5 *	Milk teeth present but unerupted	M3 erupted
6 *	-	M3 present but unerupted
7 *	-	Unerupted crowns present

(*) Indicates this score was not on the initial data collection sheet but was added during the data capturing phase to increase the specificity of the data

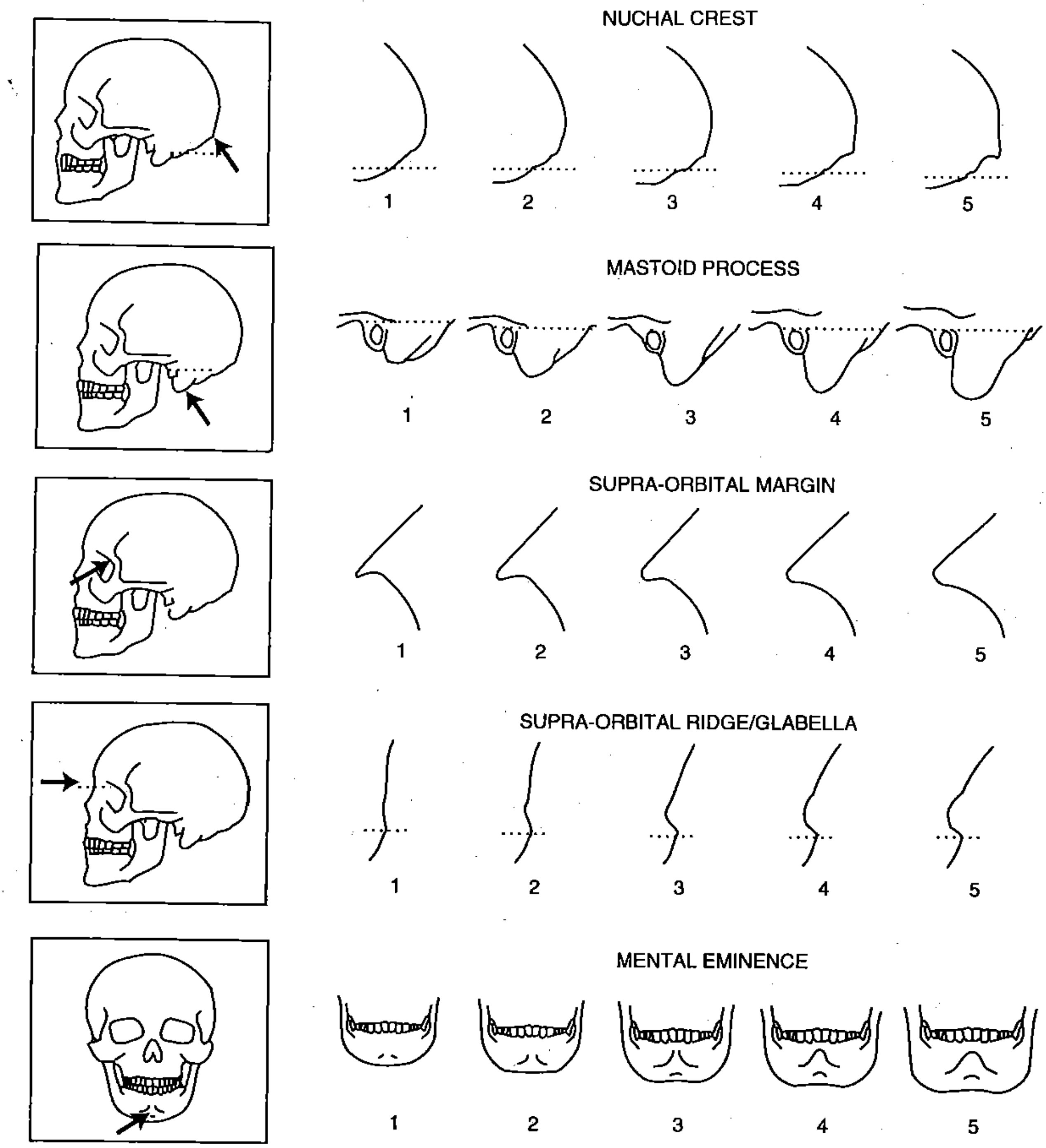


Fig 3.20: Scoring for cranial features expressing sexual dimorphism. Drawing by P. Walker. Obtained from Buikstra and Ubelaker (1994).

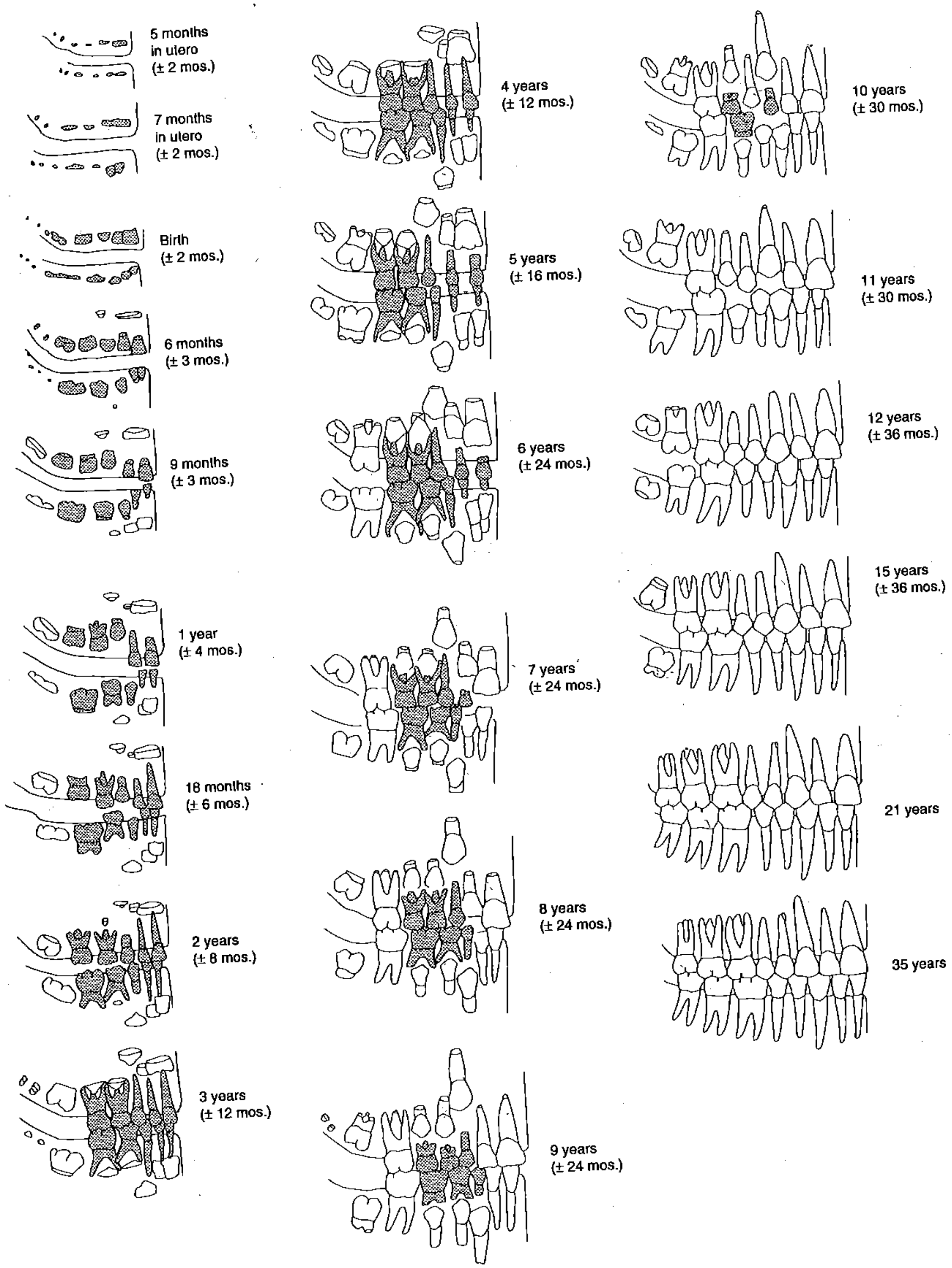


Fig 3.21: Dental eruption sequences and dental formation in American Indians (Ubelaker, 1989) obtained from Buikstra and Ubelaker (1994).

The second method employed for sub-adult aging was the epiphyseal union sequence for postcranial remains assessing the maturation of the skeletal elements (Fig 3.22 and Fig 3.23). The diaphysis and epiphyses at the locations listed in Table 3.04 were scored as follows:

1 = united, or

2 = not united

These scores were adapted from the standard of Buikstra and Ubelaker (1994).

Table 3.04: Post-cranial skeletal regions scored for epiphyseal union or ossification.

Bone region
Ischiopubic ramus
Ox coxae (acetabular triradiate cartilage zone)
Distal humerus
Proximal femur
Proximal humerus
Distal radius
Iliac crest
Medial clavicle

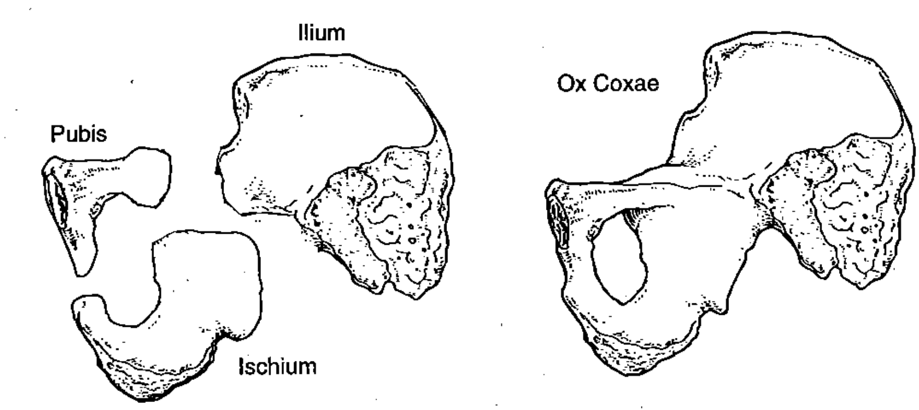


Fig 3.22: The bones that make up the ox coxae highlighting the locations of ossification centres (Steele and Bramblett, 1988) obtained from Buikstra and Ubelaker (1994).

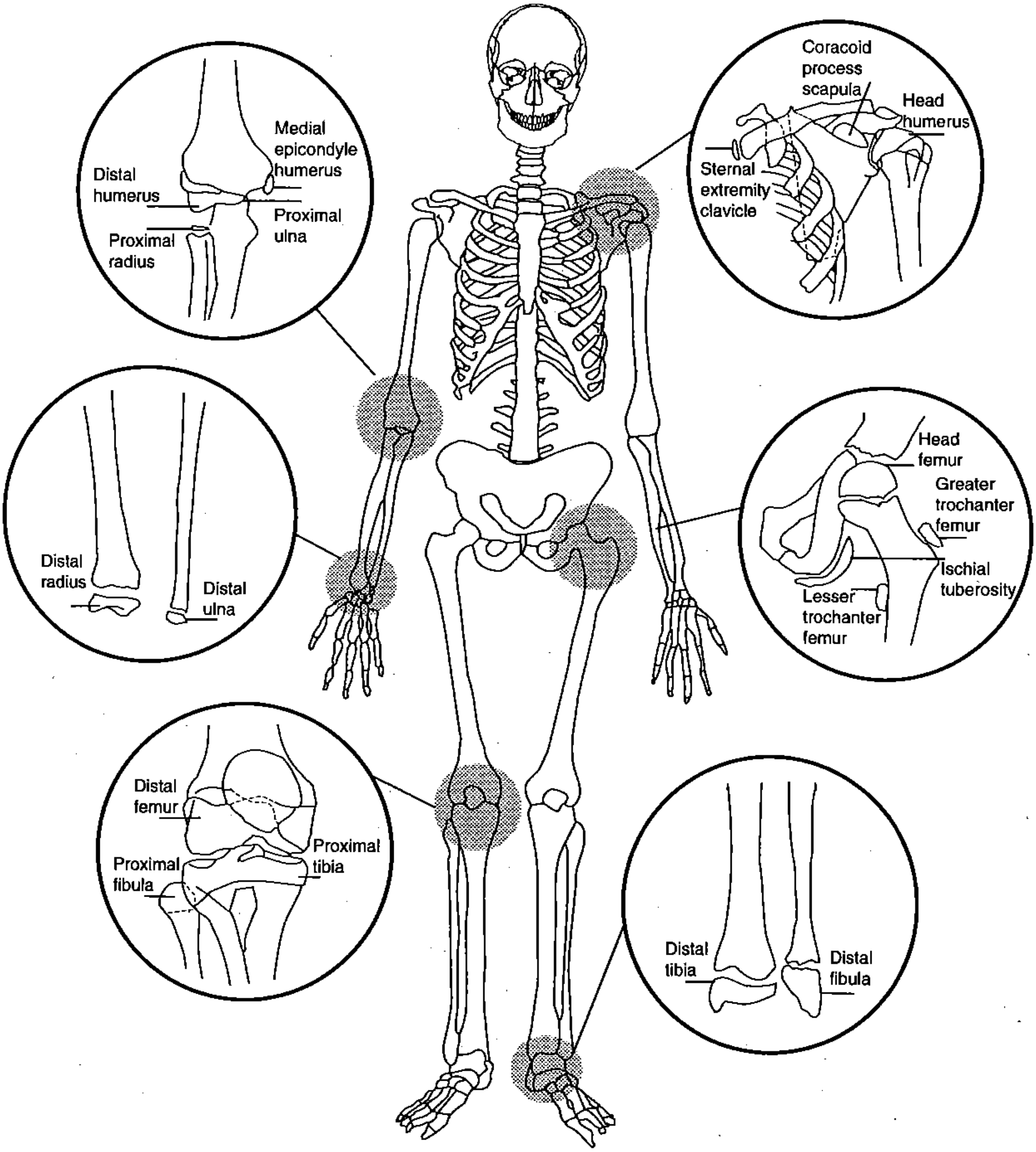


Fig 3.23: Location of the epiphyses in the human body, highlighted by skeletal parts (Buikstra and Ubelaker, 1994).

3.2.2.3.2 Adult aging

Four primary methods were utilized during the data collection phase of the project; cranial suture closure, pubic symphysis morphology (Brooks and Suchey 1990), sternal rib-end morphology (Işcan et al., 1984, 1985) and transition analysis incorporating cranial sutures, pubic symphysis and iliac auricular surface of the pelvic bone (Boldsen et al., 2002).

Aging using the cranial suture closure as outlined by Buikstra and Ubelaker (1994) is a combination of the work of multiple researchers (Baker, 1984; Meindl and Lovejoy, 1985; Mann et al., 1987). However, it has been shown that suture closure times are subject to high variation (Hershkovitz et al., 1997) and as such this method needed to be combined with other skeletal data. Four ecto-cranial sutures were scored for (Fig 3.24) according to the following; adapted from the descriptions of Meindl and Lovejoy (1985:58):

1 = not fused: the suture is open and without evidence of closure
2 = partial fusion: closure has occurred, but suture line is still visible
3 = fully fused: complete obliteration, no suture line is visible

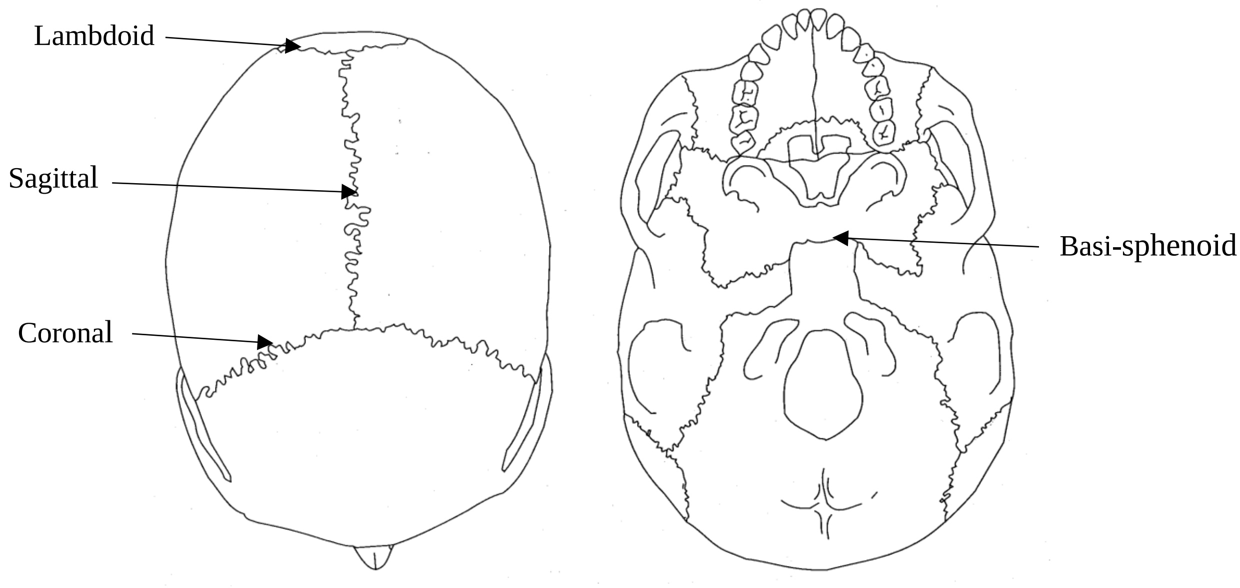


Fig 3.24: Superior and inferior view of the skull to note the locations of the sutures examined in this study (after Buikstra and Ubelaker, 1994, Attachment 8a and 8b).

The pubic symphysis morphology was examined according to the methods of Brooks and Suchey (1990) assigning a score according to their standards (see Appendix 3). The morphology was compared to casts when available and the drawings (Fig 3.25) for male and female phases of morphology by Brooks and Suchey (1990).

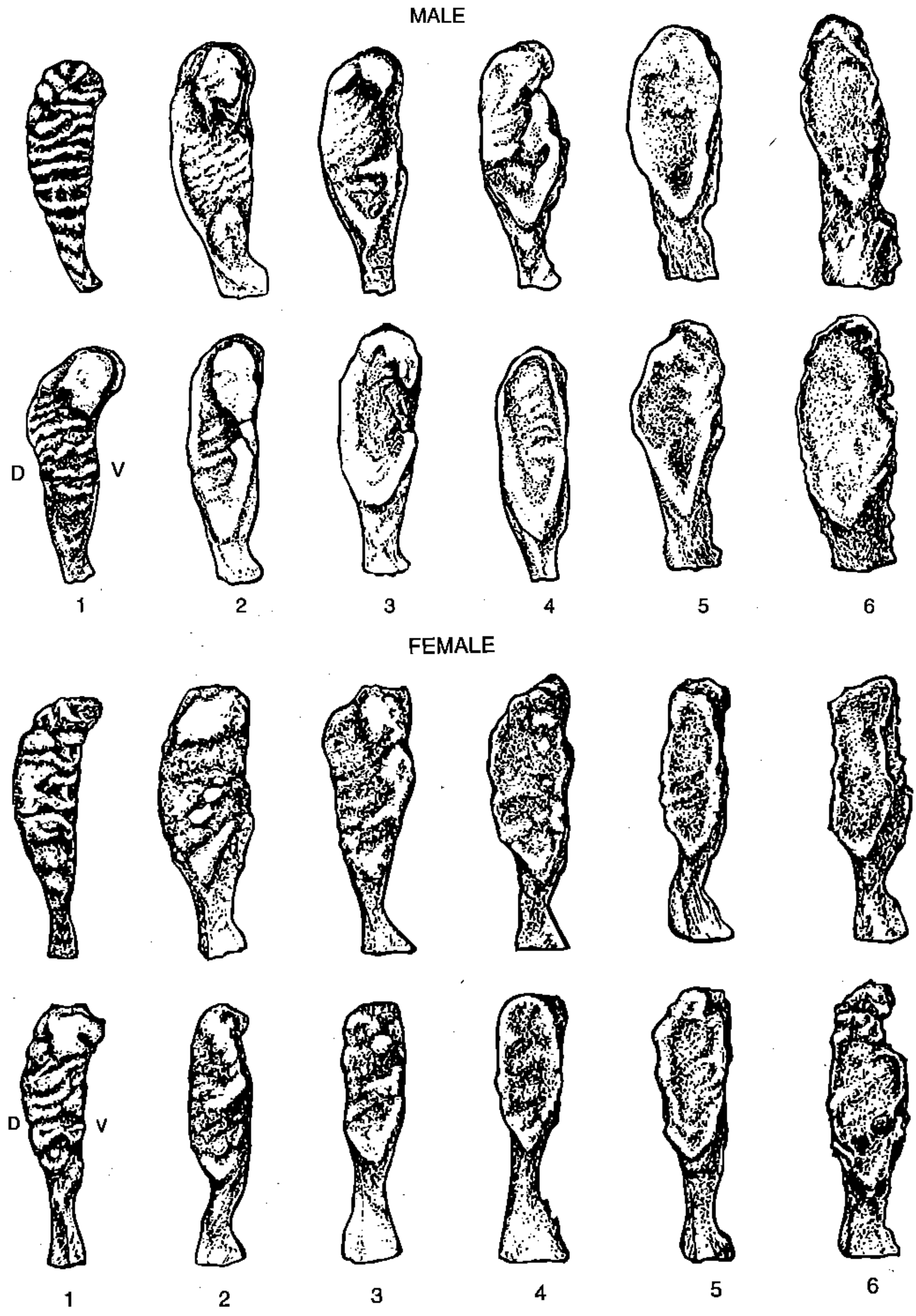


Fig 3.25: The standards for pubic symphysis morphology in males and females respectively by Suchey-Brooks. D=dorsal, V=ventral. Drawing by P. Walker (Brooks and Suchey, 1990) obtained from Buikstra and Ubelaker (1994).

The sternal rib ends were used for age estimation according to the methods of Işcan et al., (1984, 1985). Rib ends were compared to casts and written descriptions (see Appendix 4) set out by Işcan et al., (1984, 1985) and assigned an appropriate score.

The aging method, transition analysis, described by Boldsen et al., (2002) was employed using the defined landmarks on the cranial sutures, pubic symphysis and iliac auricular surface (Table 3.05). Each of the landmarks when preserved were scored according to the phase descriptions and images by Boldsen et al., (2002).

Table 3.05: Landmarks for Transition Analysis and the scoring of phases (Boldsen et al., 2002).

Skeletal Element	**Landmark**	**Phases Score**
Cranial Sutures	Coronal Pterica	1 - 5
	Sagittal Obelica (midline)	1 - 5
	Lambdoidal Asterica	1 - 5
	Interpalatine (midline)	1 - 5
	Zygomaticomaxillary	1 - 5
Pubic Symphysis	Symphyseal Relief	1 – 6
	Symphyseal Texture	1 – 4
	Superior Apex	1 – 4
	Ventral Symphyseal Margin	1 – 7
	Dorsal Symphyseal Margin	1 – 5
Iliac Auricular Surface	Superior Demiface Topography	1 – 3
	Inferior Demiface Topography	1 – 3
	Superior Surface Morphology	1 – 5
	Middle Surface Morphology	1 – 5
	Inferior Surface Morphology	1 – 5
	Inferior Surface Texture	1 – 3
	Superior Posterior Iliac Exostoses	1 - 6
	Inferior Posterior Iliac Exostoses	1 - 6
	Posterior Exostoses	1 – 3

Other skeletal features and osteological processes may assist in narrowing the age range when combined with the above methods. They include dental wear, ante-mortem tooth loss and osteoarthritis for which the data collection methods are further described below.

3.2.2.4 Measurements for adult skeletal remains

Metric methods in forensic anthropology are well established and may be utilised in sex, age, population affinity and stature estimations. Using a pair of spreading calipers and an osteometric board, measurements of the cranium and post-cranial long bones were made where possible. Where the measuring equipment was not available, a photograph was taken with a scale and measurements were made using the photograph. The descriptions and landmarks used for the measurements (Fig 3.26) in this study follow that of the standards of Buikstra and Ubelaker (1994) after the study of Moore-Jansen et al. (1994). The long bone measurements performed are listed in Table 3.06 while the cranial measurements performed are described in Table 3.07.

Table 3.06: Long bone measurements performed and their descriptions.

Measurement	Description
Clavicle: Maximum Length	From the aligned sternal end to furthest point of the acromial end
Humerus: Maximum Length	From the trochlea to the superior point of the head
Radius: Maximum Length	From the head to the distal end (excluding the styloid process)
Ulna: Maximum Length	From the superior point of the olecranon process to the head (excluding the styloid process)
Femur: Bicondylar Length	From the aligned epicondyles to the furthest point of the head
Tibia: Length	From the condyles to the distal end (excluding the medial malleolus and intercondylar eminence)
Fibula: Maximum Length	From the head to the lateral malleolus

Table 3.07: Cranial measurements performed on the study sample and their descriptions.

Measurement	Abbreviation	Description
Maximum Cranial Length	g - op	glabella to opisthocranion
Maximum Cranial Breadth	eu - eu	euryon to euryon
Nasal Height	n - mid-na	nasion to midnariale
Nasal Aperture Breadth	al - al	alare to alare
Bizygomatic Breadth	zy - zy	zygion to zygion
Basibregmatic Height	ba - b	basion to bregma
Maxillo-alveolar Breadth	ec - ec	ectomalare to ectomalare

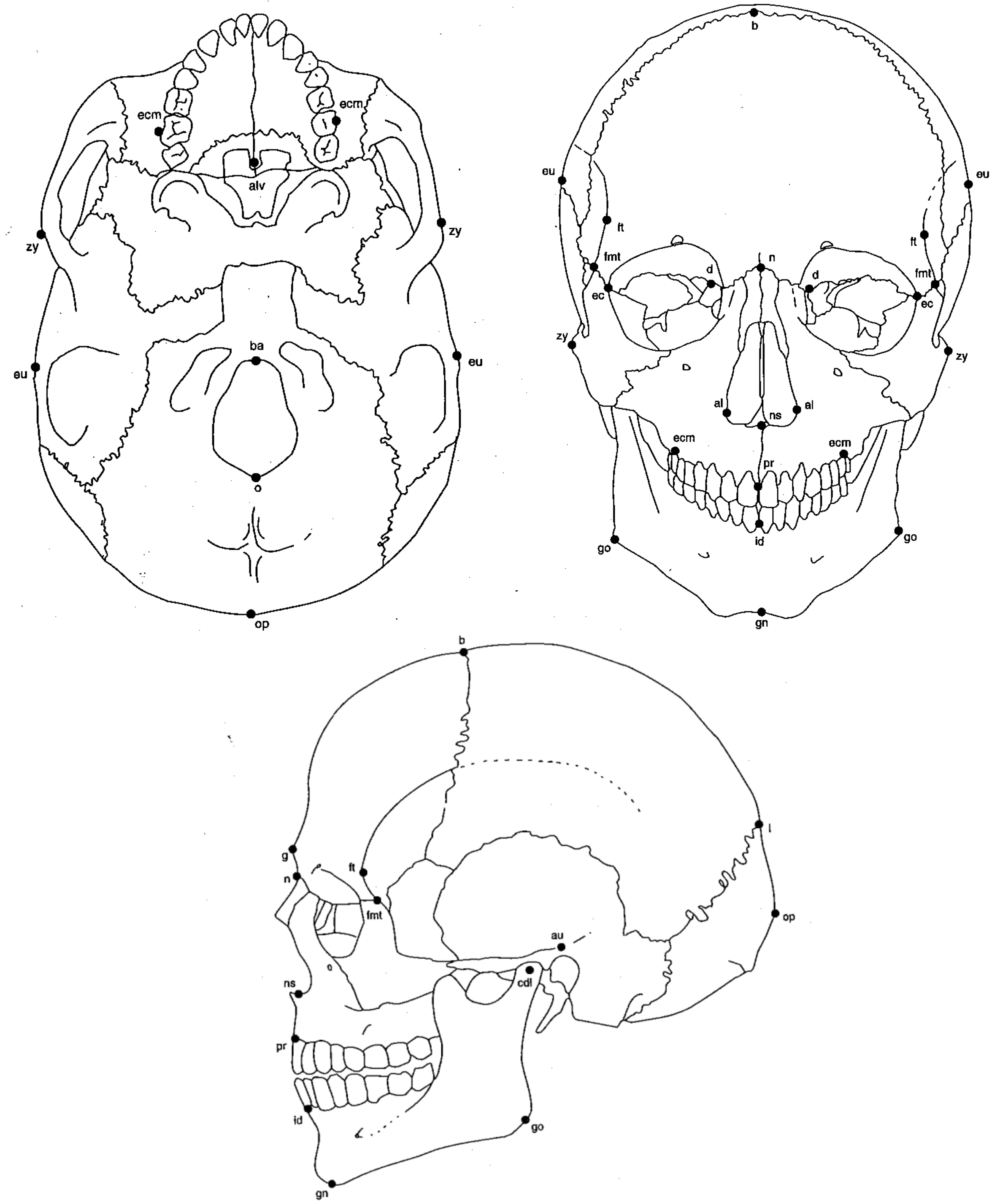


Fig 3.26: Landmarks on the skull used for cranial measurements, inferior, anterior and lateral views (Moore-Jansen et al., 1994) obtained from Buikstra and Ubelaker (1994).

3.2.2.5 Health and lifestyle

Observations of the skeletal material was undertaken to note any abnormalities that wouldn't be within the sliding scale of human variations, be it genetic, ancestral or sexually dimorphic. In addition, any non taphonomically caused processes that may indicate pathology were recorded. Four specific skeletal markers associated with skeletal degradation were searched for and scored for their severity on a scale of 1 - 4 (Table 3.08). Each of these markers may be associated with disease and provides information on the community health (Buikstra and Ubelaker, 1994). The joints scored for osteoarthritis included the major joints of the upper and lower limb and back. Porotic hyperostosis was scored for the cranial vault. Any alteration to the bone resulting in an abnormal surface feature was recorded by the observer.

Table 3.08: Scoring for pathological processes.

Score	Cribra Orbitalia	Porotic Hyperostosis and Tibial Shaft Periostitis	Osteoarthritis
1	None	None	None
2	Present Left	Slight	Slight Lipping
3	Present Right	Marked	Marked Lipping
4	-	-	Eburnation

Dental attrition is valuable data to collect, it can be useful in many aspects of the skeletal analysis as it provides information on dietary and lifestyle habits, cultural activities, age-at-death as well as its contribution to dental pathologies (Murphy, 1959; Miles, 1962, 1963, 1978; Smith, 1984; Lovejoy, 1985; Powell, 1985; Brothwell, 1989; Walker et al., 1991). Dental wear was scored on a four-point scale (Table 3.09) (see Appendix 5).

Dental pathological processes were recorded as present or if not present left blank for each tooth. Severity and location on the tooth were not specified on the data sheet and thus the data collected noted the presence of the following pathological processes on the dentition as described by Buikstra and Ubelaker (1994):

- Dental Caries
- Abscesses
- Dental Calculus
- Enamel Hypoplasia

It was further noted in the inventory of the dentition whether there was evidence for ante-mortem tooth loss through the resorption or remodelling of the alveolar bone. Any other dental anomalies were additionally recorded by the observer including any modifications or interventions.

Table 3.09: Scoring of wear state of the adult dentition adapted from Buikstra and Ubelaker (1994).

Score	Wear State
1	Minimal wear, polish only
2	Slight to moderate wear
3	Heavy and / or unequal wear
4	Extreme wear

3.2.3 Data analysis

3.2.3.1 Data capturing

The data was captured onto Excel spreadsheets for the analysis. During the capturing process the data sheets were compared with the site-photographs to review the data and ensure a consistency. There were cases where a burial was photographed and no data sheet was present, in these cases a post-excavation data sheet was drawn up using the photographs noting as much as was accurately possible, and then captured. The captured data set was then compared to the field notes and to the two site maps produced, one in the daily field notes, and the second by the land surveyor. In overcoming the data collection limitations, thorough investigation and cross referencing of the different data mediums was performed and all the burials listed in the data set were confirmed and recorded with as much completion as possible.

3.2.3.2 Sex estimation

Sex estimation was performed using the scores on cranial and pelvic features. The scoring was setup so that a score of 1 was assigned to the description that is more female while a score of 3 was on the male end of the spectrum and 2 was in between (Tables 3.01 and 3.02). This meant that a higher frequency on either end of the spectrum would indicate the applicable sex. There were several cases where the scores were not weighted towards either male or female and was thus assigned an unknown sex. Studies have shown that certain elements have a greater sexual dimorphism and thus increased reliability for sex estimation (Luo, 1995; Donnelly et al., 1998; Steyn and Iscan, 1998; Walrath et al., 2004; Williams and Rogers, 2006) as such, a greater weighting was given to the pelvic features which have a 95% reliability (Krogman and Iscan, 1986) while the cranial features have been shown to have 80% accuracy (Williams and Rogers, 2006). For individuals where the scores were mostly neutral with an element of low confidence indicating to either end of the spectrum, the sex was estimated but with an indication that the confidence of the estimation was low. The number of skeletal elements that were present and used for each estimation was also recorded (see Appendix 6). The age estimation was also considered and several sex estimations had to be altered as the individual was found to be juvenile and thus the sex estimations using those methods would be unreliable (Holcomb and Konigsberg, 1995; Scheuer and Black, 2004; White and Folkens, 2005). For each relevant age category and for the total individuals, a ratio for males to females was calculated and using a chi-square analysis comparing observed and expected values, the significance of the ratios was tested.

3.2.3.3 Age estimation

The general estimation was based primarily on the coffin size and this estimation was recorded on the data sheet. Preliminary age estimation was performed on site by the archaeological team who divided age into three categories viz adult, juvenile and baby. For many of the burials, this is the only estimation possible due to a lack of skeletal age indicators being preserved or for those where no skeletal remains were recovered. The preliminary estimations based on coffin size are not reliable as the high internment rates caused by the Spanish Influenza epidemic resulted in a lack of coffins (Patrick et al., 2019) and thus individuals were buried in coffins that were not the correct size, ie. juveniles in adult sized coffins and adults in juvenile sized coffins. True age estimation was performed by a forensic anthropologist using skeletal material.

For adult aging, several methods were used as outlined above. For transition analysis the program ADBOU Age Estimation 2.1.046 was used to process the data for cranial sutures, pubic symphysis and iliac auricular surface morphology’s. The mean age with standard deviation output was used as the age estimation. For the pubic symphysis (Brooks and Suchey, 1990) and the sternal rib end methods (İşcan et al., 1984; Işcan et al., 1985), the tables were used to estimate age (see Appendix 3 and Appendix 4 respectively) and where the sex was unknown for an individual, the broadest age range between the male and female tables was used. The cranial sutures method used for age estimation in this study included three broad categories of juvenile, young adult and old adult. Sub-adult aging was done predominantly using dental eruption and epiphyseal union. A factor not considered in epiphyseal union is the potential influence of disease on fusion rates. The dental scores related to a level of eruption (see Appendix 7) which correlates with an age range using the methods outlined by Buikstra and Ubelaker (1994). Dentition also allowed aging for adults at the level to distinguish between adult and juvenile. Where individuals had dentures, they were aged as an adult. Dental wear was not used for specific aging purposes as the standards are based on an American population and dental wear is affected strongly by other influences such as diet and the use of teeth as tools. However, where dental wear was scored as heavy or extreme, it was assigned adult as this level of wear would not be seen in a sub-adult's permanent dentition regardless of diet. Epiphyseal union aging was done according to the standards of Buikstra and Ubelaker (1994) and allowed for aging of sub-adults and indicating adults. While a specific age range was not possible, a minimum age could be provided allowing a distinction between sub-adult and adult. The ages or age ranges obtained for each of these was collectively laid out on a spreadsheet and each burial was assigned an age range and an age grouping based on the available data. For those burials where no skeletal age indicators were present, the burial photographs were used to confirm the age assessment provided by the excavators by using the scale and coffin size in the photographs. Ratios comparing age categories were calculated and using observed and expected counts, a chi-square analysis was performed to determine significance of the ratios.

3.2.3.4 Ancestry estimation

Ancestry estimation was divided into three groups determined to be historically viable for the populations that were living and dying at the Cape during the period of time that the Black River cemetery was open for burials (Bickford Smith et al., 1999). These estimations are based on human variations that occur within, and between, the anatomy of people descendant from different ancestral origin and while they may correspond to a political or social grouping used in the past governance of South Africa, they are not founded in the socio-political definitions but on biological variation. The three groups used are, African ancestry, Mixed ancestry and European ancestry.

To estimate ancestry, the cranial measurements of cranial length (glabella – opisthion) and the cranial breadth (euryon – euryon) were used along with the nasal height (nasion – midnariale) and the nasal width (alare – alare) to calculate the cranial and nasal index respectively using the following formulae:

Cranial index = **(eu – eu / g -op) x 100**
Nasal index = **(al -al / n – mid-na) x 100**

The indices were then used to estimate ancestry as a result greater than 80 indicated European ancestry while a result less than 74.9 indicated African ancestry and a result in between is neither and thus of Mixed ancestry. For some individuals, the spreading caliper was not on hand to perform the measurements and thus the skull was photographed on a measuring scale and the measurements were performed using the photograph. The three categories used were African, Mixed and European ancestry, these were further sub-categorised into non-Europeans and Europeans and tested for significance.

3.2.3.5 Stature estimation

The estimation of stature was performed using the measurements of the length of the femur. Following the generic method of Feldesman et al., (1990) the femur length was input into the regression formula below to calculate an estimated stature for an individual. Where a burial had two femora for measurements, both were used to calculate stature and an average of the two was used. For those burials where stature and sex were estimated, significance testing was performed to compare the average stature between males and females. Following the production of histograms for the stature data set as a whole and for each variable, it was determined that the data set was non-normal and the Mann-Whitney U-test was used at a significance threshold of 0.05.

Stature = **length of femur x 3.745** (Feldesman et al., 1990)

3.2.3.6 Pathologies, trauma and variations

For the specified pathologies, frequencies were calculated at each score as well as a total using the number of individuals for which the pathology was noted. Other pathologies, traumas and variations were tabulated with the percentage and count of burials as well as sex and age category ratios.

3.2.3.7 Dental analysis

For the dental analysis, frequencies and where applicable, intensities were calculated for each of the pathologies and ante-mortem tooth loss (AMTL). The following equations outline how the frequencies were calculated:

Caries intensity = **(# caries lesions / # teeth present) x 100**

Caries frequency = **(# caries teeth / # teeth in the sample) x 100**

Hypoplasia frequency = **(# teeth with hypoplasia / # teeth in sample) x 100**

Calculus frequency = **(# teeth with calculus / # teeth in sample) x 100**

Abscess frequency = **(# teeth with abscess / # teeth in sample) x 100**

% AMTL = **(# teeth lost ante-mortem / # teeth erupted) x 100** (Friedling, 2007)

For each of the above pathologies and dental attrition analysis was performed to compare sex and age categories per each individual and tooth type total were used to compare different regions of the mouth including; the anterior and posterior teeth, the mandibular and maxillary teeth and the left and right teeth. Following the determination of normality for either a Kruskal-Wallis test was performed or a Mann-Whitney U-test using the statistical analysis software, IBM SPSS Statistics (Version 25). The results were presented visually using box-plots also produced in IBM SPSS Statistics and the significance threshold for testing was 0.05 unless otherwise stipulated. Caries intensity and frequency was compared across opposing tooth types and presented in stacked bar graphs. A chi-square analysis was performed to test for significance between the mandibular and maxillary teeth. Other dental pathologies and anomalies were tabulated with counts and percentages as well as age and sex category ratios.

Chapter 4 RESULTS

4.1 Skeletal inventory

The skeletal inventory recorded the presence or absence of each skeletal element per individual (Table 4.01) with the total count skeletal material present from all the burials. The inventory was not recorded as specific to whether epiphyses/shaft etc. was present but simply whether any confirmed portion of the bone was preserved. Table 4.01 shows that the bones most frequently preserved were the more robust long bones, femur (51%), tibia (43%) and humerus (43%) as well as the cranial bones (58%) (Table 4.01).

Table 4.01: Inventory of skeletal remains present.

Skeletal type	Number of individuals	Percentage of total burials (%)	Total number
Cranial fragments	759	58	759
Calvaria	169	13	169
Mandible	433	33	433
Teeth	808	62	8733
Clavicle	247	19	417
Sternum	68	5	68
Vertebrae	307	24	307
Sacrum	103	8	103
Pelvic	324	25	582
Scapula	149	11	249
Ribs	308	24	309
Humerus	565	43	990
Ulna	435	33	728
Radius	416	32	698
Hand	203	16	335
Femur	667	51	1219
Patella	143	11	231
Tibia	558	43	1044
Fibula	303	23	518
Foot	190	15	331

There were 1305 individuals exhumed for which 1050 were of unknown sex (see Appendix 8). All baby and child estimations were of unknown sex, while only 21 out of the 169 juvenile burials had a sex estimation (see Appendix 8). Multiple skeletal methods were applied for aging (Table 4.02) and only 12 burials had an unknown age estimation (see Appendix 8). There was a low frequency of the available skeletal material for the aging methods and thus several of the burials age estimations relied solely on the grave or coffin size for an age estimation (Table 4.02). Dental eruption was the next most useful aging method, employed for 46% of the burials, while epiphyseal union and cranial suture closure was implemented for 12% and 10% of the burials respectively (Table 4.02).

Table 4:02: Aging methods employed.

Methods employed	Number of burials	Percentage of burials
Suchey Brookes Os Pubis	10	0.8
Sternal rib ends	9	0.7
Transition Analysis	26	2.0
Dental Eruption	595	45.6
Epiphyseal Union	159	12.2
Cranial Sutures	125	9.6
Grave Size	1293	99.1

Table 4.03: Count of burials, with remains present or absent by age.

Age	Remains Present (%)	Remains absent (%)
Baby	114 (40)	170 (60)
Child	129 (97)	4 (3)
Juvenile	152 (90)	17 (10)
Young Adult	127 (100)	0
Adult	488 (89)	58 (11)
Old Adult	33 (97)	1 (3)
Unknown	6 (55)	5 (45)

The preservation of the remains was the lowest amongst the baby burials with a 60% (Table 4.03) of the burials having complete taphonomic loss of skeletal material, while the adult burials had a lower 11% taphonomic loss of skeletal material (Table 4.03). Due to the high taphonomic loss, age estimations were frequently done using coffin size (Table 4.02) and the categories were then viewed for preservation (Table 4.03). The majority of the burials with remains present contained incomplete skeletons. Fifty percent of the burials contained incomplete individual/s with cranial and post-cranial remains present and 21% containing only cranial and mandibular remains (Fig 4.01). The preservation of the remains from the site was generally poor with high fragmentation of skeletal remains recorded in 75% of the burials. Only 1% of the burials was considered in well-preserved (Fig 4.02).

Table 4.04: Count of burials, with remains present or absent by quadrant.

Quadrant	Remains present (%)	Remains absent (%)	Total
A	203 (88)	27 (12)	**230**
B	175 (72)	69 (28)	**244**
C	353 (79)	96 (21)	**449**
D	319 (84)	63 (16)	**382**
Total	**1050 (80)**	**255 (20)**	**1305**

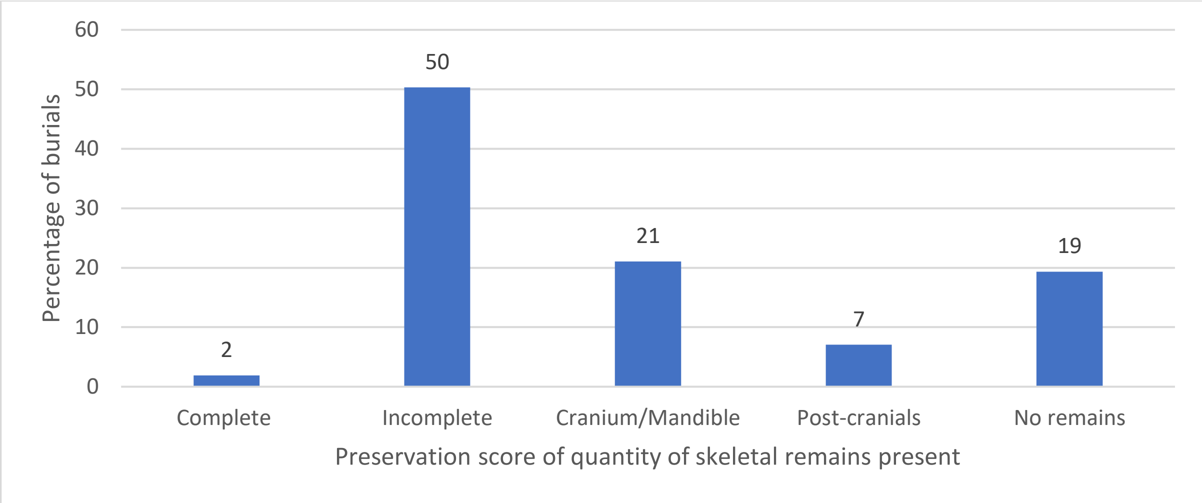


Fig 4.01: Graph indicating the percentage of burials scored for preservation by the completeness of the skeleton.

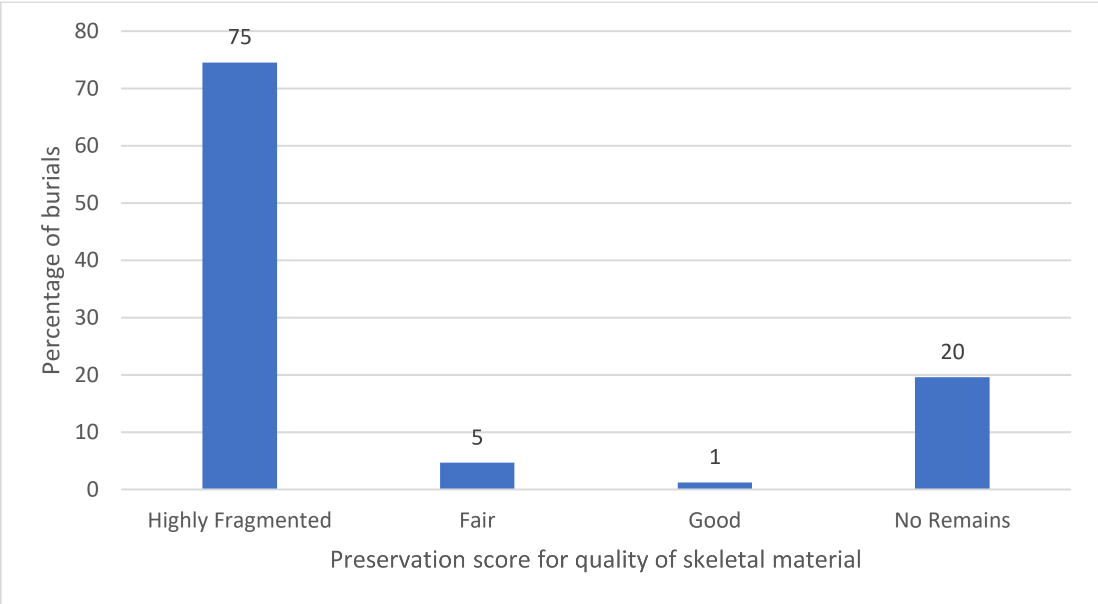


Fig 4.02: Graph indicating the percentage of burials scored for preservation by the condition of the skeletal material.

Although the quadrant divisions were arbitrary; to facilitate the control of earth moving and daily recordings of burial data, the differences in taphonomy and thus preservation across the site has resulted in the data differing in each quadrant. Quadrant C had the highest density of burials at 449 followed by quadrant D at 382, while quadrant A had the least total burials at 230 (Table 4.04). Quadrant B had the highest taphonomic loss with 28% of the burials excavated having no skeletal remains preserved and quadrant A had the lowest percentage of taphonomic loss (12%) (Table 4.04). The number of multiple burials as calculated per quadrant shows the greatest percentage of multiple burials present in quadrant C with 26% of the burials being multiple (Fig 4.03). Quadrant B has the lowest count and percentage of multiple burials across the site (Fig 4.03).

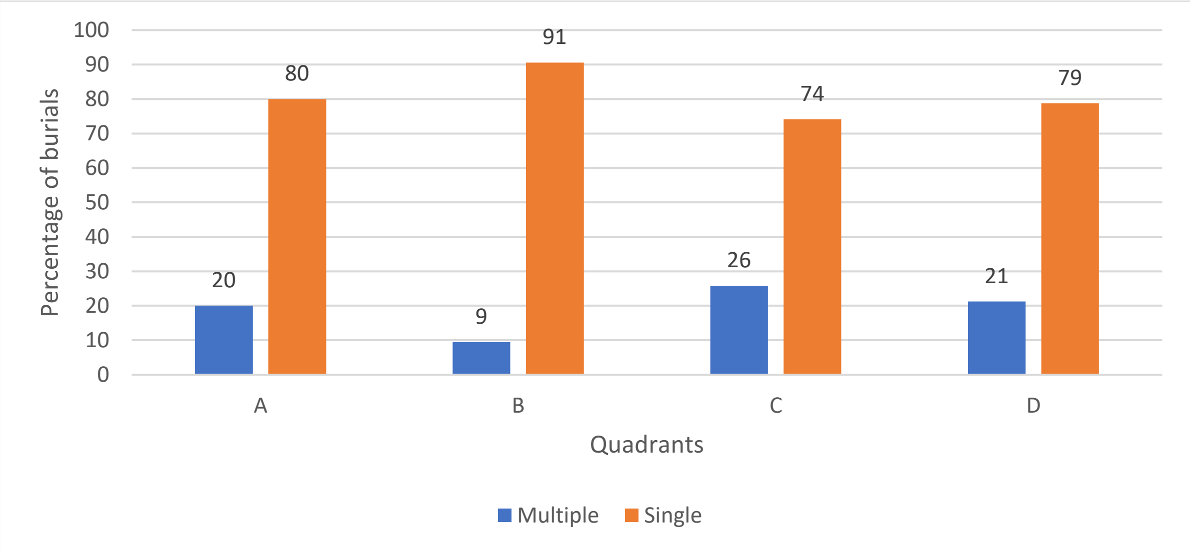


Fig 4.03: The percentage of multiple and single burials in each quadrant.

4.2 Demography

The demographic analysis within this study looks at ancestry estimation and analysis and estimations of sex at the individual level as well as the ratios of male to female for the burial site. Age-at-death was estimated for each burial and an analysis of age ratios provided data covering the time the burial site was in use.

4.2.1 Ancestry estimation

Ancestral estimation using the cranial index was only possible for 4.4% of the 1050 burials that had skeletal remains present. The 46 individuals for which ancestry estimation was possible showed a 48% majority for Mixed ancestry individuals followed by 39% African ancestry and the least frequent, 13% European ancestry (Fig 4.04). This shows a 3.7 : 3 : 1 ratio of Mixed to African to European ancestry. When the mixed ancestry and the African ancestry numbers are combined as non-European and compared with the European ancestry a significant difference is noted (p=2.47E-09) (Fig 4.04).

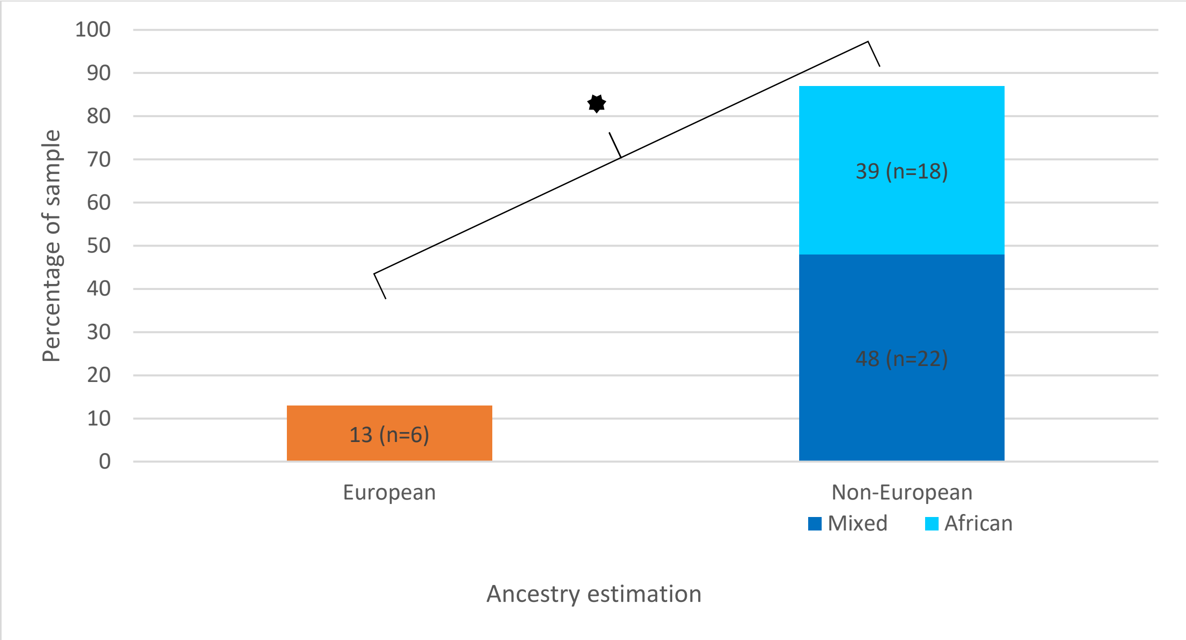


Fig 4.04: Number of individuals in each ancestral group. *(*) indicates significance (p=2.47E-09)*

4.2.2 Sex estimation

There were 324 burials that had skeletal material required for sex estimation, which is less than a third of the 1050 burials with skeletal remains present (Table 4.04). Of these, 21% of the estimations were inconclusive while a further 14% were probable estimations (Fig 4.05). A probable estimation occurred in cases where there was either not enough data to make an estimation, or the individual is estimated as juvenile. There was on average 3% more males than females across the site when probable estimations were summed with the sex estimations (Fig 4.05).

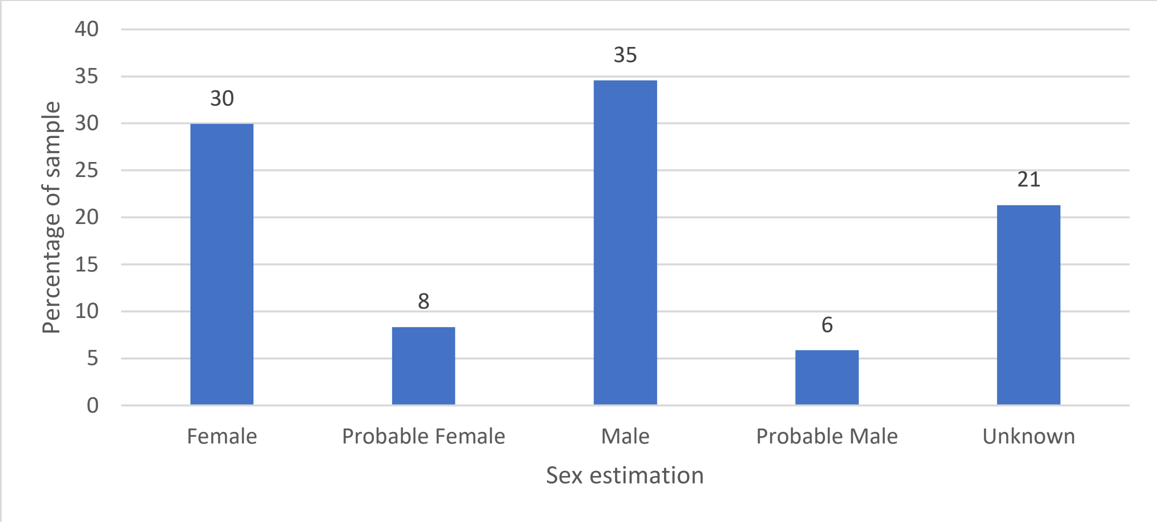


Fig 4.05: Number of males and females in each age group and in total for the burials in which sex estimation was possible.

Table 4.05: The ratios for sex data.

Categories (M:F)	Ratio	p-value
Juvenile	1 : 3	0.16
Young Adults	1.3 : 1	0.27
Adults	1.2 : 1	0.40
Old Adults	1.1 : 1	0.82
All Ages	1.2 : 1	0.30

Key: M=Male, F=Female

The ratio between males and females was calculated for each age category and in total for all the ages combined (Table 4.05). The ratio of the total number of individuals is slightly skewed towards males (Table 4.05), this trend follows for all the age categories separately except for the juveniles, which is more greatly skewed toward females (Table 4.05). When a chi-square analysis was performed comparing the observed versus expected counts for males and females in each age group it showed that the differences were not significant (Table 4.05).

4.2.3 Age-at-death estimation

Figure 4.06 shows adults had the highest frequency of burials (42%) present in the age group, followed by baby burials at 22% of the site. There was a total of 12 burials with unknown age estimates (Fig 4.06).

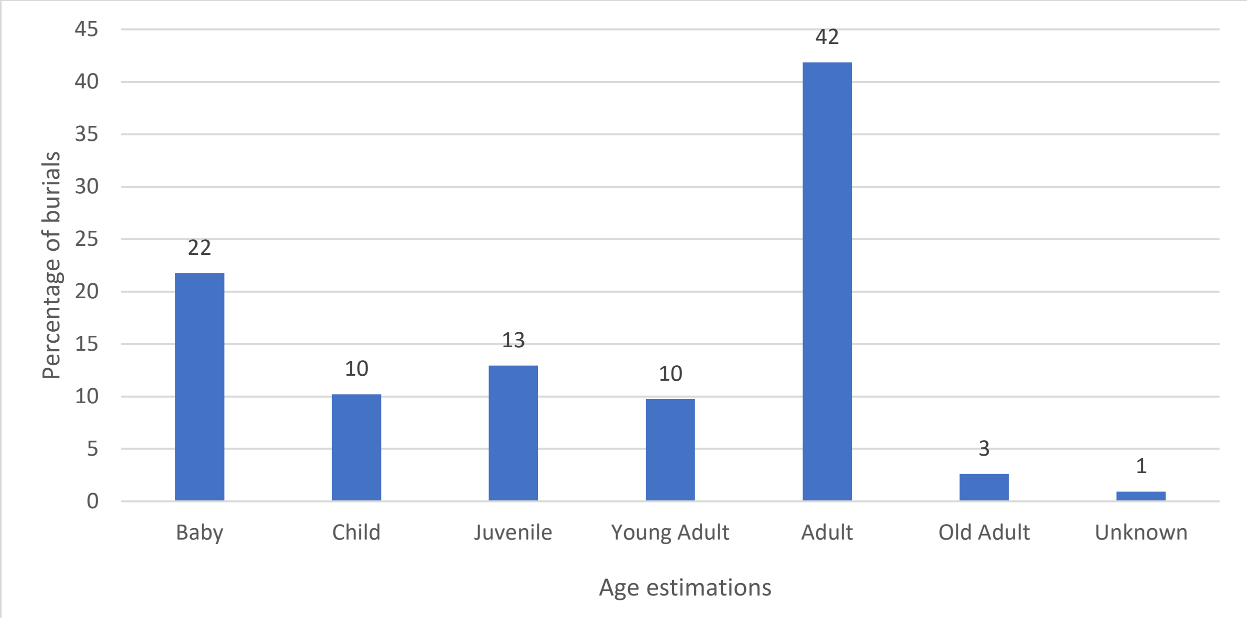


Fig 4.06: Percentage of individuals in each age group.

Table 4.06: The ratios for age data.

Categories	Ratio	p-value
B:AA	**1 : 2.5**	3.67E-41
C:AA	**1 : 5.3**	2.70E-87
J:AA	**1 : 4.2**	7.80E-74
YA:OA	**3.7 : 1**	2.31E-13
Sub-A:AA	**1 : 1.2**	7.65E-04

Key: B=Baby, C=Child, J=Juvenile, YA=Young Adult, OA=Old Adult, AA=All Adults (inclusive of OA and YA), Sub-A=Sub-Adu J), bold=statistically significant

Ratios were calculated for age categories comparing each of the sub-adult categories to the adults both separately and combined which was skewed toward adults (Table 4.06). A comparison of young adults to old adults showed a higher number of young adults (Table 4.06). A chi-square analysis for each ratio comparing the observed counts to the expected counts produced significant test results (Table 4.06).

4.3 Stature estimation

Table 4.07: Data of analysed stature.

	Female	Male
Mean height (cm)	159	165
Mean rank	11.09	17.39
n	11	18

Stature estimation using the femur was possible for 32 individuals from the site, 18 were male and 11 were female and 3 had an unknown sex estimation (Table 4.07). The sample was not normally distributed with two peaks and outliers on the low and high ends of the spectrum. In the female category one individual was short while a higher frequency of females are tall, while the males were evenly spread in terms of height (160-170cm) with a single short individual. Considering the parametric nature of the sample, a Mann-Whitney U-test (U = 56.0, Z = -1.942) was performed to compare the stature between males and females and showed that the difference was not significant [p (exact) = 0.055].

4.4 Skeletal variations

Table 4.08: Burials containing skeletal variations.

Burial Numbers	Variation	Count n (%)	Sex ratio (M:F:U)	Age
A82I, C190a, C198, C214, C241, D13b	Metopic Suture	6 (4)	4:1:1	4:1:1 (YA:A:OA)
A12Ia, B47, C173, D135	Unfused sacrum	4 (4)	1:1:2	1:1:2 (J:YA:A)

Key: M=Male, F=Female, U=Unknown sex, J=Juvenile, YA=Young Adult, A=Adult, OA=Old Adult

Other variations noted within the sample included 6 adult individuals presenting with a metopic suture that hadn't fully obliterated including an older adult, A82I (Table 4.08). Likewise, in 3 adult individuals and one juvenile individual the vertebral bodies of the first and second sacral vertebrae was unfused (Table 4.08). The frequencies of these variations were calculated as a percentage of the relevant presence of skeletal material viz. cranial vault and sacrum.

4.5 Health and lifestyle

4.5.1 Pathologies and trauma

Degenerative joint disease was observed on a total of 88 individuals (8.4% of the site for individuals with remains present). The highest prevalence of this was found in the form of vertebral osteophytosis, with the majority of these being scored as marked lipping on the vertebral bodies, 36% of the lumbar vertebrae and 28% of the thoracic vertebrae (Fig 4.07). In the other joint locations, the highest frequency was found to be at the hip joint where the acetabulum and head of the femur articulate, although the greater percentage (17%) was for slight lipping rather than marked lipping (Fig 4.07). The shoulder joint had the least prevalence of degenerative joint disease with a combined percentage of 9% for both slight and marked lipping (Fig 4.07). The lower limb joints (the hip joint comprising the head of the femur and acetabulum and the knee joint comprising the femoral condyles, tibial plateau and patella) had a greater frequency of degenerative joint disease than the upper limb joints (glenohumeral shoulder joint and elbow joint comprising the distal humerus, head of the radius and olecranon and coronoid processes of the ulna) (Fig 4.07).

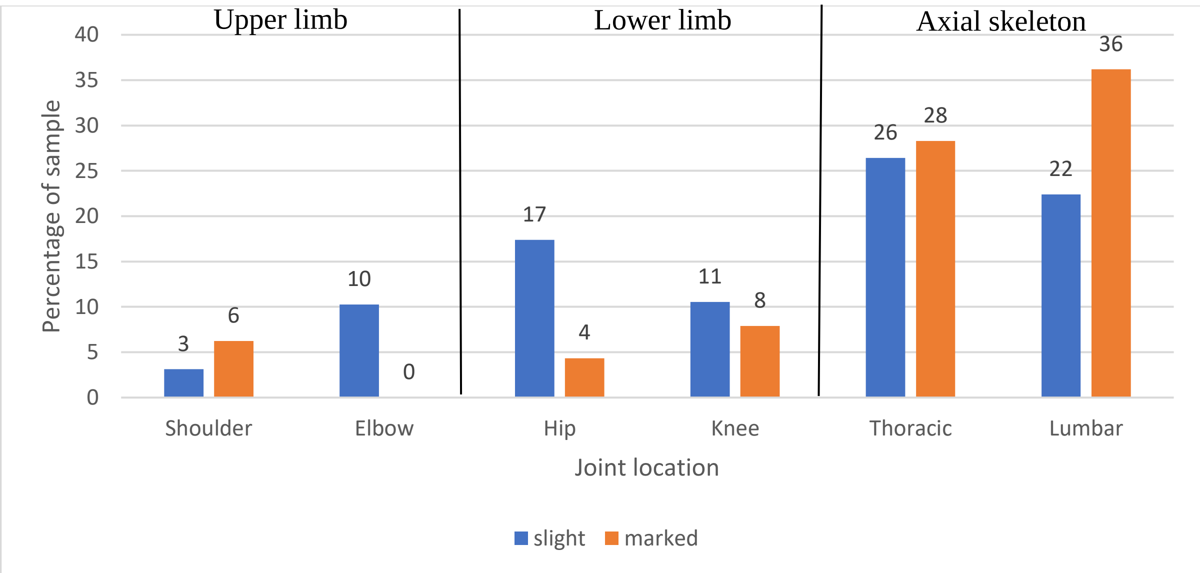


Fig 4.07: The frequency of degenerative joint disease observed within the sample at different joint locations.

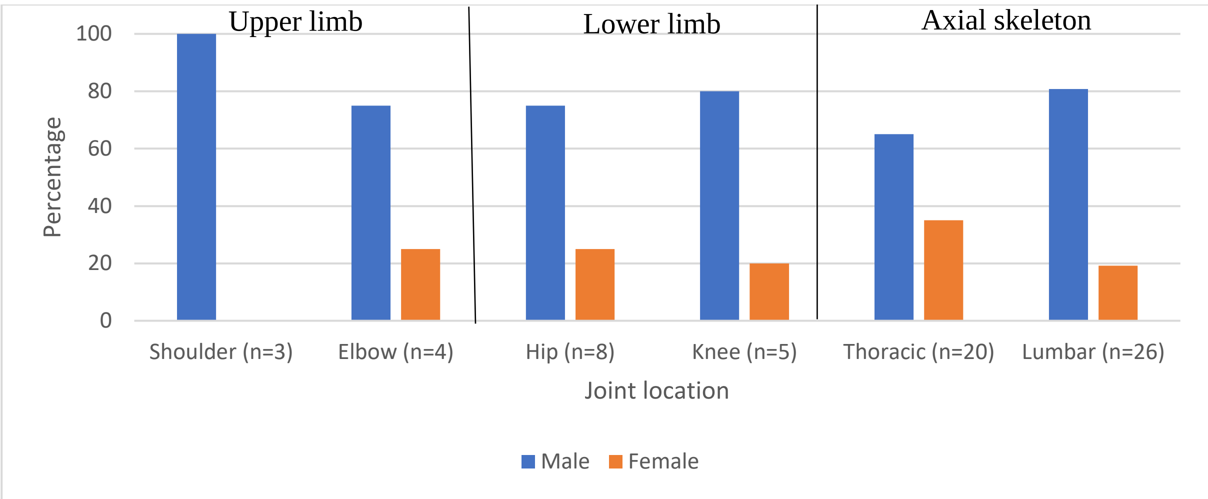


Fig 4.08: The frequency of degenerative joint disease observed within the sample at different joint locations comparing sex estimations.

Within the sample of individuals with degenerative joint disease there was a ratio of 1.8 : 1.7 : 1 for sex categories Male : Female : Unknown indicating a greater prevalence of degenerative joint disease in male individuals than females in the sample. The differences between males and females show a higher frequency of presentation in males at all joint locations (Fig 4.08). Statistical testing would not add value due to the nominal data set and small sample sizes.

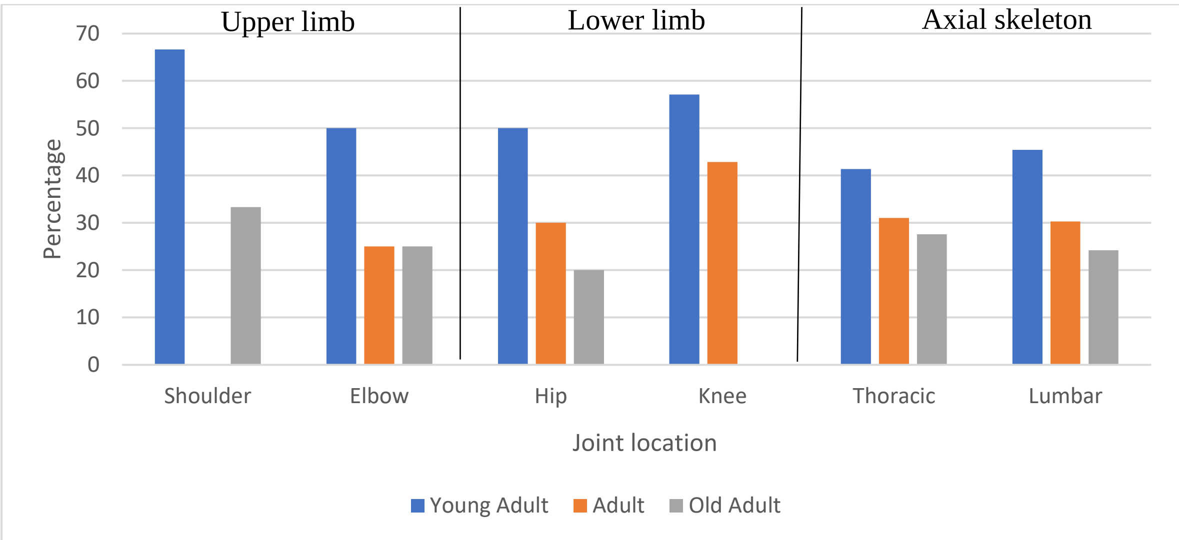


Fig 4.09: The frequency of degenerative joint disease observed within the sample at different joint locations comparing age estimations.

Degenerative joint disease was found in 4 individuals that were estimated to be juveniles while the ratio of young adults to adults to old adults was 2.5 : 2.1 : 1. When comparing age categories, the young adults had the highest frequency of degenerative joint disease while the old adults had the lowest frequency at all the joint locations except the shoulder joint in which there were no individuals from the adult category (Fig 4.09). Figures 4.10 and 4.11 show two examples of osteophytic proliferation of the vertebrae.

Fig 4.10: A29I: Osteophytic lipping of vertebrae. ***Fig 4.11: D10: Osteophytic lipping of vertebrae***
(Photographic Source: This Study).

Tibial shaft periostitis was only noted in 9 individuals of which 5 were scored as slight for severity and 4 were scored as marked (Table 4.09). The skeletal material and preservation level required to observe whether this pathology was present or absent was accounted for 48 individuals, for which 81% of individuals, the tibial periostitis skeletal markings were absent. The total percentage calculated as the count for which the pathology was observable by the number of individuals for which the tibia was present was only 0.09% (Table 4.09). Porotic hyperostosis was observed on both the parietal and occipital bones with 8% and 6% scored as slight respectively and only 3% of the occipital being scored as marked. These percentages were calculated as a portion of the count of individuals for which this pathology was observable which totalled at 39 and 36 for the parietal and occipital bones respectively (Table 4.09).

Table 4.09: Percentage and count of individuals with pathology markings.

	Tibial Periostitis	**Porotic hyperostosis**	
Severity	**Tibial shaft % (n)**	**Parietal % (n)**	**Occipital % (n)**
Slight	10 (5)	8 (3)	6 (2)
Marked	8 (4)	0	3 (1)
Total	**0.09 (48)**	**23 (39)**	**21 (36)**

\

The total percentages of 23% and 21% were calculated as a percentage of the count of cranial vaults that were preserved (Table 4.09). Cribra orbitalia was noted as present in the right orbits of two individuals. A further thirteen individuals examined for this skeletal marker did not show any signs of the pathology.

Table 4.10: Possible pathological processes noted within the sample.

Burial Number	**Description**	**Area Affected**	**Count n (%)**	**Sex Ratio (M:F:U)**	**Age**
A90, B116, C31, C32, D2X	Bowed legs	femora, tibia	5 (0.7)	2:0:3	1:4 (YA:A)
A29I, C93, C162a, C214, C242, D10, D14, D23	Osteoarthritis	hands & feet	8 (2)	1.6:1:0	4:3:1 (YA:A:OA)
D20	Osteosarcoma	pelvis, femoral head, lumbar vert.	1 (0.3)	1:0:0	1 OA
C267, D2X, D14	Possible infection (periostitis)	long bones; femur (1), ulna (2)	3	3:0:0	2:1 (YA:A)
A29I, A36I, B126, B210, C42c, C77, C103, C126, C150, C179a, C242, D3X, D170, D261, D278	Possible infection (thickened bone)	cranium	15 (2)	1:1.8:1	1:2.5:4 (J:YA:A)
D138b	Abscess	hard palate	1	1 M	1 YA

Key: M=Male, F=Female, U=Unknown sex, J=Juvenile, YA=Young Adult, A=Adult, OA=Old Adult

Table 4.11: Processes of excess ossification noted within the sample.

Burial Number	Description	Area Affected	Count n (%)	Sex Ratio (M:F:U)	Age
A28, B131, C190a, C237b, C301c, D32a, D167, D202	Osteophytosis	cervical vertebrae	8 (3)	3:1:0	3:3:2 (YA:A:OA)
A29I, A311, C215, C267, D167	Cartilaginous ossification	sternal cartilage (3), thyroid (1), interosseus membrane (1)	5	4:1:0	3:2 (YA:OA)
A53I, A62I, A90, C59a, C237b, C249a	Fusion of bony joints	lumbar vertebrae (4), pelvis (1), xiphisternum (1)	6	3:1:2	1:1:1 (YA:A:OA)
C190a	Tendon ossification	humerus, deltoid insertion	1 (0.2)	1 M	1 YA

Key: M=Male, F=Female, U=Unknown sex, YA=Young Adult, A=Adult, OA=Old Adult

Table 4.12: Possible traumas noted within the sample.

Burial Number	Description	Area Affected	Count n (%)	Sex Ratio (M:F:U)	Age
A1 (x3), C57a, C59a, C190a, C214, D8b, D16a, D136, D202	AM fracture	upper limb	11 (2)	8:2:1	6:4:1 (YA:A:OA)
A1 (x2), A87I, B37, C255, D24, D72 (x2), D136, D169	AM fracture	lower limb	11 (1.6)	1:0:2.3	1:2:6:1 (J:YA:A:OA)
C190a	AM fracture	ribs (left)	1 (0.3)	1 M	1 YA
A96I, D17	Sharp force trauma	parietal (1), femur (1)	2	2 F	2 J
A47I, A60I, A88I	Blunt force trauma	cranium	3 (1.8)	1:2:0	1:1:1 (YA:A:OA)
A58I, B13, C334	Possible ballistic trauma	cranium	3 (1.8)	1:1:1	2:1 (YA:A)
A15a, A15b, A89, A105, B209, C56, C184a, C216, C246	Autopsy (cut bone)	cranium	9 (1.3)	1:1:2.5	1:3.5 (YA:A)

Key: AM=Ante-Mortem, M=Male, F=Female, U=Unknown sex, J=Juvenile, YA=Young Adult, A=Adult, OA=Old Adult

All skeletal markers observed were noted and described, these were then categorised according to the possible pathology, trauma or cause and the data on sex and age for the affected individuals was then compared for each of the categories (Tables 4.10 - 4.12). Individual C190a has osteophytosis of the cervical vertebrae, ossification of the tendon at the deltoid tuberosity as well as ante-mortem fractures to the upper limb and the left ribs (Tables 4.10 and 4.12). Individual A1 had multiple ante-mortem fractures to both the upper limb (humerii and ulna) and the lower limb (femora) (Table 4.12). Additional ante-mortem fractures recorded in Table 4.12 can be seen in Figures 4.12 – 4.14. Individual D2X had bowed legs as well as a possible infection evident on the long bones (Table 4.11). Figures 4.15 and 4.16 show traumas to the cranial bone in two burials with the autopsied cranium and a possible ballistic trauma respectively.



Fig 4.12 above left: C59a: AM fracture of humerus.
Fig 4.13 above centre: B37: AM fracture of tibia.
Fig 4.14 above right: C255: AM fracture of femur.
(Photographic Source: This Study).


Fig 4.15 above top: B209S: autopsied skull.
Fig 4.16 above bottom: A58aI: possible ballistic trauma to frontal bone.
(Photographic Source: This Study).

4.5.2 Dental analysis

A total of 6,597 teeth were recovered, excluding primary dentition, from a total of 579 individuals. Teeth were often preserved in exception to the rest of the skeletal material. Figures 4.17 and 4.18 show the total number of teeth recovered per tooth type for the maxilla and mandible respectively. For the analysis of the dental pathology’s, comparisons were done to portions of the mouth; maxilla and mandible, left and right and anterior and posterior teeth. The left and right teeth were split between the two central incisors in the mandible and maxilla respectively. The anterior teeth included the 4 incisors, 2 canines and first premolars of the maxilla and mandible respectively and the posterior teeth included the second premolars and first, second and third molars of the mandible and maxilla respectively.

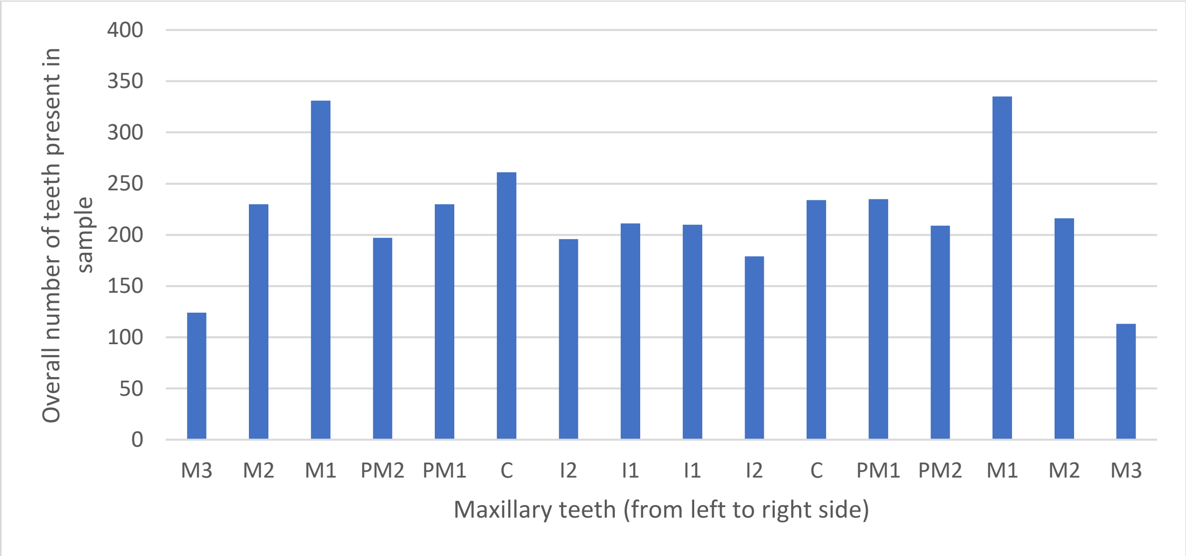


Fig 4.17: The number of teeth present by tooth type for maxillary teeth.

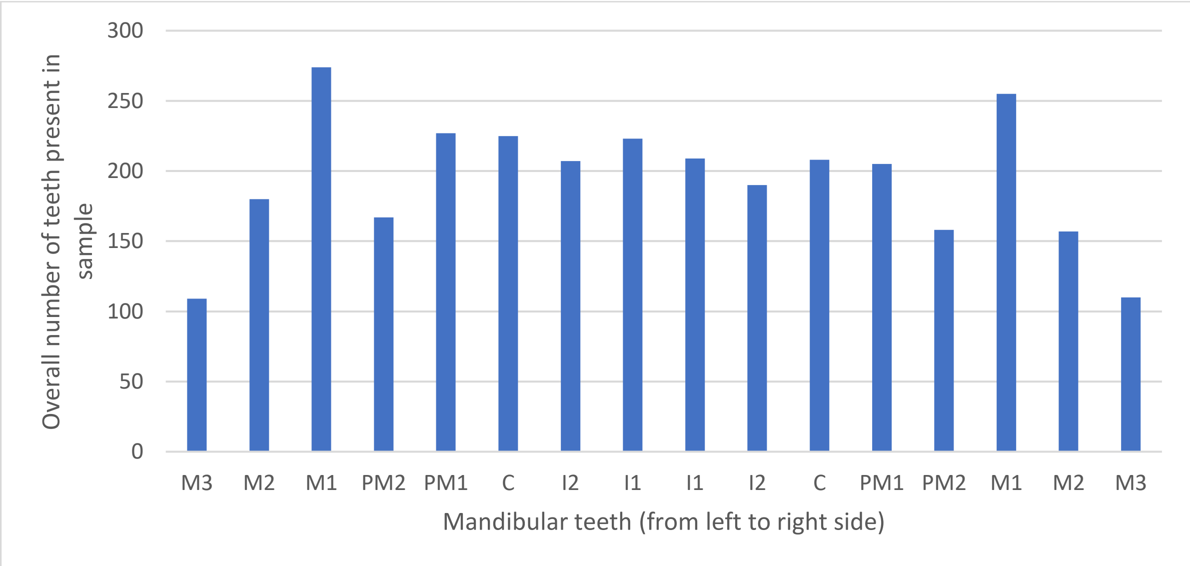


Fig 4.18: The number of teeth present by tooth type for mandibular teeth.

4.5.2.1 Dental attrition

Males have a higher dental attrition score than females (Fig 4.19), and the majority of females had an attrition score of 2 or 1 whereas the majority of males had scores of 2 or 3 (Fig 4.20). There was a greater number of individuals in the unknown category and when comparing the distribution across the attrition scores for each sex category, all had a score of 2 as the most frequent score and the unknown category had more in the attrition score of 1 when compared to the male and female categories (Fig 4.20). A Kruskal-Wallis test ($H = 14.29$) showed a significant difference within the categories ($p = 0.001$). Further pairwise testing using the Mann-Whitney U-test with a new significance threshold of 0.016 showed there was a significant difference between the male and unknown categories ($U = 5386$, $p = 0.009$) and the male and female categories ($U = 2490$, $p = 1.06E-04$) but not between the female and unknown categories ($U = 6044.5$, $p = 0.151$).

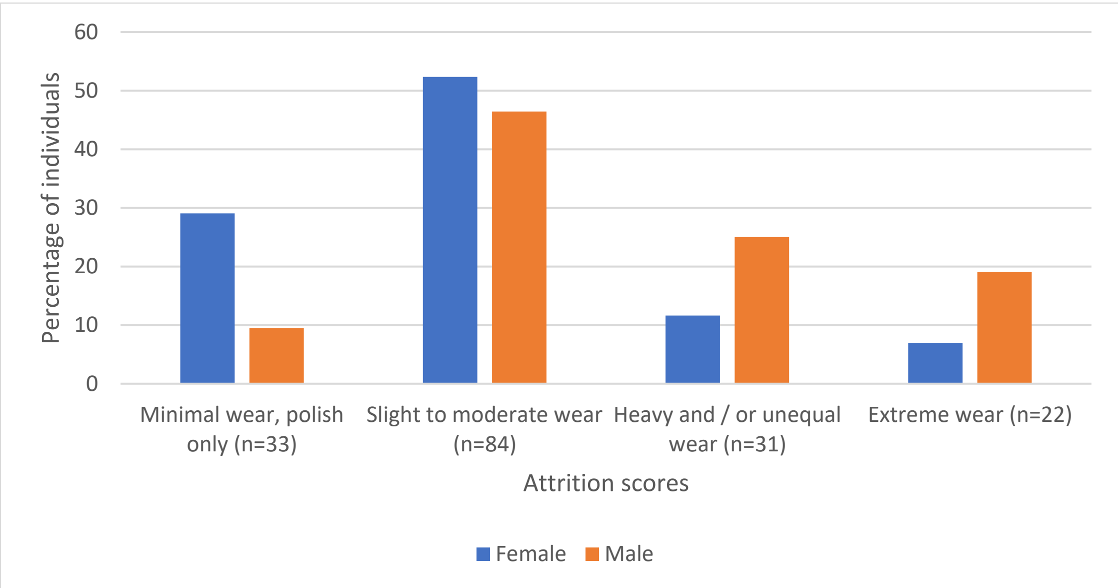


Fig 4.19: Dental attrition scores categorised by sex estimation categories.

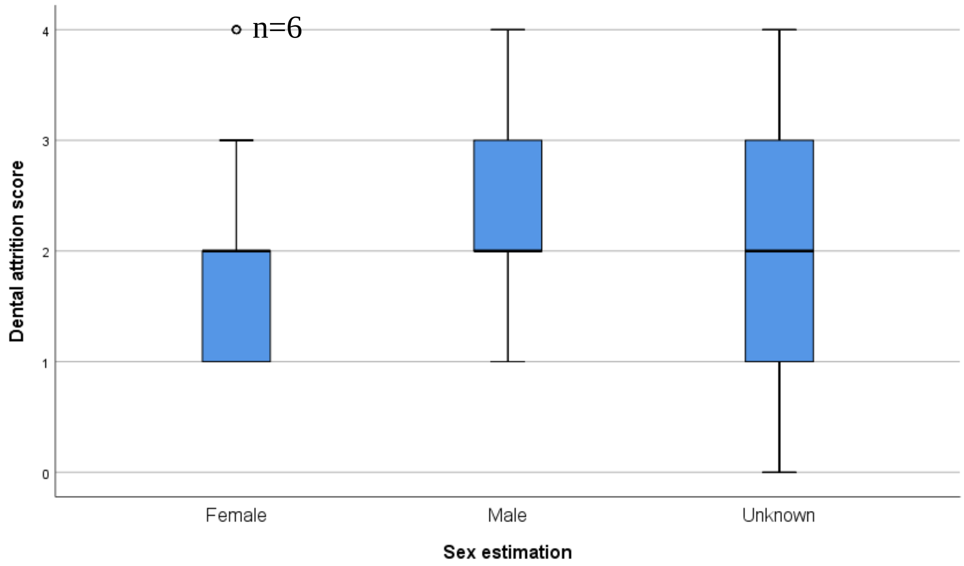


Fig 4.20: Comparison of sex estimations for dental attrition scores.
**n=x denotes the number of outliers*

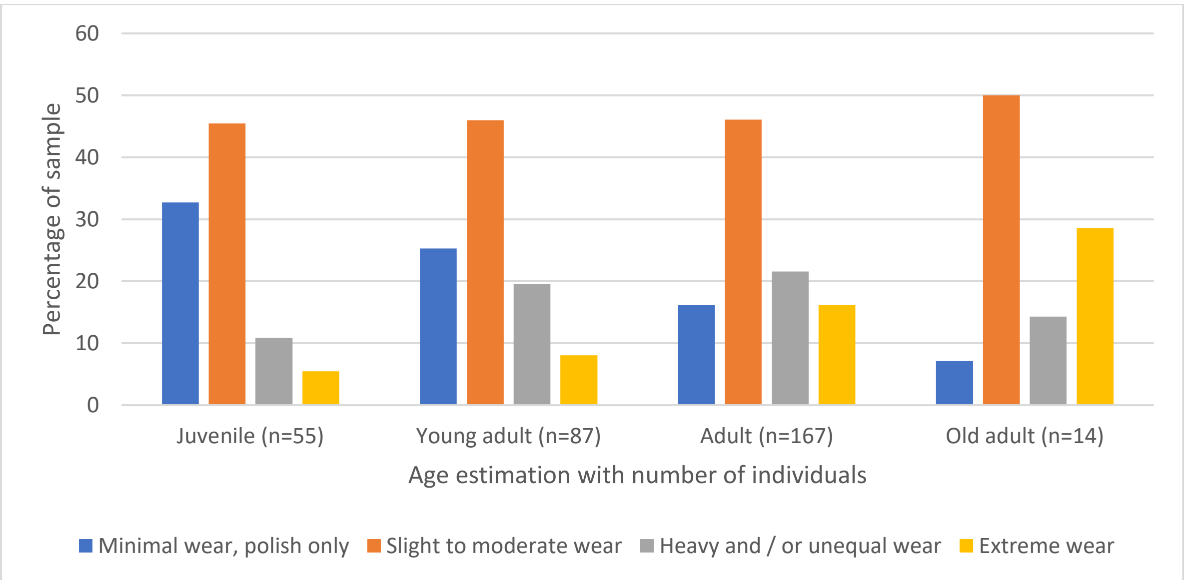


Fig 4.21: Dental attrition scores categorised by age estimation categories.

The most frequent dental wear score across all age groups was 2 (Fig 4.21). The intensity of dental attrition increased with age with all children having a score of 1 except for an outlier and most old adults scoring with 2 or higher (Fig 4.22). In the adults and old adults' categories the next highest frequency was a score of 3 while in the juvenile and young adult categories the next highest frequency was a score of 1. The Kruskal-Wallis test (H = 22.639) showed a significance within the group of four age categories (p = 1.5E-04).

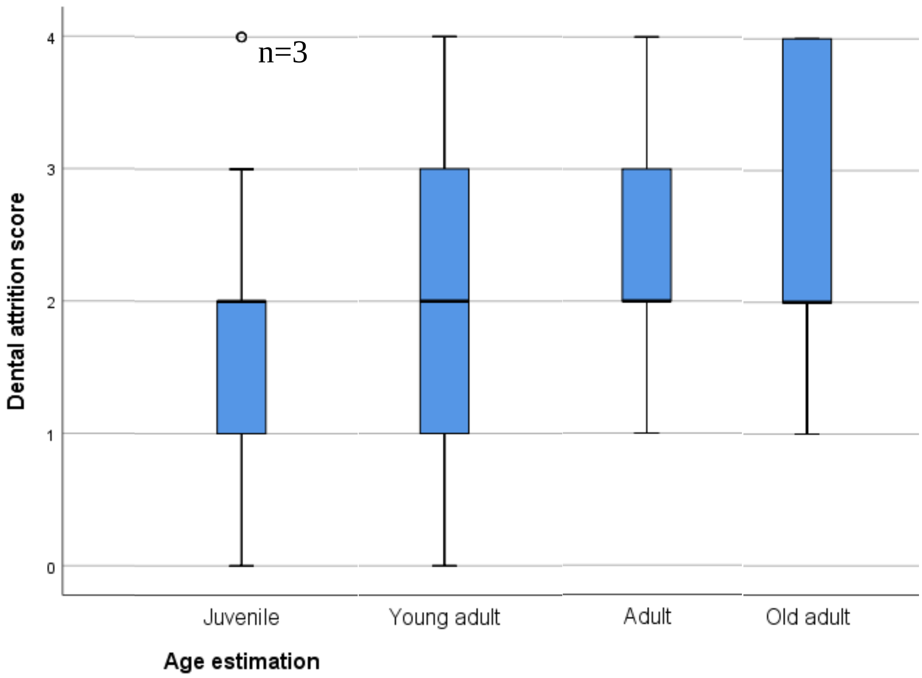


Fig 4.22: Comparison of age estimations for dental attrition scores.
**n=x denotes the number of outliers*

To determine where the significance lies between the categories, further pairwise testing using the Mann-Whitney U-test was performed (Table 4.13). In such a case it is necessary to adjust the significance threshold according to the number of categories originally tested to prevent over testing that results in significant outcomes that are not accurate. The new threshold was set at 0.01 and the significant difference was found to lie between the adult and juvenile categories (p = 1.07E-04) and the juvenile and old adult categories (p = 0.006) (Table 4.13).

Table 4.13: Results of non-parametric tests comparing dental attrition for age groups.

Mann-Whitney U-test	Test statistic (U)	Z statistic	p-value (threshold=0.01)
A vs YA	6006.5	-2.415	0.016
A vs OA	1003.5	-0.937	0.349
A vs J	3088.5	-3.874	**1.07E-04**
A vs C	207.5	-2.031	0.042
C vs J	101.5	-1.028	0.304
C vs OA	14.0	-2.033	0.042
C vs YA	132.0	-1.568	0.117
J vs OA	211.5	-2.765	**0.006**
J vs YA	1992.0	-1.795	0.073
OA vs YA	420.5	-1.982	0.047

Key: C=Child, J=Juvenile, YA=Young Adult, A=Adult, OA=Old Adult

4.5.2.2 AMTL (Ante-Mortem Tooth Loss)

Table 4.14: The percentage and number of individuals in the dental sample expressing dental pathologies or processes.

Percentage of individuals with:	%	n
Ante-mortem tooth loss	19	110
Enamel hypoplasia	7	40
Dental calculus	16	91
Dental abscess	2	10
Dental caries	27	151

Table 4.15: Number and percentage of individuals with ante-mortem tooth loss by sex and age.

			Sex estimation			
			F	M	U	Total
Age estimation	J	Count (n)	3	0	5	8
		% of Total	2.7%	-	4.5%	7.3%
	YA	Count (n)	11	21	8	40
		% of Total	10%	19.1%	7.3%	36.4%
	A	Count (n)	18	10	16	44
		% of Total	16.4%	9.1%	14.5%	40%
	OA	Count (n)	9	6	3	18
		% of Total	8.2%	5.5%	2.7%	16.4%
Total		Count (n)	41	37	32	110
		% of Total	37.3%	33.6%	29.1%	100%

Key: M=Male, F=Female, U=Unknown sex, J=Juvenile, YA=Young Adult, A=Adult, OA=Old Adult

Fig 4.23: A30Ib: mandible with resorption (Photographic Source: This Study).

Fig 4.24: A30I: mandible with resorption (Photographic Source: This Study).

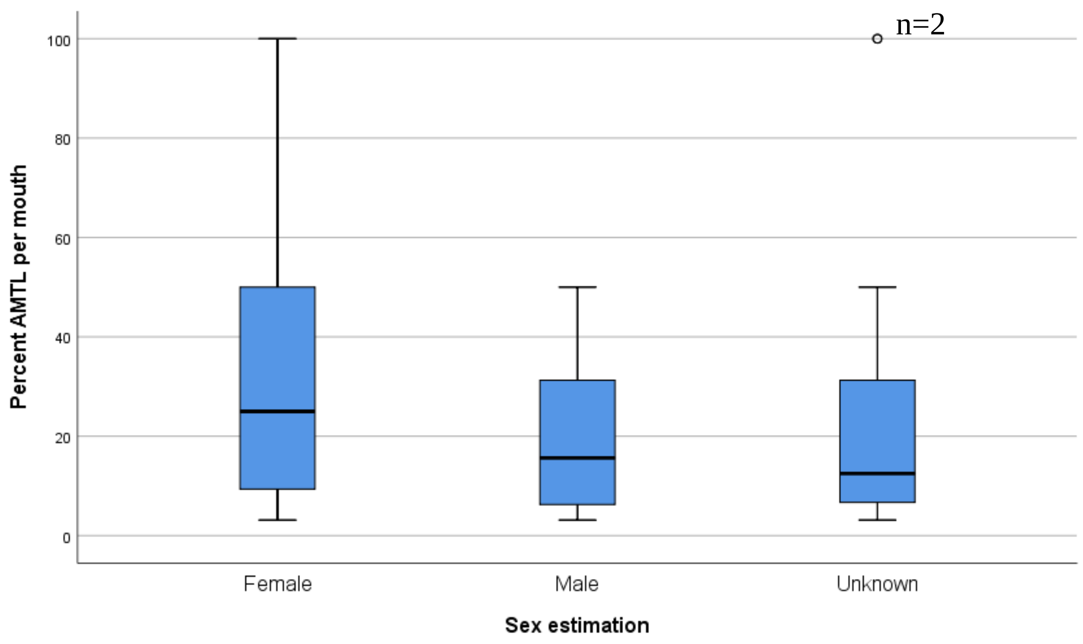


Fig 4.25: Percentage AMTL per mouth by sex estimation.
**n=x denotes the number of outliers*

Figures 4.23 and 4.24 show two examples of antemortem tooth loss in the mandible. Ante-mortem tooth loss (AMTL) was recorded in 110 individuals, the equivalent of 19% of the sample when dental analysis was possible (Table 4.14). The majority of the sample was female (37.3%) with 33.6% males and 29.1% of unknown sex (Table 4.15). Most of the individuals lost a quarter of their dentition. The majority of those that lost within the upper 50th percentile of their teeth is female (Fig 4.25). The Kruskal-Wallis Test showed a statistic of k = 5.627 (df=2) and showed no significant difference in the percentage of AMTL per mouth between the sexes (p = 0.60).

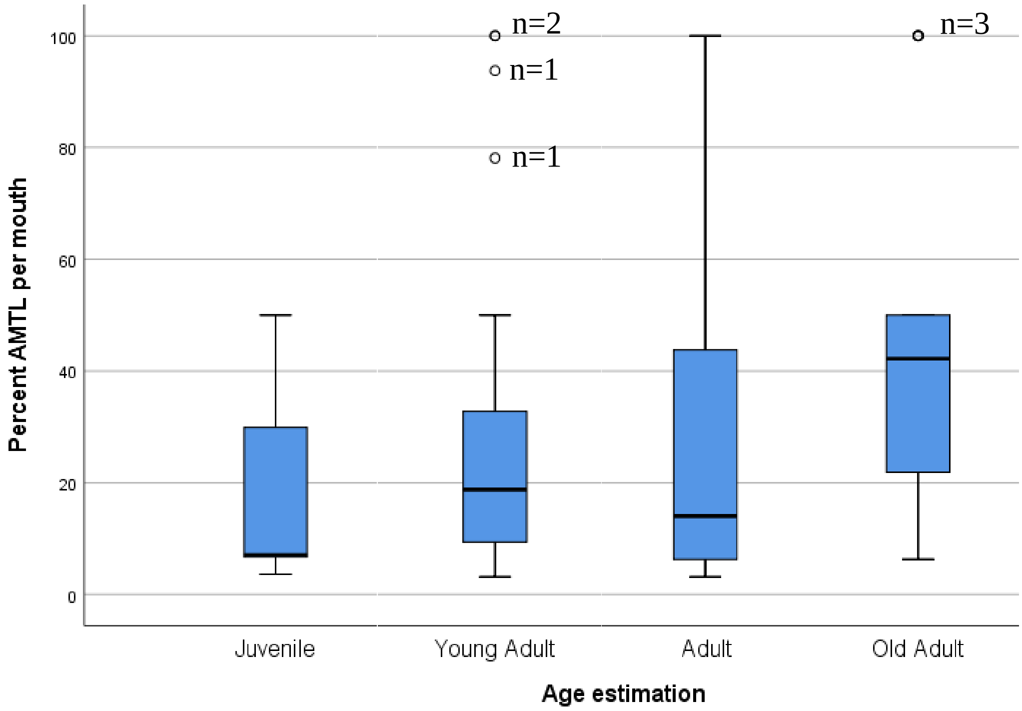


Fig 4.26: Percentage AMTL per mouth by age estimation.
**n=x denotes the number of outliers*

The adult and young adult categories had the highest number of individuals with 40% and 36.4% respectively, while old adults accounted for 16.4% and juveniles 7.3% with only 8 individuals (Table 4.15). The median percentage tooth loss was below 25% for the juvenile, young adult and adult categories while the old adult median lay higher reaching above 40% AMTL per mouth (Fig 4.26). The Kruskal-Wallis Test ($k = 7.894$, $df = 3$) revealed a significant difference ($p=0.048$) within the 4 age categories and a further pairwise analysis revealed that the greatest differences lay between the juvenile and old adult categories ($p = 0.031$) the young adults and old adults ($p = 0.023$) and the adults and old adults ($p = 0.011$). However, with the adjusted significance done by the Bonferroni correction for multiple tests, none of the pairwise comparisons are judged significant with the greatest difference lying between adults and old adults (adj. $p = 0.066$).

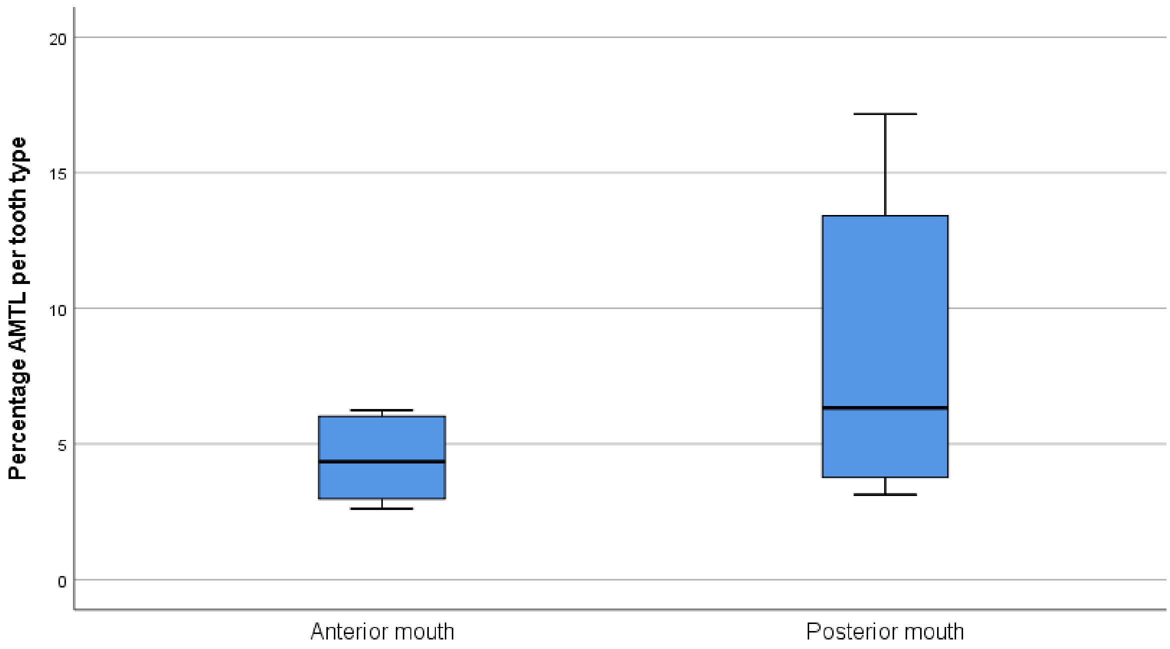


Fig 4.27: Percentage AMTL per tooth type comparing anterior and posterior teeth of the mouth.

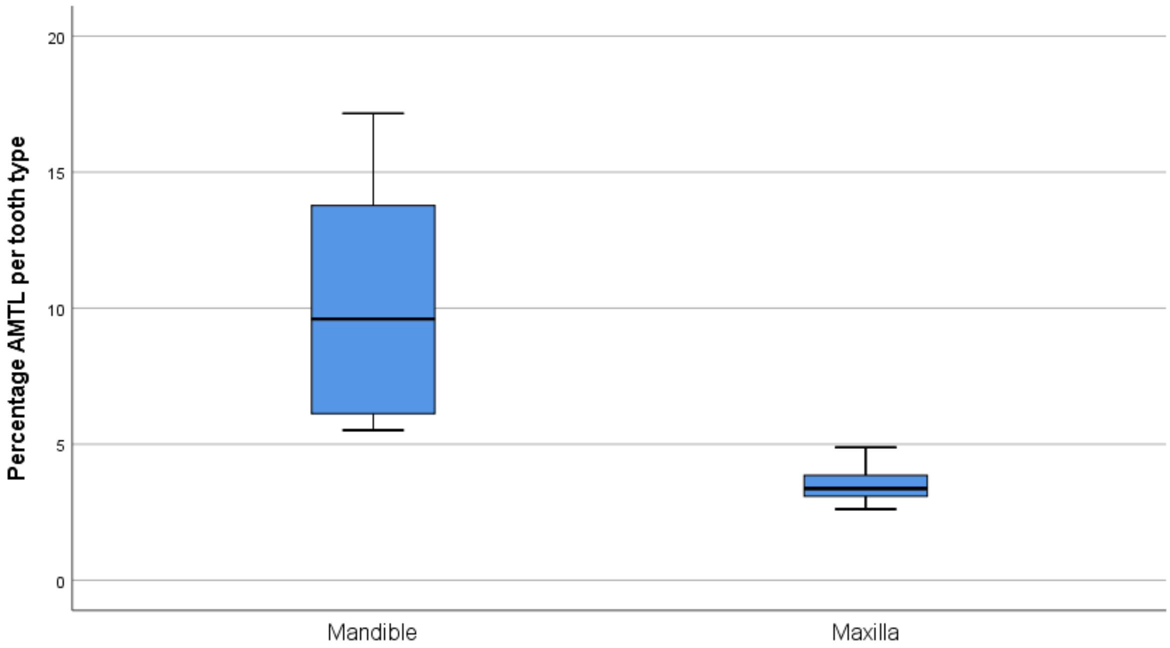


Fig 4.28: Percentage AMTL per tooth type comparing teeth of the mandible and maxilla.

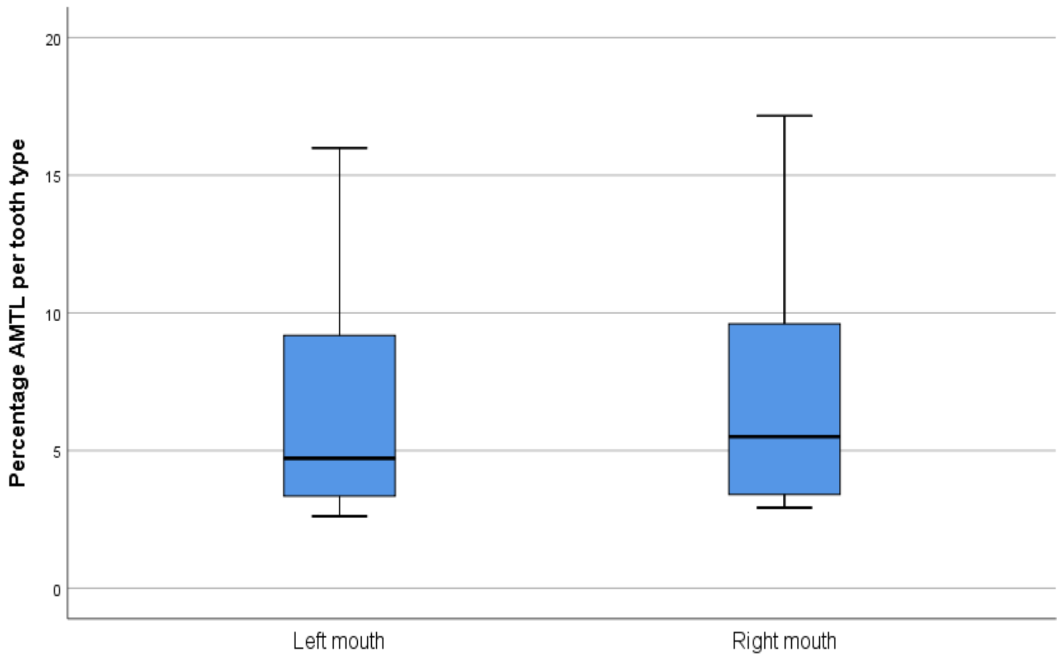


Fig 4.29: Percentage AMTL per tooth type comparing teeth of the left and right mouth

The percentage ante-mortem tooth loss was calculated per each tooth type amounting to a sample size of 32. The teeth were then categorized according to the position in the mouth in three different grouping variables; anterior vs posterior teeth (Fig 4.27), mandibular vs maxillary teeth (Fig 4.28) and teeth in the left side of the mouth vs those in the right side of the mouth (Fig 4.29). The Mann-Whitney U-Test was performed to compare the difference in percentage AMTL for each grouping variable (Table 4.16) add showed that there was significant differences (Table 4.16) between anterior and posterior teeth ($p = 0.024$) with posterior teeth having a greater percentage AMTL (Fig 4.27) as well as mandibular and maxillary teeth ($p = 3.3273E-9$) with a greater percentage seen in mandibular teeth (Fig 4.28). There was not a significant difference ($p = 0.590$) for percentage AMTL between the teeth of the left and right parts of the mouth (Table 4.16).

Table 4.16: Results of non-parametric tests comparing tooth types in sections of the mouth.

Mann-Whitney U-test	**Anterior vs posterior**	**Mandible vs maxilla**	**Left vs right**
Test statistic (U)	62.00	0.00	113.00
Z statistic	-2.258	-4.824	-0.565
p-value (exact)	**0.024**	**3.3273E-9**	0.590

4.5.2.3 Dental caries

Table 4.17: Number and percentage of individuals with caries present by sex and age.

			Sex estimation			
			F	M	U	Total
Age estimation	C	Count (n)	0	0	2	2
		% of Total	-	-	1.3%	1.3%
	J	Count (n)	3	3	21	27
		% of Total	2%	2%	13.9%	17.9%
	YA	Count (n)	13	19	15	47
		% of Total	8.6%	12.6%	9.9%	31.1%
	A	Count (n)	18	12	38	68
		% of Total	11.9%	7.9%	25.2%	45%
	OA	Count (n)	3	3	1	7
		% of Total	2%	2%	0.7%	4.6%
Total		Count (n)	37	37	77	151
		% of Total	24.5%	24.5%	51%	100%

Key: M=Male, F=Female, U=Unknown sex, C= Child, J=Juvenile, A=Adult, YA=Young Adult, OA=Old Adult

A total of 151 individuals presented with dental caries accounting for 27% of the individuals where dental analysis was possible (Table 4.14). Of these, 51% were of unknown sex and 24.5% were males and females respectively (Table 4.17).

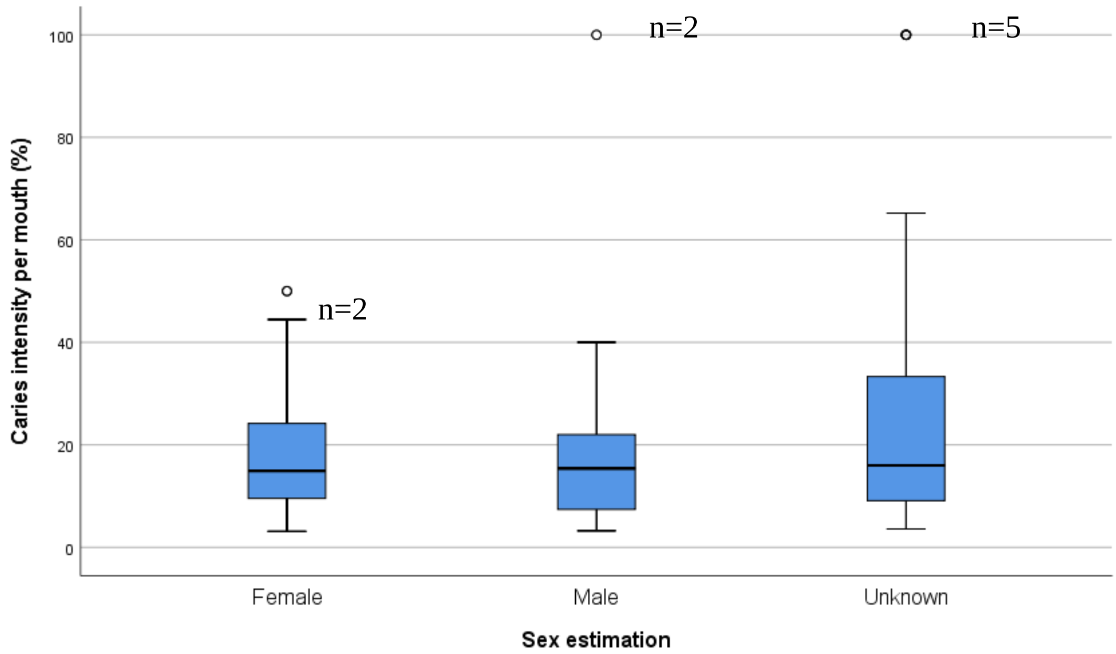


Fig 4.30: Caries intensity per mouth by sex estimation.
**n=x denotes the number of outliers*

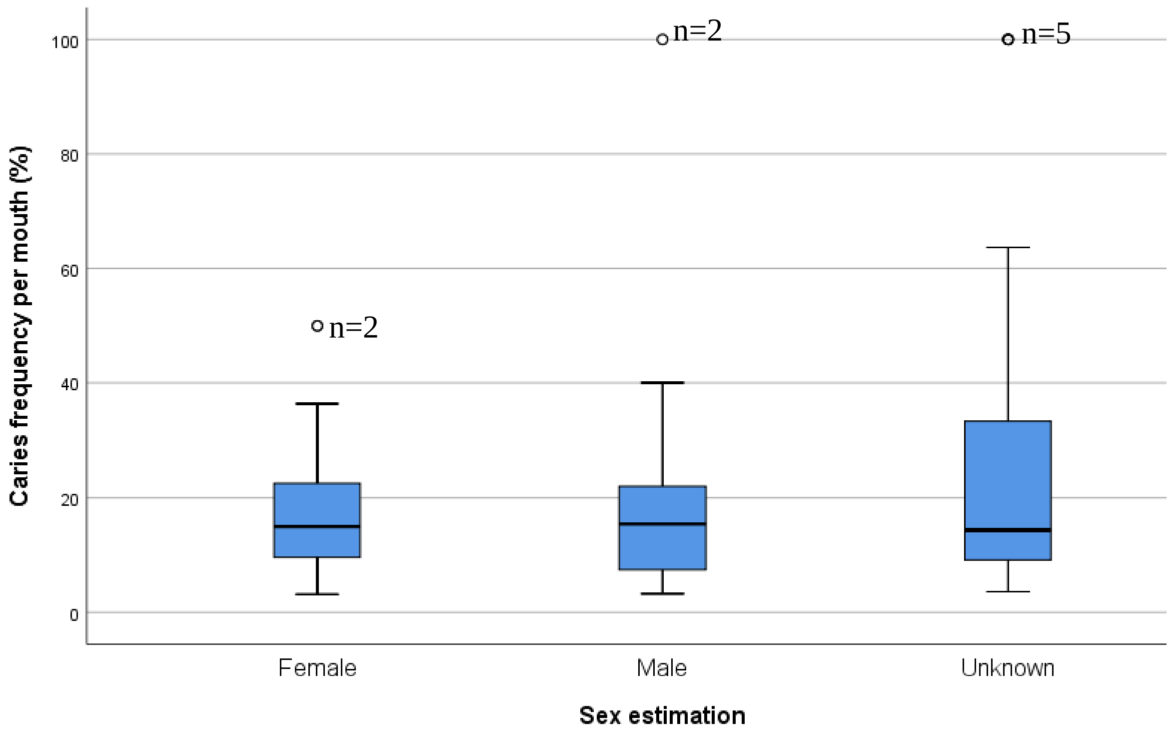


Fig 4.31: Caries frequency per mouth by sex estimation.
**n=x denotes the number of outliers*

Neither caries intensity or caries frequency presented with significant differences between sex categories and all individuals (Table 4.18). The two individuals with 100% caries intensity and frequency had a single caries lesion on one tooth that was recovered thus presenting outliers on the boxplots (Fig 4.30 and 4.31). The majority of individuals had a less than 20% caries intensity (Fig 4.30) and caries frequency (Fig 4.31).

Table 4.18: Results of non-parametric tests comparing sex categories.

Kruskal-Wallis Test for:	Caries intensity per mouth	Caries frequency per mouth
Test statistic (k)	1.924	1.893
Df	2	2
P	0.382	0.388

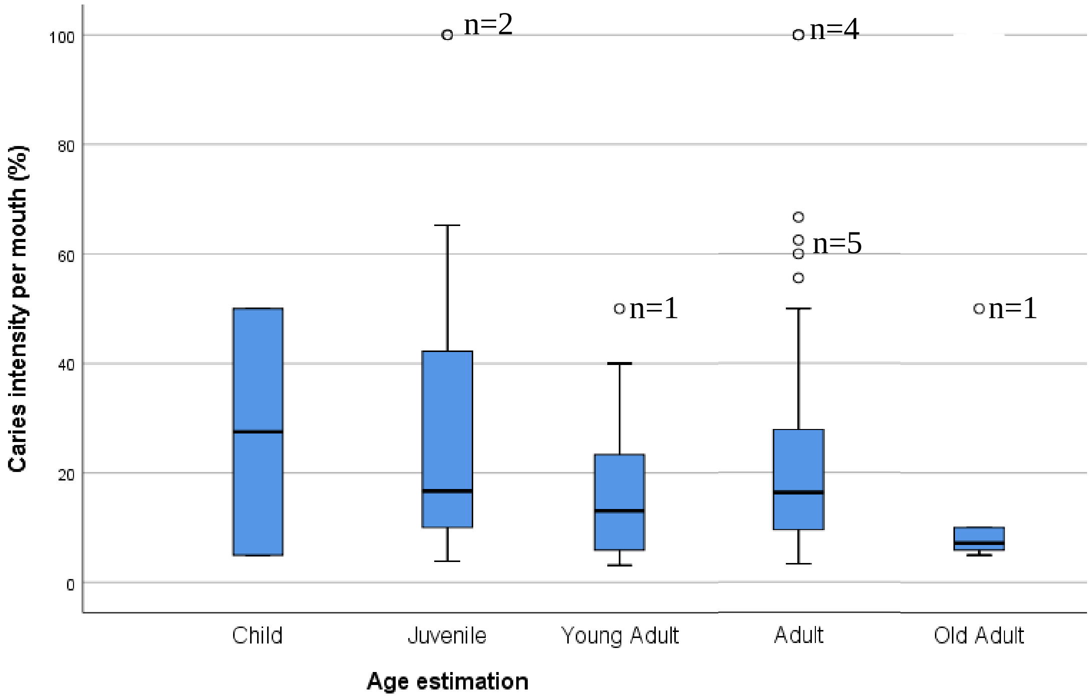


Fig 4.32: Caries intensity per mouth by age estimation.
**n=x denotes the number of outliers*

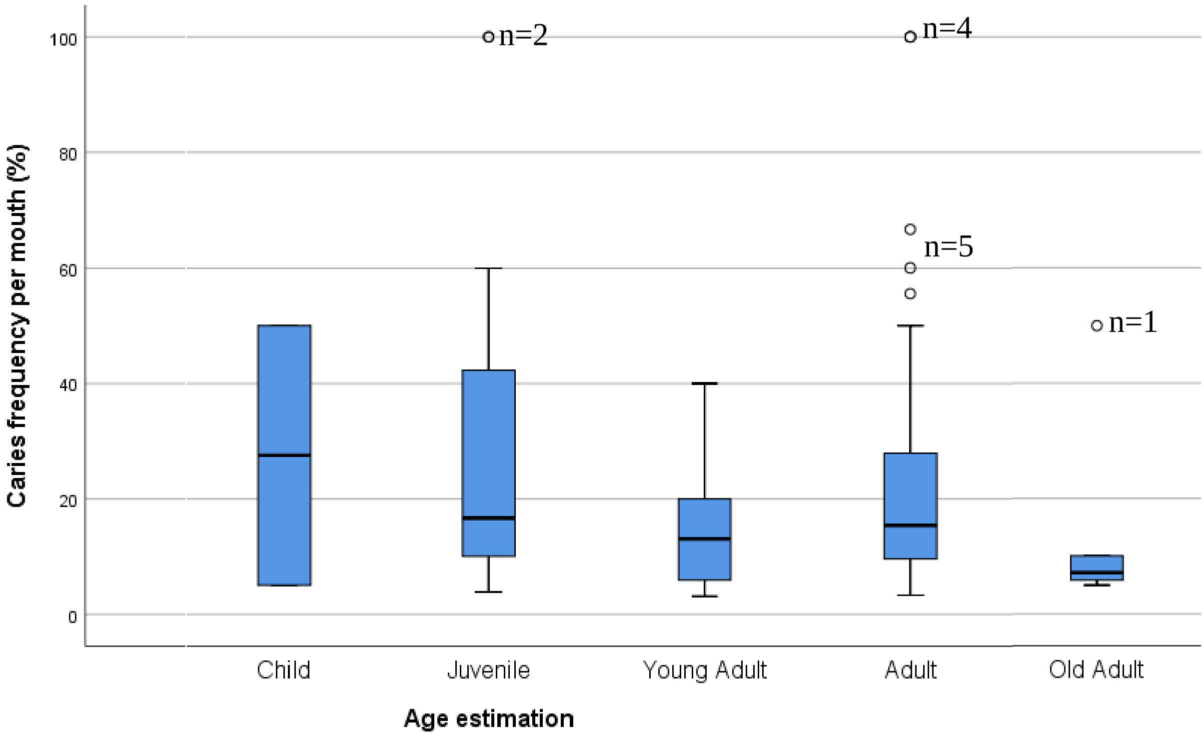


Fig 4.33: Caries frequency per mouth by age estimation.
**n=x denotes the number of outliers*

The majority of individuals for which dental caries were present were adult and young adult estimations making a combined percentage of 76.1% of the sample while only 2 child, 27 juvenile and 7 old adult estimations making up the other 23.9% (Table 4.17). The Kruskal-Wallis test for significance in both caries intensity and frequency per mouth revealed no significant differences within the age categories (Table 4.19). The majority (75th percentile) of individuals in all age groups had less than 50% caries intensity (Fig 4.32) and caries frequency (Fig 4.33).

Table 4.19: Results of non-parametric tests comparing age categories.

Kruskal-Wallis Test for:	Caries intensity per mouth	Caries frequency per mouth
Test statistic (k)	4.922	4.899
Df	4	4
P	0.295	0.298

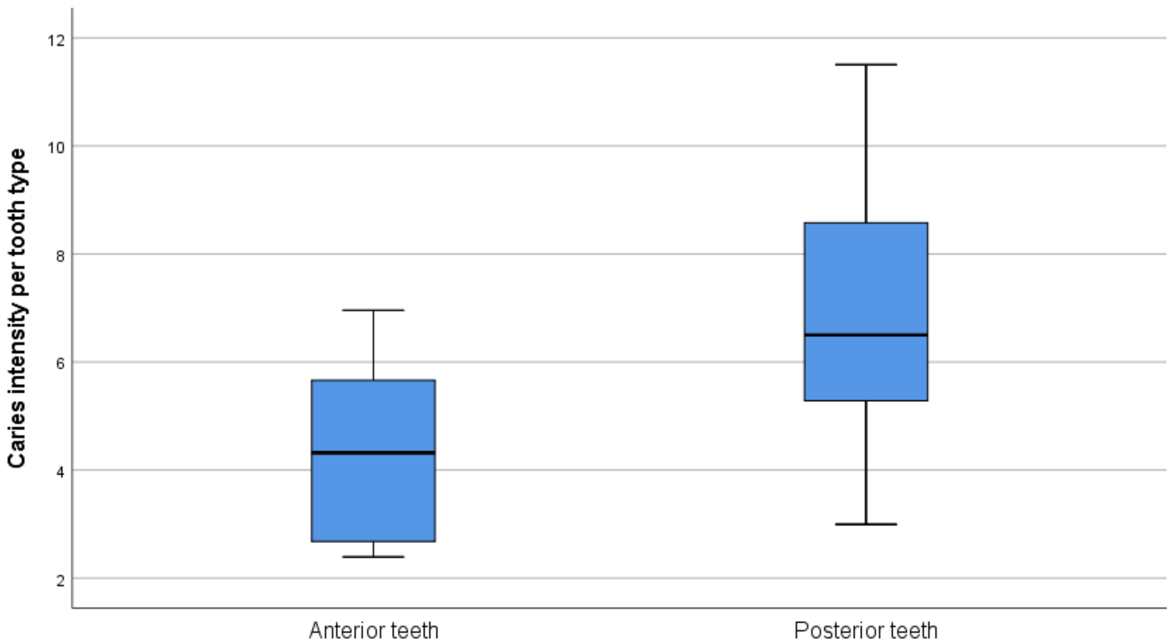


Fig 4.34: Caries intensity per tooth type comparing anterior and posterior teeth.

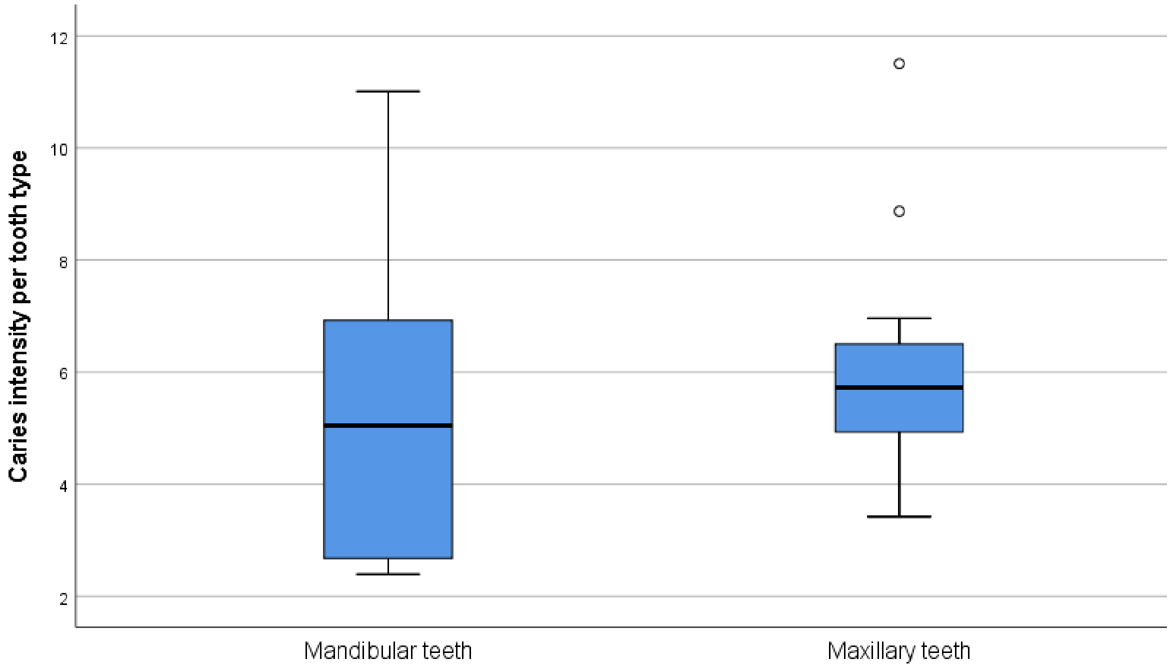


Fig 4.35: Caries intensity per tooth type comparing mandibular and maxillary teeth.

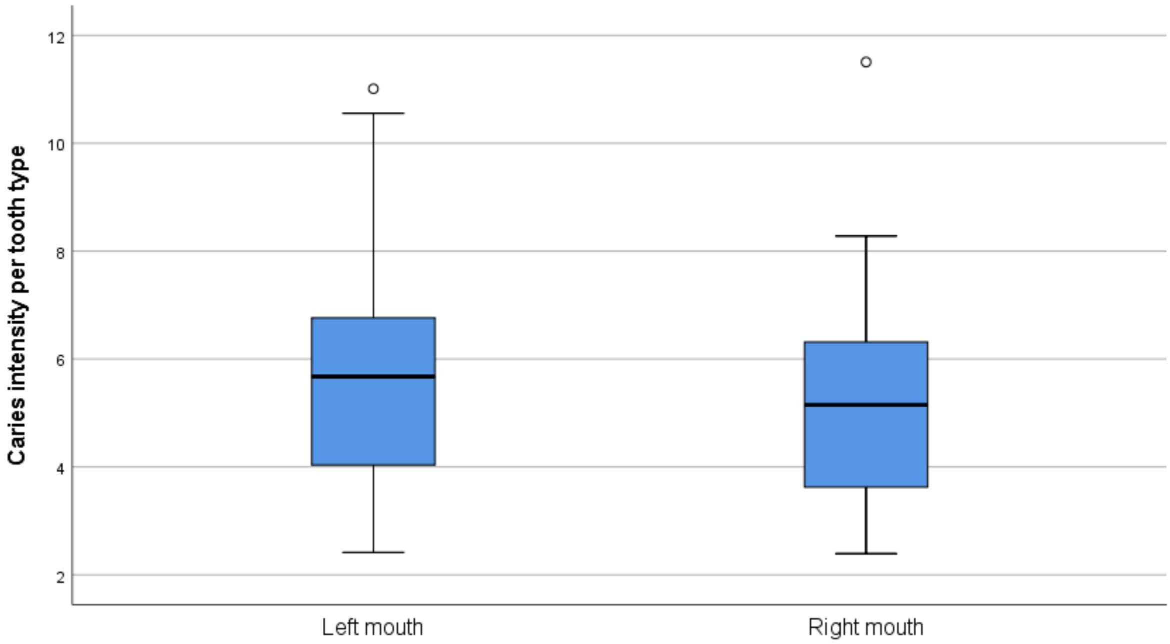


Fig 4.36: Caries intensity per tooth type comparing left and right teeth.

Caries intensity was calculated per tooth type and then compared across different sections of the mouth. The difference in caries intensity between the anterior and posterior teeth of the mouth was significant (p = 0.002) (Table 4.20) with posterior teeth having a greater caries intensity (Fig 4.34). The maxillary teeth had a more concentrated range of caries intensity with a few outliers in the higher percentages while mandibular teeth expressed a greater variety of caries intensity (Fig 4.35). The differences between the left and right mouth (Fig 4.36) were not significant (p = 0.468) (Table 4.20) although the median and range of caries intensity is slightly greater in the left mouth than the right mouth (Fig 4.36). The mandibular and maxillary teeth also did not express a significant difference (p = 0.196) when compared using the Mann-Whitney U-Test (U = 48.00, z = -3.015) (Table 4.20).

Table 4.20: Results of non-parametric tests comparing caries intensity for tooth types in sections of the mouth.

Mann-Whitney U-test	**Anterior vs posterior**	**Mandible vs maxilla**	**Left vs right**
Test statistic (U)	48.00	93.00	108.00
Z statistic	-3.015	-1.319	-0.745
p-value (exact)	**0.002**	0.196	0.468

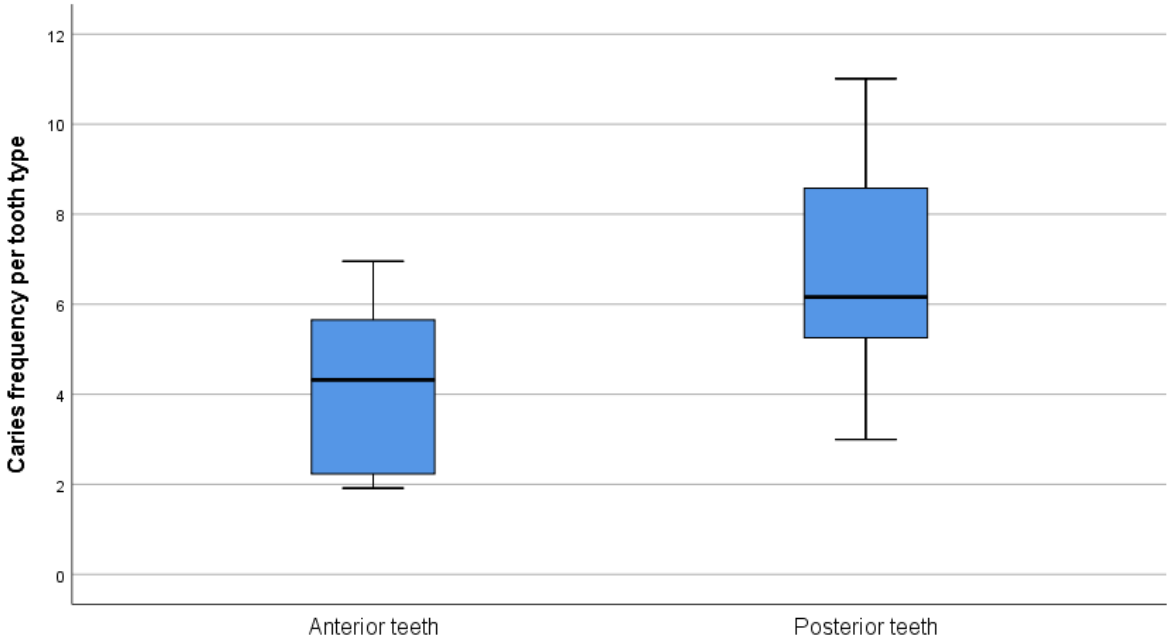


Fig 4.37: Caries frequency per tooth type comparing anterior and posterior teeth.

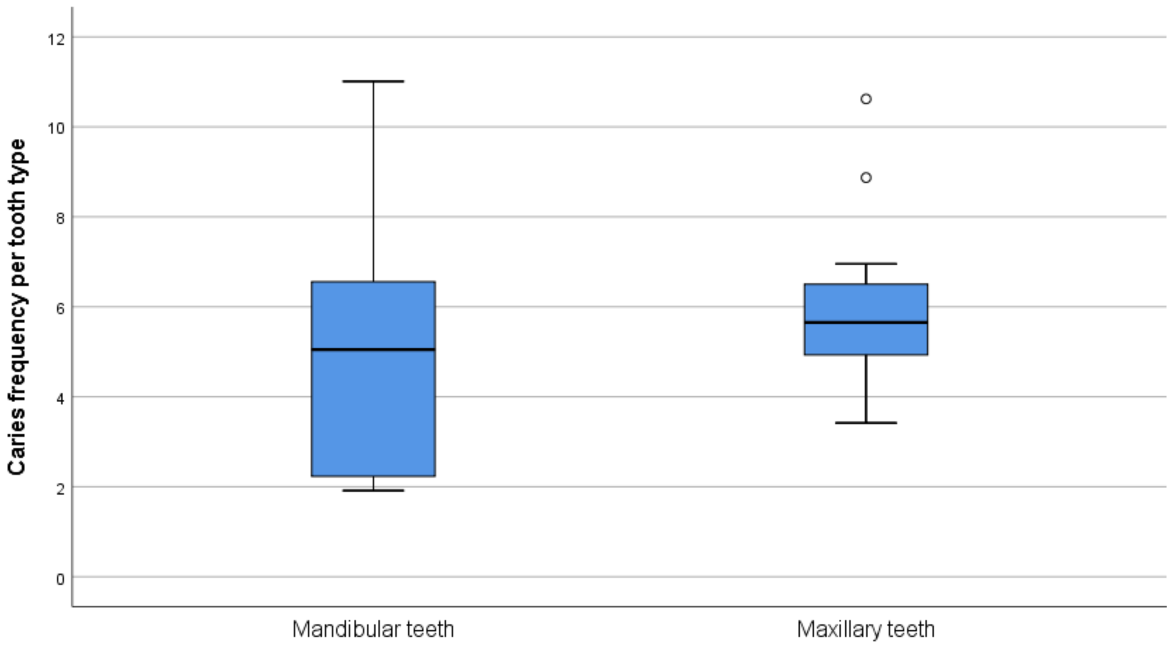


Fig 4.38: Caries frequency per tooth type comparing mandibular and maxillary teeth.

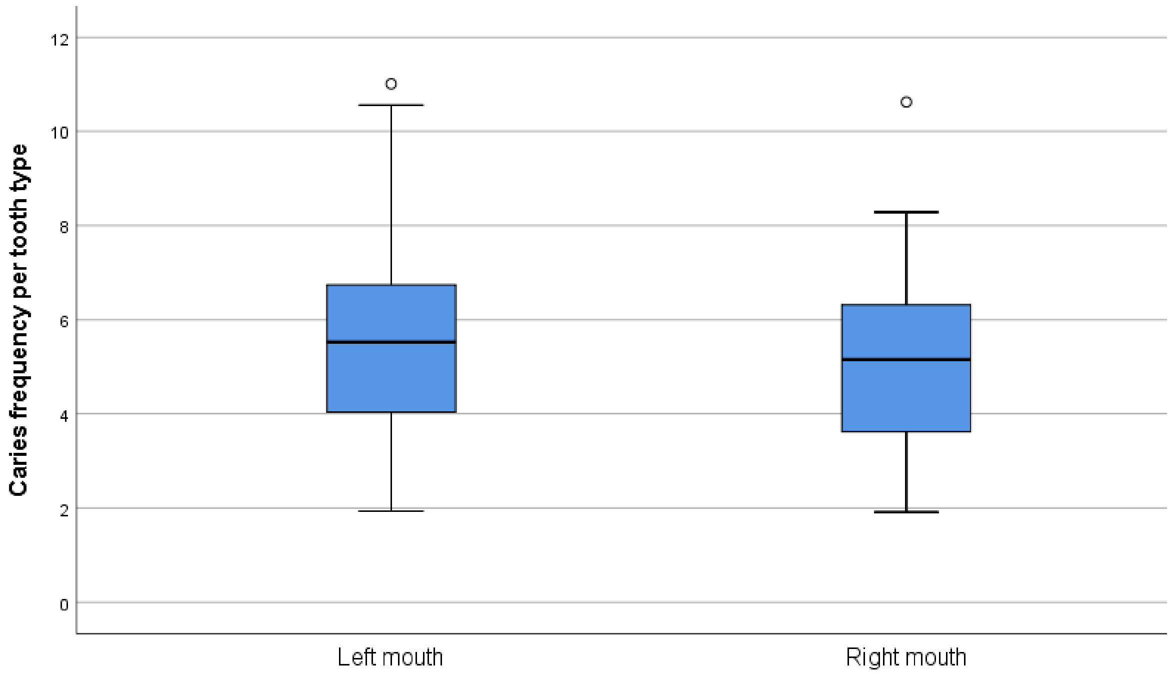


Fig 4.39: Caries frequency per tooth type comparing left and right teeth.

Caries frequency was calculated per tooth type and then compared across different sections of the mouth. The difference in caries frequency between the anterior and posterior teeth of the mouth was significant (p = 0.003) (Table 4.21), with posterior teeth having a greater caries frequency (Fig 4.37). The maxillary teeth had a more concentrated range of caries intensity with a few outliers in the higher percentages while mandibular teeth expressed a greater variety of caries intensity (Fig 4.38). The differences between the left and right mouth (Fig 4.39) were not significant ($p = 0.642$) (Table 4.21). The mandibular and maxillary teeth also did not express a significant difference ($p = 0.196$) when compared using the Mann-Whitney U-Test ($U = 48.00$, $z = -3.015$) (Table 4.21).

Table 4.21: Results of non-parametric tests comparing caries frequency for tooth types in sections of the mouth.

Mann-Whitney U-test	Anterior vs posterior	Mandible vs maxilla	Left vs right
Test statistic (U)	50.00	94.00	115.00
Z statistic	-2.940	-1.281	-0.490
p-value (exact)	**0.003**	0.210	0.642

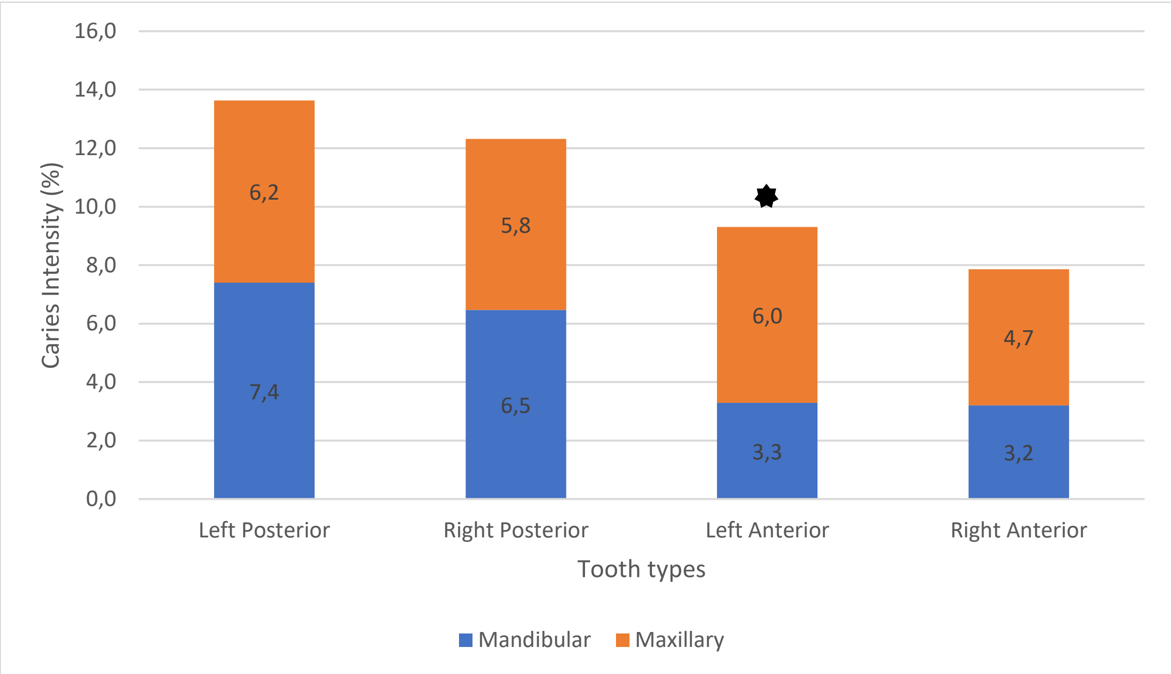


Fig 4.40: Caries intensity per tooth type comparing opposing teeth.
*Key: * denotes significance (p=0.0061)*

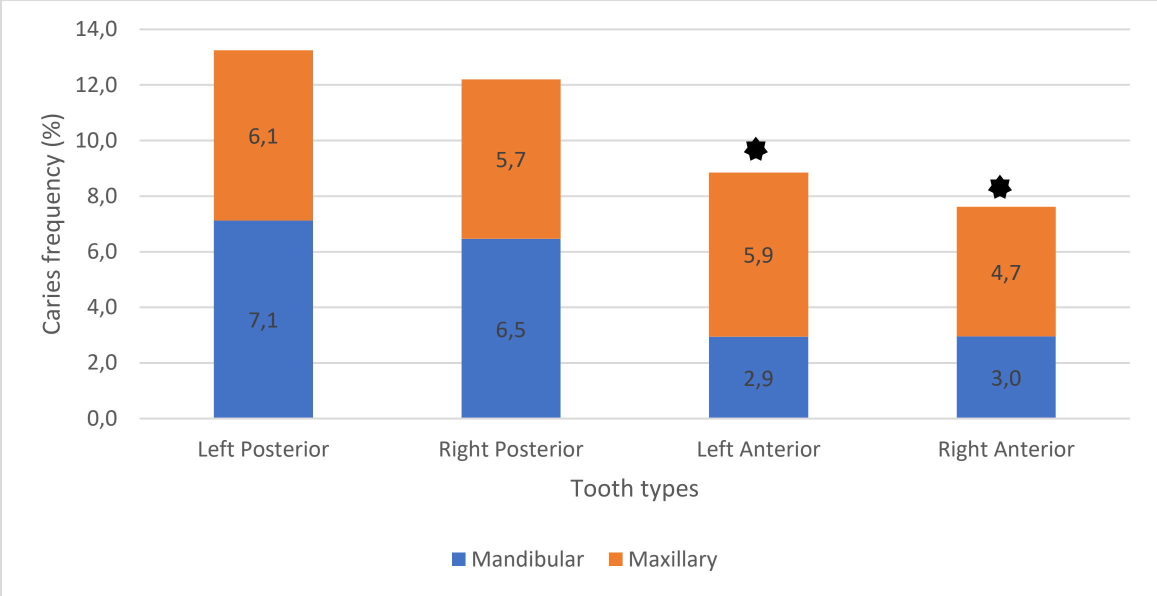


Fig 4.41: Caries frequency per tooth type comparing opposing teeth.
*Key: * denotes significance (p=0.0024 and 0.0455 respectively)*

Caries intensity and frequency in the posterior teeth was greater in the mandibular teeth than the maxillary teeth while the opposite was true for the anterior teeth (Fig 4.40 - 4.41). For caries frequency the difference between the mandibular and maxillary teeth of the left anterior portion was tested significant ($p=0.0061$) (Fig 4.40), while both the left and right anterior teeth tested significant ($p=0.0024$ and 0.0455 respectively) when comparing mandibular to maxillary teeth (Fig 4.41).

4.5.2.4 Dental calculus

Table 4.22: Percentage and count of individuals for which dental calculus was present by sex and age.

			Sex estimation			
			F	M	U	Total
Age estimation	J	Count (n)	3	2	13	18
		% of Total	3.2%	2.1%	13.8%	19.1%
	YA	Count (n)	7	13	10	30
		% of Total	7.4%	13.8%	10.6%	31.9%
	A	Count (n)	7	11	22	40
		% of Total	7.4%	11.7%	23.4%	42.6%
	OA	Count (n)	1	5	0	6
		% of Total	1.1%	5.3%	-	6.4%
Total		Count (n)	18	31	45	94
		% of Total	19.1%	33%	47.9%	100%

Key: M=Male, F=Female, U=Unknown sex, J=Juvenile, A=Adult, YA=Young Adult, OA=Old Adult

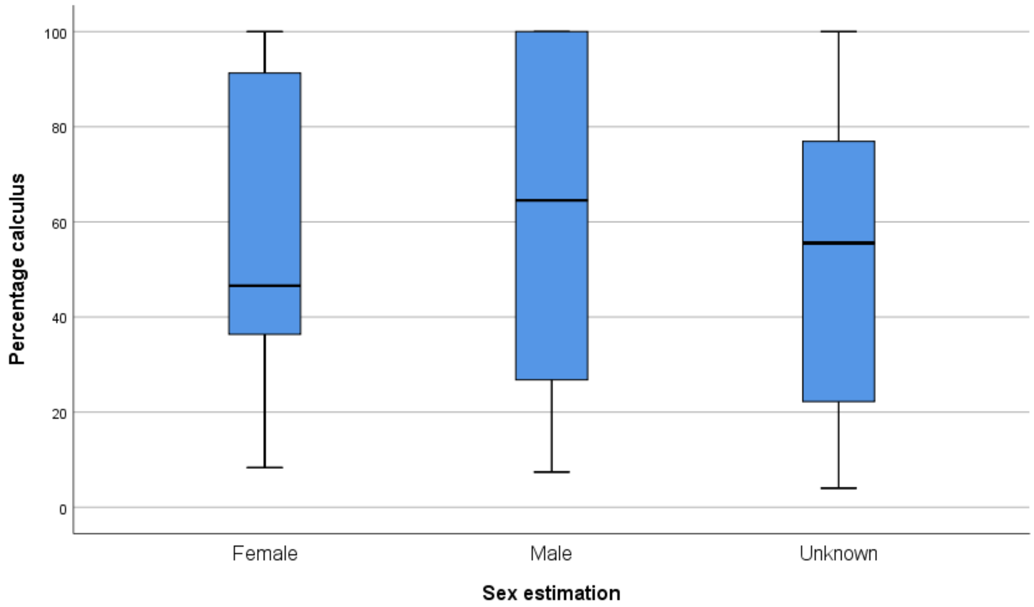
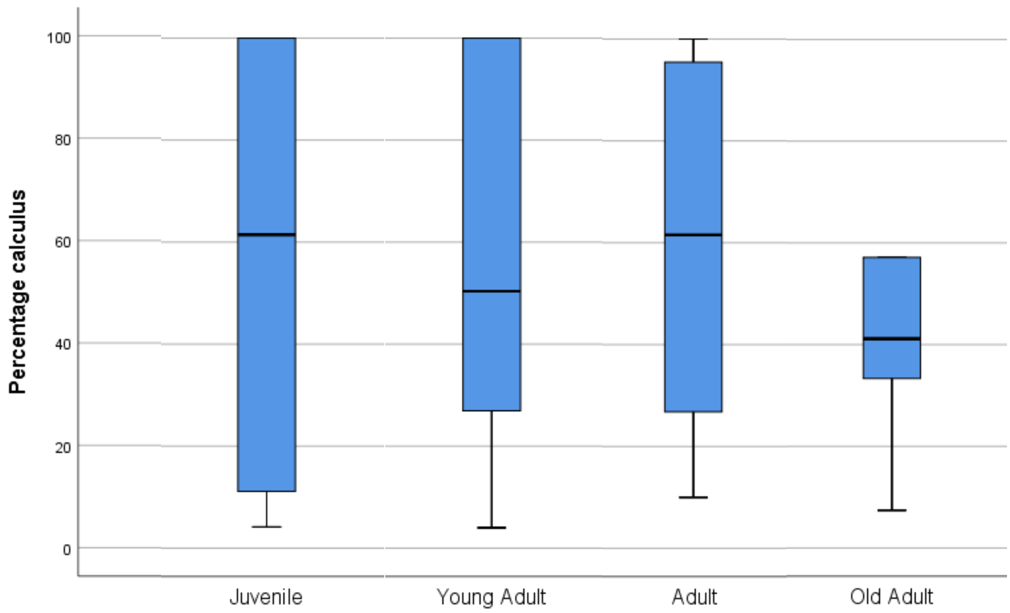


Fig 4.42: Percentage calculus per mouth by sex estimation.

There was a total of 91 individuals for which dental calculus was present, this accounts for 16% of the dental sample (Table 4.14). The majority of those were unknown sex while 19% were female and 33% were male (Table 4.22). The median percentage calculus was higher in males compared to females (Fig 4.42). No significant difference ($p = 0.681$) was found within the sample comparing sex estimations with the Kruskal-Wallis Test ($k = 0.786$, $df = 2$) and thus no further pairwise comparisons were performed.



Age estimation

Fig 4.43: Percentage calculus per mouth by age estimation.

The majority of the sample for dental calculus were estimated adults (42.6%) and young adults (31.9%) with only 6.4% old adults and 19.1% juveniles (Table 4.22). The Kruskal-Wallis Test (k = 1.24, df = 3) showed no significant difference (p = 0.743) within the age groups and thus no further pairwise testing was performed. In the young adult and old adult categories respectively, a greater number of individuals had a percentage calculus higher than the median while in the adult and juvenile categories, the number of individuals were relatively evenly distributed across the median (Fig 4.43).

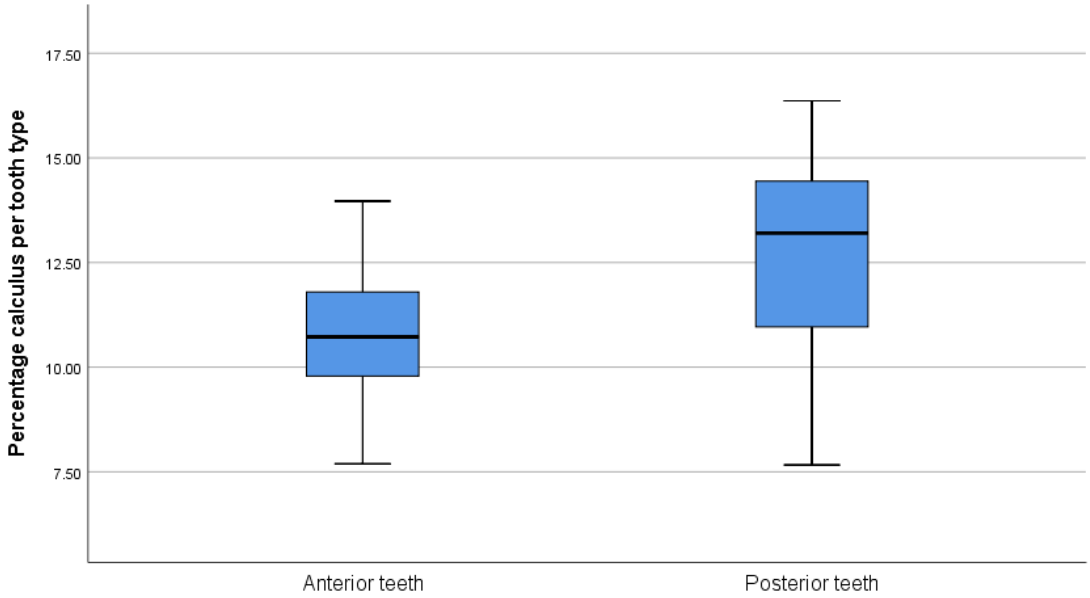


Fig 4.44: Percentage calculus per tooth type comparing anterior and posterior teeth.

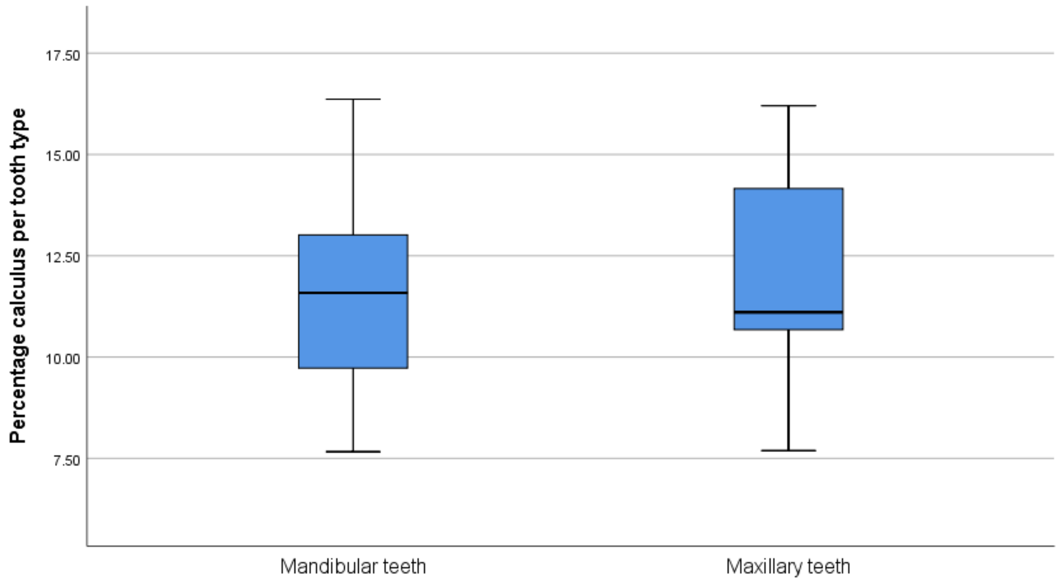


Fig 4.45: Percentage calculus per tooth type comparing mandibular and maxillary teeth.

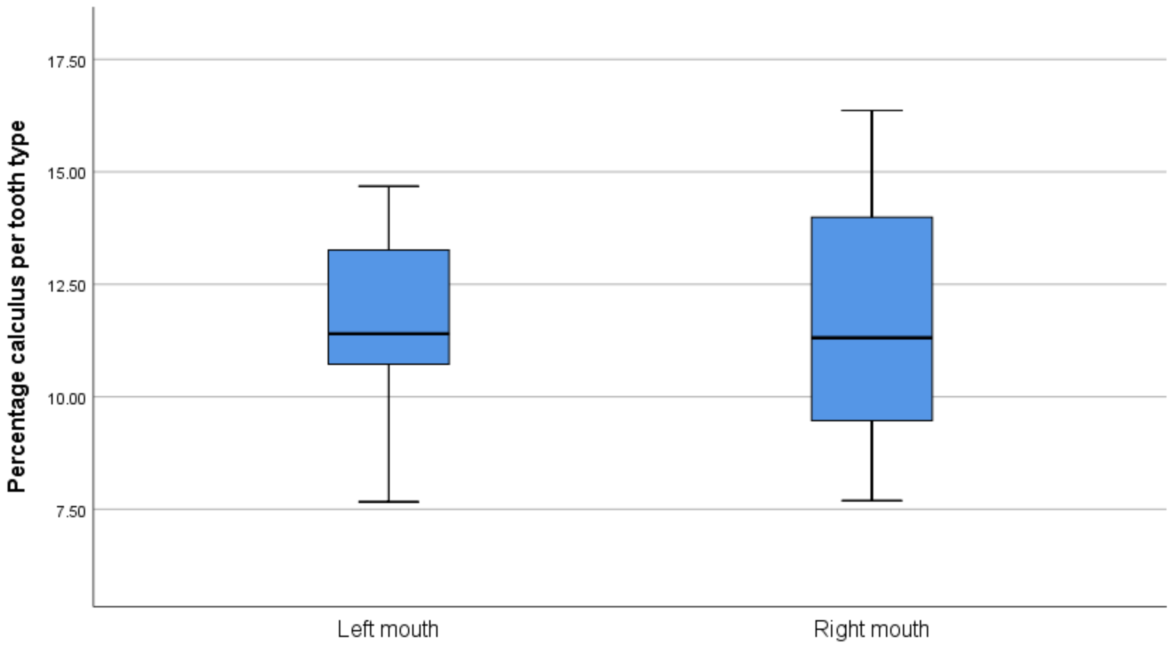


Fig 4.46: Percentage calculus per tooth type comparing left and right teeth.

The percentage calculus was calculated per tooth type accounting for a sample size of 32. The teeth were then categorized according to the position in the mouth in three different grouping variables; anterior vs posterior teeth (Fig 4.44), mandibular vs maxillary teeth (Fig 4.45) and teeth in the left side of the mouth vs those in the right side of the mouth (Fig 4.46). The Mann-Whitney U-Test was performed to compare the difference in percentage calculus for each grouping variable (Table 4.23) and showed that there was a significant difference (Table 4.23) between anterior and posterior teeth ($p = 0.023$) with posterior teeth having a greater percentage calculus (Fig 4.44). The difference between mandibular and maxillary teeth and the left and right teeth of the mouth were not significant (Table 4.23).

Table 4.23: Results of non-parametric tests comparing percentage calculus for tooth types in sections of the mouth.

Mann-Whitney U-test	**Anterior vs posterior**	**Mandible vs maxilla**	**Left vs right**
Test statistic (U)	68.00	123.00	120.00
Z statistic	-2.261	-0.188	-0.302
p-value (exact)	**0.023**	0.867	0.780

4.5.2.5 Enamel hypoplasia

Table 4.24: Percentage and count of individuals for which enamel hypoplasia was present by sex and age.

			Sex estimation			
			F	M	U	Total
Age estimation	Sub-A	Count (n)	0	1	16	17
		% of Total	-	2.5%	40%	42.5%
	AA	Count (n)	3	7	13	23
		% of Total	7.5%	17.5%	32.5%	57.5%
Total		Count (n)	3	8	29	40
		% of Total	7.5%	20%	72.5%	100%

Key: M=Male, F=Female, U=Unknown sex, Sub-A=Sub-Adults, AA=All Adults

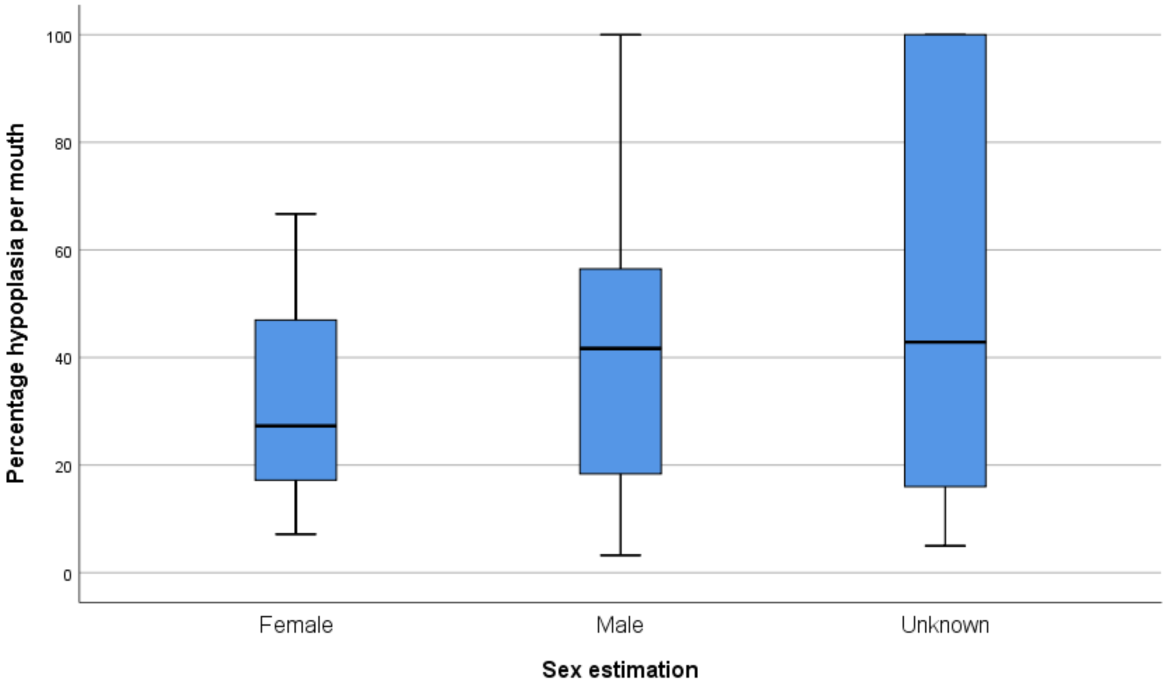


Fig 4.47: Percentage enamel hypoplasia per mouth by sex estimation.

Enamel hypoplasia was present in only 40 individuals and thus only 7% of the dental sample (Table 4.14). Of these, 72.5% were unknown sex, 20% male and 7.5% females (Table 4.24). The Kruskal-Wallis Test (k = 0.687, df = 2) showed that there were no significant differences (p = 0.709) between sex estimations and no further pairwise testing was necessary. The median percentage enamel hypoplasia was higher in males and unknown sex than in females and the greater frequency of individuals in the unknown sex category is greater than the median whereas in the male category the greater frequency is below the median (Fig 4.47).

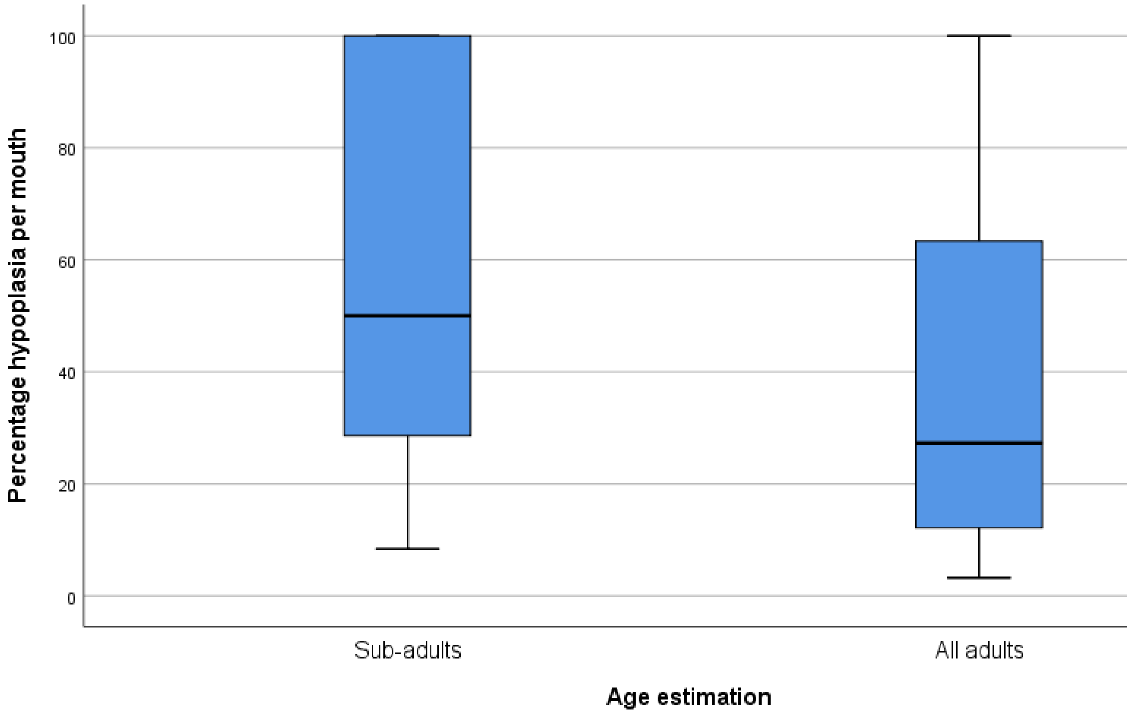


Fig 4.48: Percentage enamel hypoplasia per mouth by age estimation.

Age categories were grouped to form two new categories; all adults being inclusive of young adults, adults and old adults while sub-adults included child and juvenile categories (Fig 4.48). This was done due to small sample sizes within enamel hypoplasia and the new age categories were 42.5% sub-adult and 57.5% all adults (Table 4.24). Significance testing was performed using the Mann-Whitney U-Test ($U = 143.00$, $Z = -1.452$) and showed no significant difference [p (exact) = 0.156] between age categories.

The percentage enamel hypoplasia was calculated per each tooth type accounting for a sample size of 32. The teeth were then categorized according to the position in the mouth in three different grouping variables; anterior vs posterior teeth (Fig 4.49), mandibular vs maxillary teeth (Fig 4.50) and teeth in the left side of the mouth vs those in the right side of the mouth (Fig 4.51). The Mann-Whitney U-Test was performed to compare the difference in percentage enamel hypoplasia for each grouping variable (Table 4.25). It showed that there was a significant difference (Table 4.25) between anterior and posterior teeth ($p = 2.75E-4$) with anterior teeth having a greater percentage enamel hypoplasia (Fig 4.49). The difference between mandibular and maxillary teeth and the left and right teeth of the mouth were not significant (Table 4.25).

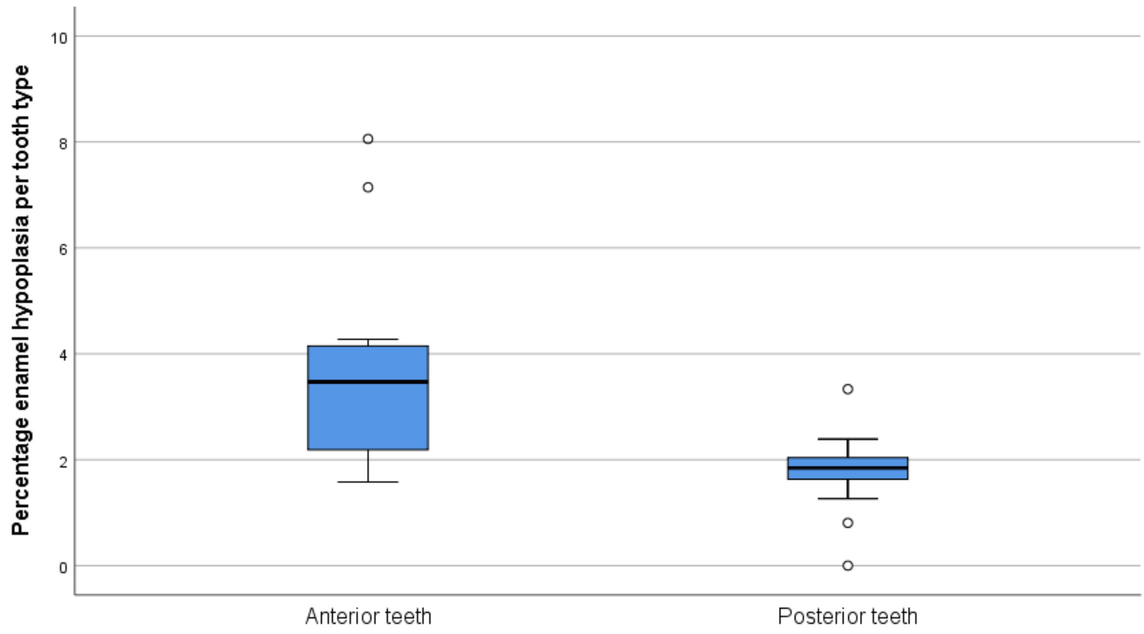


Fig 4.49: Percentage enamel hypoplasia per tooth type comparing anterior and posterior teeth.

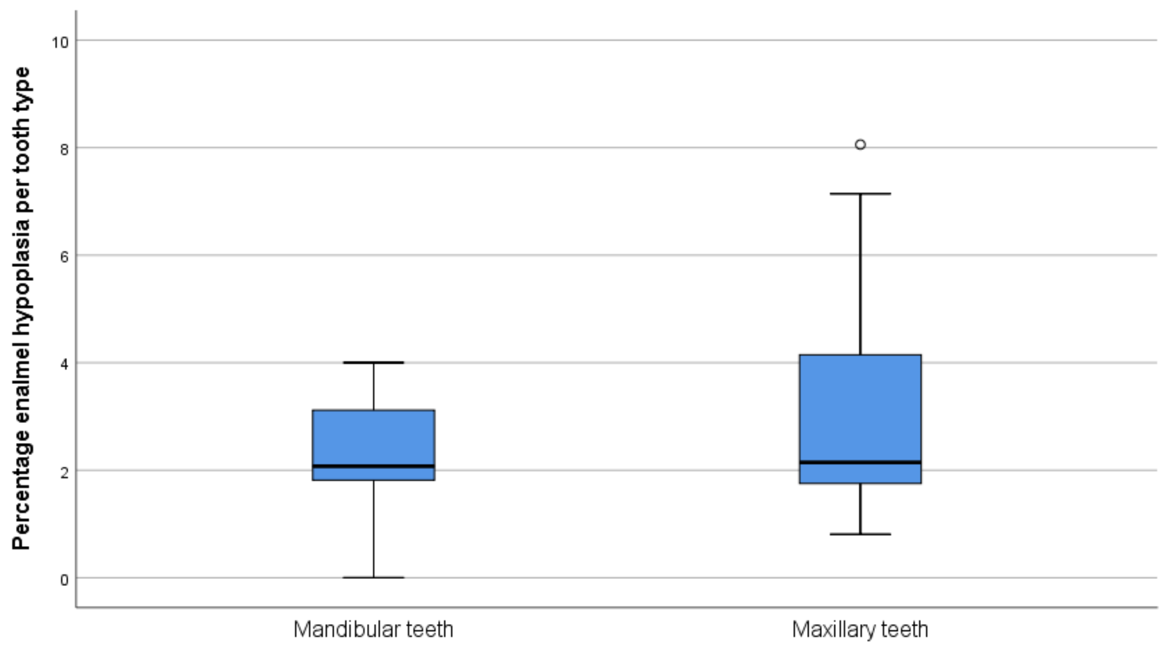


Fig 4.50: Percentage enamel hypoplasia per tooth type comparing mandibular and maxillary teeth.

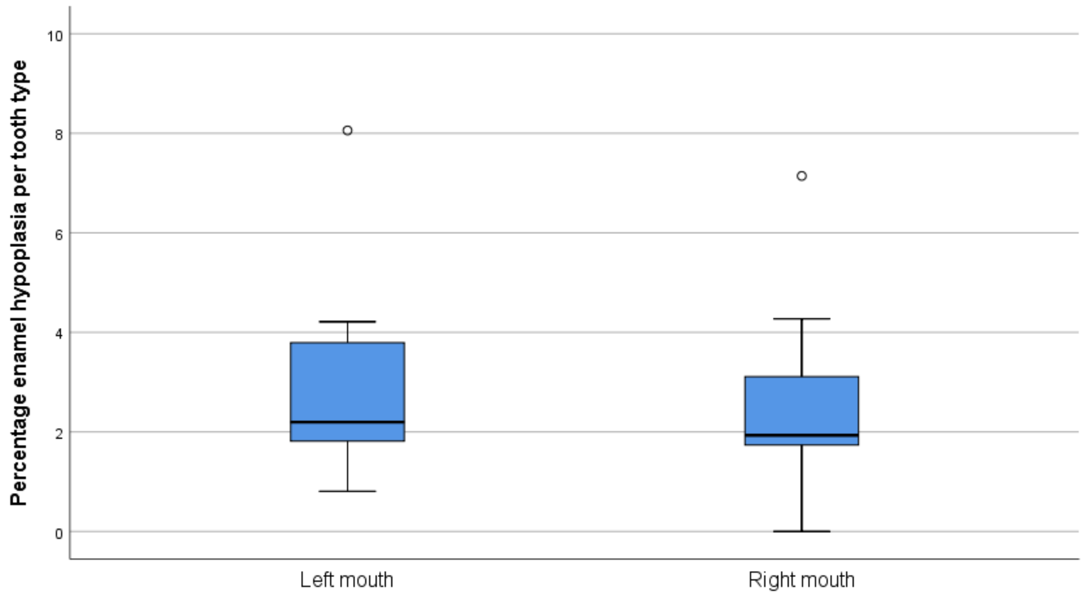


Fig 4.51: Percentage enamel hypoplasia per tooth type comparing left and right teeth.

Table 4.25: Results of non-parametric tests comparing percentage enamel hypoplasia for tooth types in sections of the mouth.

Mann-Whitney U-test	**Anterior vs posterior**	**Mandible vs maxilla**	**Left vs right**
Test statistic (U)	36.00	114.00	104.00
Z statistic	-3.467	-0.528	-0.905
p-value (exact)	**2.75E-4**	0.616	0.381

4.5.2.6 Dental abscess

Table 4.26: Percentage and count of individuals for which enamel hypoplasia was present by sex and age.

			Sex estimation			
			F	M	U	Total
Age estimation	J	Count (n)	0	0	1	1
		% of Total	-	-	10%	10%
	YA	Count (n)	1	3	0	4
		% of Total	10%	30%	-	40%
	A	Count (n)	1	0	2	3
		% of Total	10%	-	20%	30%
	OA	Count (n)	1	1	0	2
		% of Total	10%	10%	-	20%
Total		Count (n)	3	4	3	10
		% of Total	30%	40%	30%	100%

Key: M=Male, F=Female, U=Unknown sex, J=Juvenile, A=Adult, YA=Young Adult, OA=Old Adult

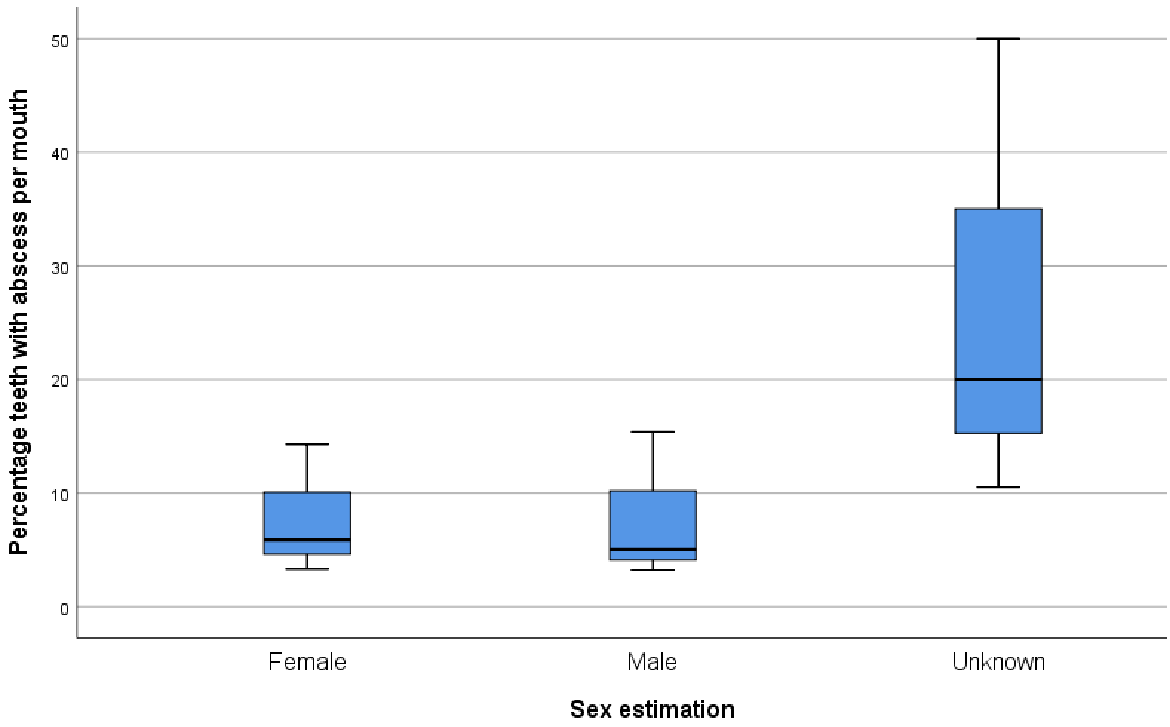


Fig 4.52: Percentage dental abscess per mouth by sex estimation.

Dental abscess' was only present on 10 individuals and thus 0.2% of the dental sample (Table 4.14). There were 40% females, 30% males and 30% unknown sex individuals (Table 4.26). The male and female categories were similarly distributed across the sample while the unknown sex category had a higher median (Fig 4.52). There was no significant difference (p = 0.145) in percentage teeth with dental abscess across the categories according to the Kruskal-Wallis Test (k = 3.86, df = 2).

Sample sizes across the 4 age categories present were very small with 10% juvenile, 30% young adult, 40% adult and 20% old adult (Table 4.26). The Kruskal-Wallis Test applied (k = 4.777, df = 3) showed no significant difference (p = 0.189). The maximum percentage of teeth present affected by dental abscess was 50% in an adult burial with the majority of individuals having 20% or less of their teeth affected by dental abscess (Fig 4.53).

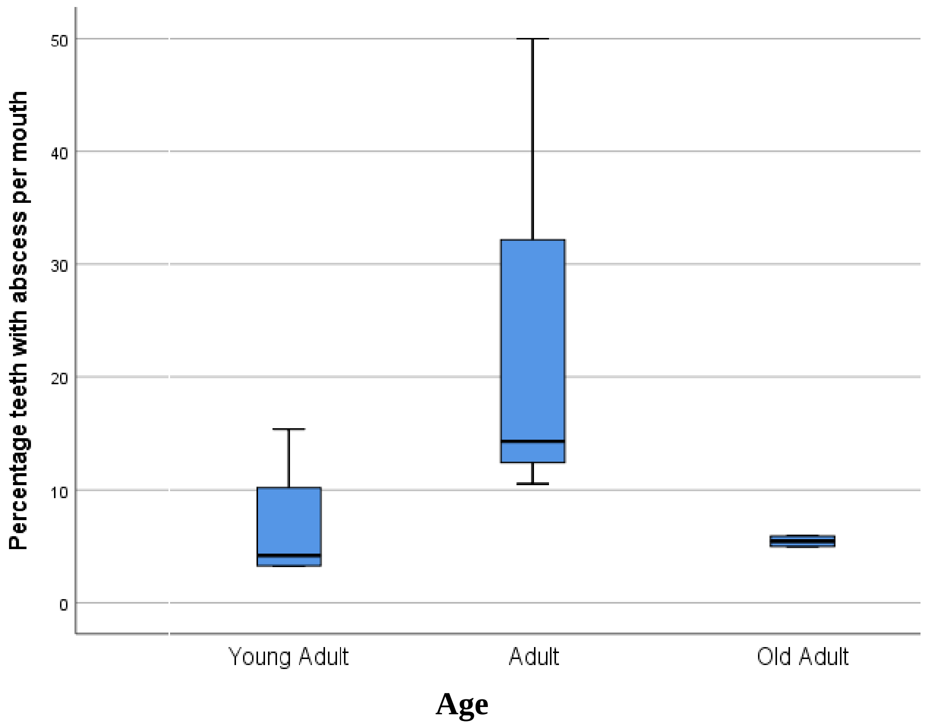


Fig 4.53: Percentage dental abscess per mouth by age estimation.

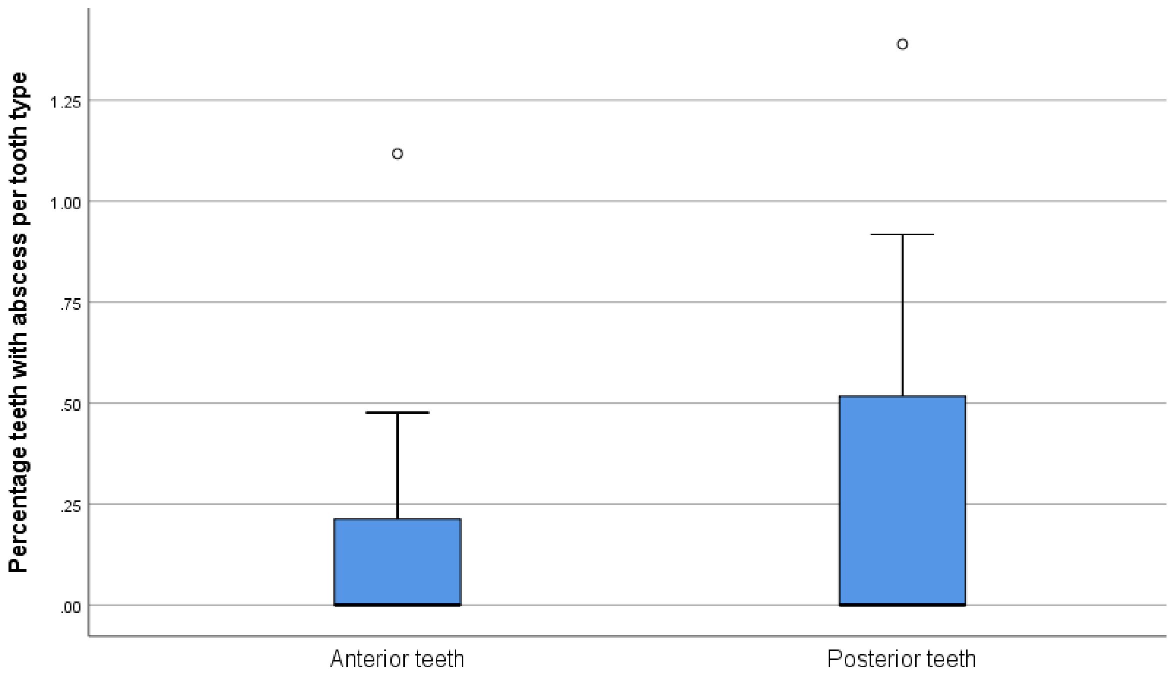


Fig 4.54: Percentage teeth with abscess per tooth type comparing anterior and posterior teeth.

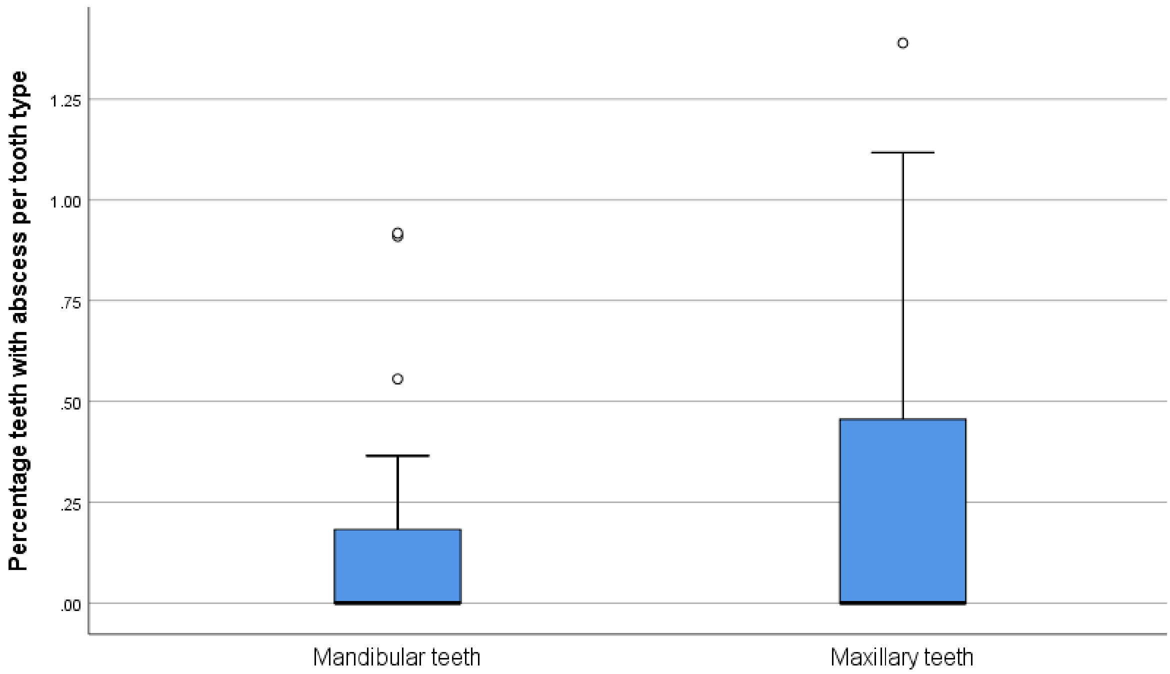


Fig 4.55: Percentage teeth with abscess per tooth type comparing mandibular and maxillary teeth.

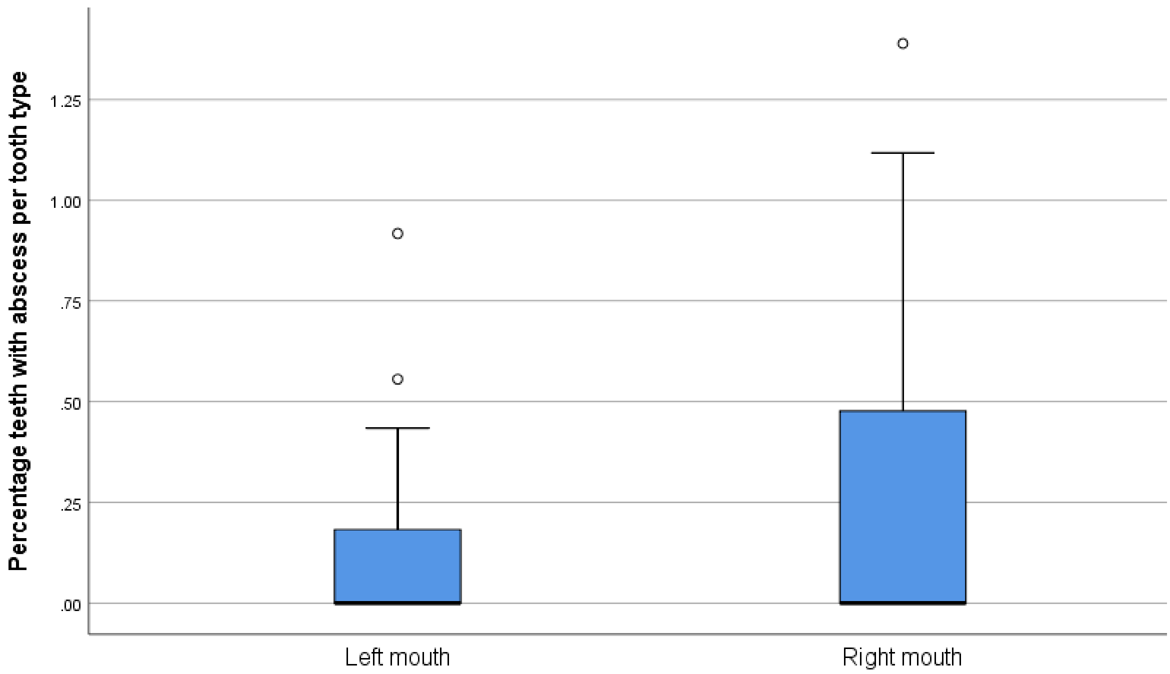


Fig 4.56: Percentage teeth with abscess per tooth type comparing left and right teeth.

The percentage teeth affected by abscess was calculated per each tooth type accounting for a sample size of 32. The teeth were then categorized according to the position in the mouth in three different grouping variables; anterior vs posterior teeth (Fig 4.54), mandibular vs maxillary teeth (Fig 4.55) and teeth in the left side of the mouth vs those in the right side of the mouth (Fig 4.56). The Mann-Whitney U-Test was performed to compare the difference in percentage teeth affected by abscess for each grouping variable (Table 4.27) and showed that there were no significant differences between any of the pairwise comparisons performed.

Table 4.27: Results of non-parametric tests comparing percentage abscess for tooth types in sections of the mouth.

Mann-Whitney U-test	Anterior vs posterior	Mandible vs maxilla	Left vs right
Test statistic (U)	100.00	105.00	101.00
Z statistic	-1.246	-1.023	-1.201
p-value (exact)	0.305	0.402	0.323

4.5.2.7 Other dental pathologies

Other pathologies noted in the sample was pitting on the enamel surface of the teeth in 3 individuals of which 2 were children and 2 young adults presented with impacted teeth (Table 4.28).

Table 4.28: Additional pathological processes recorded on the dentition.

Burial number	Description	Count of individuals n (%)	Sex Ratio (M:F:U)	Age
C49, C171, C218	Pitting/irregular enamel	3 (0.5)	3 U	2:1 (C:A)
C242, D168	Impacted tooth	2 (0.3)	1:1:0	2 YA

Key: M=Male, F=Female, U=Unknown sex, C= Child, A=Adult, YA=Young Adult

4.5.2.8 Dental anomalies

Dental anomalies observed in the sample include unique wear patterns occurring in adult dentition, in 8 individuals this was due to habitual pipe smoking and in 4 individuals it was likely due to the use of teeth as tools (Table 4.29). Supernumerary teeth were observed in 4 individuals and peg teeth in 2 individuals (Table 4.29). Changes to the morphology of the tooth such as shovel-shaped incisors and carabellies cusps were also noted in 6 individuals including juveniles and adults (Table 4.29). Figure 4.57 shows an impacted molar while figure 4.58 shows an example of pipe-smokers wear in the mandibular teeth.

Table 4.29: Dental anomalies observed in the sample.

Burial number	Description	Count of individuals n (%)	Sex Ratio (M:F:U)	Age
A9a, A19, B192, C105, C373b, D8b, D167, D169	Pipe-smokers wear	8 (1.3)	2:1:5	1:6:1 (YA:A:OA)
A211, C67, C191, C296	Unequal wear (tool use)	4 (0.6)	0:1:3	4 A
A7I, B43, C29, D32b	Supernumerary tooth	4 (0.6)	1:2:1	1:1:2 (J:YA:A)
D33, D130	Peg tooth	2 (0.3)	0:0:2	1:1 (C:YA)
A7, B188	Shovel-shaped incisors	2 (0.3)	0:1:1	1:1 (J:A)
B43, C202a, C249b	Carabelli cusp	3 (0.5)	2:0:1	2:1 (J:A)
C270a	Single root on molar	1 (0.2)	1 U	1 A

Key: M=Male, F=Female, U=Unknown sex, C= Child, J=Juvenile, A=Adult, YA=Young Adult, OA=Old Adult

Fig 4.57: D6: impacted maxillary molar (Photographic Source: This Study).

Fig 4.58: B192: pipe smokers wear (Photographic Source: This Study).

Chapter 5 DISCUSSION

Both graphical and statistical information is presented relating to demography, lifestyle and disease for people living at the Cape between the 18th and early 20th centuries to help answer questions set out at the beginning of the study. Each question encompasses a certain aspect of the nature of a bioarchaeological study and its discussion will help to understand the story of the individuals and community of Black River and the surrounding geographic locations.

5.1 Can the death assemblage accumulated over an extended period of time be studied as a homologous group?

A two-fold answer applies – firstly, looking at secular trends over a period of time and secondly, who was buried there and why they were buried there. Secular trends refer to the changes in a population over time with differences in the growth of individuals regarding rate of growth, duration and timing (Uhl, 2013). This can contribute toward our understanding of sexual selection and human variation. One complication to the accomplishment of this goal is ‘demographic non-stationarity’, as described by Wood et al. (1992), that a cemetery sample does not comprise of a stationary population from one moment in time, but rather, individuals spanning many generations that may have experienced changing mortality patterns and lifestyles within the time period when internment occurred. Demographic studies allow us to better understand life history and population history and to understand a story unwritten about the lifestyles of people in the past (eg. Katzenberg and Grauer, 2018). The reconstruction of the demographic profile of an individual and subsequently a group of individuals will help assess the homogeneity of the skeletal sample and the expression of possible secular trends.

5.1.1 Ancestry

Ancestral estimation is used as part of developing a biological profile for an individual and provides more information about the appearances of an individual. An ancestral estimation however, is not a definitive phenotypical description, it is a biological estimate and the methods employed look at variation in shape and size of the skull and facial bones (Hefner, 2009; L’Abbé et al., 2011; Klales and Kenyhercz, 2015). The estimation thus refers to an ancestral origin rather than a phenotypical descriptor. In this study the historical research provides information about the beginnings, ownership and use of the cemetery, and when considered along with the social history of the Cape, the geographical location of the church cemetery suggests that individuals buried at the site would be most likely Black and Coloured individuals of the Anglican faith (Patrick et al., 2019). The results of the ancestral estimation support the history, with the estimation possible for a small sample (n=46) of the site, and the results show that those of European ancestry were in the minority (n=6) with greater African (n=18) and Mixed (n=22) ancestry individuals. When summed, the Mixed and African ancestry categories were significantly greater than the European category (Fig 4.04) suggesting that the cemetery was in use predominantly by non-Europeans although not exclusively.

5.1.2 Stature

Stature is an interesting trait as it is not purely determined by genetic and intrinsic factors but is also affected by extrinsic factors such as nutrition, environment and natural selection (Trotter and Gleser, 1951, 1958; Roser et al., 2019). A poor nutritional quality and quantity would result in a reduced stature in both males and females, thus, a shorter and more sexually homogenous population could be regarded as less healthy (Wolfe and Gray, 1982). When nutrition is good, not only are people generally greater in stature relative to intrinsic factors but there is also a greater degree of sexual dimorphism as males have a larger gain in stature than females (Wolfe and Gray, 1982). It is also possible for changes in stature to occur within a single geographic population over time and could be due to secular trends such as environmental conditions and natural selection over many years, which shape a modern population (Roser et al., 2019).

As nutrition is a strong contributing factor toward stature of an individual, then the means by which food is distributed within a familial or cultural context may contribute towards the growth or lack thereof for certain individuals. Molnar (1999) describes food insecurity in terms of sex in that there is an inequality between men and women amongst cultural patterns and suggests that the disparity may be caused by beliefs that result in men being the more dominant sex, early age of marriage for women, and a lack of investment in education for women. These cultural roles can form the ‘ideas, rituals and rules’ (Bonnekessen, 2010) through which food is distributed and consumed.

The informative step of estimating living stature as a part of creating a biological profile for an individual involves the use of regression formulae applied to measurements of long bones (Lundy and Feldesman, 1987; Feldesman et al., 1990; Wilson and Lundy, 1994; Özaslan et al., 2003). As different methods have inconsistencies, it was decided to limit the analysis to the use of a single method by Feldesman et al., (1990) in which the femoral bones are measured to prevent problems in the data. Living stature was calculated for a small number (n=32) of adult individuals which were then categorised by sex estimations as it is known that average height differs between sexes (Wilson and Lundy, 1994; Feldesman and Fountain, 1996; Dlamini, 2006; Friedling, 2007; Roser et al., 2019). There was a difference of 6cm in the average heights between males and females of the site, but the difference was not deemed significant (p=0.055) through non-parametric testing (Table 4.07). This would suggest that people were somewhat homogenous in stature.

The mean stature for males at the Black River site lies within a mid-range in comparison to statures from other studies and sites (Table 5.01). The site is closest to the more contemporary South African Black population examined by Feldesman and Fountain (1996) and is in fact a higher mean stature than the more contemporary population suggesting a possibly better nutritional health for the historic population. The Black River site males were shorter on average than the historic Marina Residence site individuals but was above the range of San individuals and taller than the earlier Cobern Street individuals (Table 5.01). The females at Black River are taller than both the historic Marina Residence and Cobern street individuals as well as the contemporary statures for South Africans, both White and Black (Table 5.02). This suggests an improved health environment or other changes within the population such as sexual selection. The Black River females are within the upper range of height for San females (Table 5.02).

Table 5.01: Mean stature determined for males of different populations.

Source	**Mean height / range (cm)**	**Reference**
Black River	165.1	This study
White males	157.0	Feldesman and Fountain (1996)
South African black	162.9	Feldesman and Fountain (1996)
Cobern Street	160.0	Friedling (2007)
Marina Residence	168.2	Friedling (2007)
San	144.1 - 164.8	Wilson and Lundy (1994)

Table 5.02: Mean stature determined for females of different populations.

Source	**Mean height / range (cm)**	**Reference**
Black River	159.0	This study
White females	151.9	Feldesman and Fountain (1996)
South African black	154.1	Feldesman and Fountain (1996)
Cobern Street	155.4	Friedling (2007)
Marina Residence	154.1	Friedling (2007)
San	135.6 – 159.4	Wilson and Lundy (1994)

5.1.3 Metopic suture

The metopic suture is the cranial suture that originates at the bregma and extends anteriorly towards the nasal bone along the sagittal plane of the skull and is the adjoining point of the two frontal bones (Guerram et al., 2014). The metopic suture typically reaches full obliteration within the first eight years after birth (Vikram et al., 2014) with one study showing that 100% of individuals in the study older than 9 months had fully-closed metopic sutures (Vu et al., 2001). There have been cases of persistent metopic sutures in later life and even in elderly individuals (da Silva et al., 2013; Vikram et al., 2014). Guerram et al., (2014) found an association between the persistent metopic suture and frontal sinus size, however there is, as yet, no known clinical consequence or physiological disadvantage to either (Shapiro and Schorr, 1980; Blaney, 1990; Guerram et al., 2014).

A metopic suture was found to be present in 6 adult individuals including one old adult from the Black River site (Table 4.08). This amounts to a small percentage of individuals from the site, 4% of those for which it was observable (Table 4.08). However, the poor preservation of the skeletal remains and specifically the crania (Table 4.01 and Fig 3.10) prevented the observation of this trait and it is possible that there was a greater prevalence at the site. A recent study examining metopism in different populations around the world found that the African crania analysed in the study did not exhibit metopism (Zdilla et al., 2018) and the few individuals in this study with persistent metopic sutures suggest that a more in depth study should be done into metopism within African populations. Metopism may have clinical significance as it has been found to be associated with craniofacial defects such as cleft lip, cleft palate and frontal sinus size (Zdilla et al., 2018).

5.1.4 Dental anomalies

The dentition may express a large degree of variation and traits that are seen less frequently. Often individuals express dental anomalies which may range from unusual wear patterns, additional teeth and different shapes of the tooth crown or root structures. These were observed in the sample with the most prominent being 8 individuals, mostly adults (Table 4.29), that presented with a specific wear pattern to the incisors which has been named pipe-smokers wear as it is formed through the consistent use of a clay pipe for smoking that is held between the anterior teeth for long periods of time. Other unusual wear patterns were noted on 4 adult individuals (Table 4.29) and must have been caused by the repetitive use of the teeth on an abrasive object and it is thus possible that individuals were using their teeth as a tool to accomplish a task they were frequently required to do (Molnar, 2011). Another dental anomaly is that of the supernumerary tooth which was recorded in 4 individuals (Table 4.29) and while the aetiology is not fully understood there are two theories, the first is that the supernumerary tooth is formed due to the division of the tooth bud and the second is that the dental lamina has become overactive (Liu, 1995; Garvey et al., 1999). The most common form of a supernumerary tooth is the mesiodens which occurs at the midline of the two central incisors of the maxilla (Garvey et al., 1999).

Other anomalies that were noted relate to differences in the shape of the tooth, where 2 individuals (Table 4.29) had a peg tooth, which may be linked to a genetic dental disturbance (Peck et al., 1996). Shovel-shaped incisors were observed in 2 individuals (Table 4.29). This difference in shape of the incisor crowns is believed to be a genetic, heritable trait and is most common in Asian and Native American populations and generally less prevalent in European and African ancestral lines (Kimura et al., 2009). The Carabelli cusp trait is formed when there is an additional enamel knot present on the molar surface and has been shown to be more likely to be expressed on a larger tooth (Kondo and Townsend, 2006). In the dental sample, 3 individuals were recorded to have the Carabelli cusp present (Table 4.29). In addition, individual C270a had a molar tooth which only had one root (Table 4.29).

While these do provide some information on the lives lived, it is limited in that the skeletal sample only speaks to the individuals who died at those ages at a specific moment in time and as such does not speak to an overall population (Wood et al., 1992). It cannot be assumed that the skeletons in the graveyard were made up of one population over a small number of generations as the cemetery received burials from 1867 until 1952, a period of 85 years. This means that although, for example, old adults are categorised together, one individual may have died as an old adult and been buried in 1867 while another old adult died and was buried in 1938 may have lived in different era's and are not necessarily comparable in their lived experiences. The historical and reconstructed burial registers are unable to provide accurate data, on an individual level, for the corresponding name and burial and thus the sample is treated as a community of people spanning many generations living in a geographic location rather than a specified population.

5.2 Is there a differential mortality rate between males and females?

The ratio of sexes within a burial site is a point of interest as it speaks to the mortality rates over the period of time and whether there may have been an anthropological reason for a skewed ratio favouring one or the other sex. Reasons for a skew in the sex ratio at a burial site may include environment, fertility, health, stressors and division of labour (Kruger and Nesse, 2004). Sex selection through selective-abortion and discriminatory health care towards a specific sex has been documented in parts of the world where specifically, male births were preferred for cultural reasons which thus tends toward a higher mortality of young females (Hesketh and Xing, 2006). At Black River Cemetery, the people historically did experience a division of labour with the men engaged more in work outside the home within wage labour, industry, commerce and maintenance, while women were restricted to textiles and domestic service within the home (Boddington, 1984). Throughout the period that Black River Cemetery was open there were also changes in the ratio of men to women according to census reports which showed a greater number of men present in the Cape Colony by 1904 following the Boer War (Worden et al., 1998). Another factor affecting the sex ratio would be migrant work opportunities that see the men travel for long periods of time to work away from home. Such opportunities arose at the Cape with diamond and gold mining occurring further north as well as the First and Second World Wars which saw men volunteer and join the fighting forces (Bickford Smith et al., 1999; Cleveland, 2014).

A standard sex ratio for what is considered normal for grave sites was determined to be 1:1 through the study of anthropological data on mortality rates from both demographic models as well as modern and historical data sets and living and skeletal populations by Weiss (1973). By comparison, the sex ratio calculated for all ages across the Black River data set was 1.2 : 1 for males versus females (Table 4.05) suggesting a greater mortality rate for men in the area over the period or within periods of time when the cemetery was open. When the sex ratio was calculated separately for each age group; the results showed a higher number of men than women in all the adult age groups with only the juvenile age group having a ratio of 1 : 3 skewed toward females (Table 4.05). A possible reason for the shift from the trend with the juvenile age group is that sex estimation is not reliable within juvenile individuals as the hormones that drive sexual dimorphism may not have been present in great volumes or alternately, for a period long enough for the effect to be translated to the skeleton. Since the primary hormonal driver of sexual dimorphism is testosterone in males, it follows that an incorrect estimation of female is possible when sexing juvenile remains (Scheuer and Black, 2004; Vlak et al., 2008; Komar and Buikstra, 2009).

The Black River data suggests a greater mortality risk in males than females living at the Cape Colony in the late 18th and early 19th centuries. Historical research suggests a possible cause may have been due to the division of labour, men may have had work that took a greater toll on their health and bodies which could weaken their system to disease. Working environment may have contributed likewise, while women were often confined to homes and sometimes textile factories (Boddington, 1984; Worden et al., 1998), men were often engaged in more high risk environments, both through exposure to the natural elements being outdoors, as well as to animals infected by or carrying disease vectors, bacteria *Yersinia pestis* (World Health Organization, 2020), such as the rats at the docks that claimed the first victims of the bubonic plague in the men working there (James, 1978). The type of work would also contribute to mortality risk; with physical, heavy weight or construction related jobs bringing a higher risk of physical injury than working within homes (Bickford Smith et al., 1999). Nutrition is also a key factor in the overall health of an individual and both malnutrition and undernutrition will weaken the body and its immune system making a person more susceptible to disease and infection (Buzon, 2006). Due to the socioeconomic environment and a poorly administrated city, the diet of those living in the Black River community and the other suburbs that the cemetery served was likely not high in nutritional value and families may often have experienced lack which would make them more vulnerable to the bacterial and viral attacks on the city.

Table 5.03: Sex ratios of burial sites in South Africa.

Excavation Site	Sex ratio M:F	Source
Black River	1.2 : 1	This study (Table 4.05)
Marina Residence	2.6 : 1	(Friedling, 2007)
Cobern Street	1.4 : 1	(Friedling, 2007)

The Marina Residence and Cobern Street sites provide an agreeable comparison anthropologically as the sites are both from the Cape and the 18th and 19th centuries (Friedling, 2007). The Cobern Street site consisted of 123 individuals dating from 1755 - 1797 while Marina Residence comprised 81 individuals (Friedling, 2007). These sites have sex distributions with greater skew towards males than the Black River site, with the Cobern Street ratio more similar than the Marina Residence site ratio (Table 5.03). This may be due to the influence of slavery on morbidity at the times of those burials.

5.3 Did the acute epidemic diseases in the period that the Black River Cemetery was operational lead to a higher mortality rate in specific age ranges?

The expectation for the distribution of ages within a formal burial site would be that it would match a typical mortality rate within a population. Mortality and morbidity rates do however depend greatly on the population in question and the challenges faced by individuals and age categories of people as a whole (Weiss, 1973). The history of the Cape through the duration in which Black River Cemetery was open for burials saw a great number of challenges that would likely affect the mortality rates with regard to age groups such as disease, epidemics, wars and poor access to knowledge of health care (James, 1978; Phillips, 1984; Naude, 1987; Worden et al., 1998; Bickford Smith et al., 1999). The expectations going into the excavation of this site was that there would be a high number of infant, child and juvenile burials at this cemetery, due in particular to the Spanish influenza epidemic of 1918 highlighted in the reconstructed burial records researched prior to the excavation (Patrick et al., 2019). The distribution of age in the early 20th century at the Cape was skewed toward young adults as Worden et al., (1998) reported that 45% of the Cape population was between 15 – 39 years of age.

Through the study of several mortality profile data sets, Weiss (1973) determined a normal mortality profile for age categories indicating a distribution of 20% infant and juvenile mortality, 14% sub-adult mortality, 16% young adult and 45% older adult mortality. While the aging techniques employed for the site were often hindered by poor preservation (Table 4.06) the adult category is the greatest and was not able to be further subdivided into young and old adults in many cases, a look at the percentages relevant to the Weiss (1973) categories shows some difference to the normal pattern. When infant and child percentages are combined, they form 32% of the site (Fig 4.06), a mortality which is greater than the 20% determined as normal by Weiss (1973). The juvenile percentage is similar differing by only 1% (Fig 4.06) to Weiss's (1973) normal sub-adult mortality and the young adult normal pattern of 16% (Weiss, 1973) is slightly higher than the Black River 10% young adult mortality (Fig 4.06). The older adults at Black River only formed 3% (Fig 4.06), which is a vast decrease from Weiss's (1973) 45% older adult mortality. While this comparison is not ideal due to differing age categories and a decreased ability to estimate age at death among the Black River sample, it does suggest that there is indeed a greater than normal expectation of infant and child burials and potentially a less than normal percentage of older adults at the site.

A high number of sub-adult graves and a lower number of older adults in the sample speaks to the survivability at the time and suggests that it was not an easy task to live long enough to reach adulthood during this period. It may be suggested that a healthy living population would see a greater percentage of older adults in a grave site, as the populace were physically strong enough to live through many years, while the converse suggests a harsh environment and potentially poor general health resulting in high numbers of youth succumbing and not being healthy enough to overcome the physical stressors of their environment (Wood et al., 1992). The ratio of young adults to old adults for the site shows a significantly greater number of young adults with a ratio of 3.7 : 1 (Table 4.06), supporting the likelihood of greater youth mortality. This appears to be a possibility for the people of Black River, where history indicates a lifestyle of repetitive hard labour, poor sanitation and living conditions, little access to proper medical care and low-income homes unable to do without a days' wage in order to properly rest and allow the body to fight infection (Phillips, 2018). Within the Black River site, ratios of ages were calculated by comparing the different categories. When each sub-adult age category (baby, child and juvenile) were compared to the sum of adult categories (young adult, adult and old adult) both individually and as a combined sub-adult age category, the number of adults remained significantly higher in ratio (Table 4.06).

5.4 What may be inferred about the lifestyles and health of those people living at the Cape in the late 19th and early 20th centuries?

5.4.1 Evidence discussed from the skeleton

When discussing the health of historic populations from a bioarchaeological perspective an important item to address is that of the osteological paradox and its applications to interpretation conclusions of an individual's health. The osteological paradox argues for alternate routes of interpretation of skeletal data. One of the arguments is 'selective mortality' which suggests that the presence of skeletal and pathology markers may not indicate an unhealthy individual but rather someone who was physically strong enough to withstand the pathological load and live long enough that the stress could be transferred to the bone through the lengthy process of bone remodelling (Wood et al., 1992; Wright and Yoder, 2003; DeWitte and Stojanowski, 2015). Another argument from the osteological paradox is 'differential fragility' which considers the fact that people, through varying mechanisms, be it genetic or immunological, do not have equal capability to withstand physical stress from disease and the environment (Wood et al., 1992; Wright and Yoder, 2003; DeWitte and Stojanowski, 2015).

Through this interpretation it could be suggested that the old individuals in the sample, although they may express skeletal stress markers, may have been the stronger and healthier individuals within their respective communities as they were able to live through the stressor's causative of the visible skeletal markers. For this reason, it is important to take a biocultural approach (Goodman et al., 1988) to interpreting the results of the skeletal analysis through coupling the information of the results with historical knowledge and research from a social perspective for the time period in question.

5.4.1.1 Trauma

One way to understanding the overall population health and social interactions that may have occurred in a historical population is through studying the trauma frequencies as it pertains to the skeleton (Kroman and Symes, 2013). In the bioarchaeological context, the scarring and fracture patterns are the only identifiers from which to diagnose a trauma and the potential context or outcome thereof (Larsen, 2002). Trauma analysis is divided into three broad categories, blunt force trauma, sharp-force trauma and ballistic trauma and the fracture patterns left on the bone are what allows the differentiation to be made (Kroman and Symes, 2013). Trauma patterns may also be classified as ante-mortem, peri-mortem or post-mortem, which provides valuable information on the context of the injury; whether it may have been or contributed towards the cause of death or, whether the individual lived past the incident of injury and how well the injury may have healed (Dirkmaat et al., 2008).

The frequency of observed trauma within the sample was low with the highest percentage for any type of trauma being 2% for ante-mortem fractures to the upper limb (Table 4.12). Males appeared to have a greater number of ante-mortem fractures to different parts of the body than females (Table 4.12) and thus it is possible that occupation may have increased the likelihood of fractures for males as female employment was restricted to the household or textiles (Boddington, 1984). Special mention should be made of individual A1 who had three ante-mortem fractures to the upper limb and two to the lower limb (Table 4.12), which would have had a debilitating recovery process although the remodelling to the bone suggests this individual was strong and healthy enough to survive and heal from the injuries. There were two incidences recorded of sharp force trauma, one to the parietal bone and the other to the femur and both individuals were juvenile females (Table 4.12). The sample size is too small to make inferences on interpersonal violence at a population level, however, the injury's inflicted on these two individuals without evidence of remodelling indicates that they were either the cause of death or occurred around the time of death and thus these two individuals could have been subjected to a violent end to their lives.

Six other individuals, all adults, both male and female, also faced a violent death with three individuals who had blunt force trauma to the cranium and three individuals with ballistic trauma to the cranium (Table 4.12). This evidence does speak to potential violence and social troubles within the populations living over the Black River Cemetery open period, the sample is not sizable enough to speak to specific trends or likelihoods of sex or age vulnerability. The post-mortem trauma recorded, excluding fracturing due to internment and preservation (Fig 3.10), was that of cranial bones being cut due to post-mortem autopsy's that were performed. There were nine individuals for which this was recorded (Table 4.12) and this indicates that the circumstances surrounding the deaths of these individuals were either unknown, abnormal or suspicious, although, during the twentieth century there was a decline in the numbers of autopsies performed due to an increase in medical knowledge and diagnostics (Charlton, 1994).

5.4.1.2 Pathological indicators

The health of an individual could also be assessed through the study of specific skeletal markers and lesions. It is not always possible to precisely diagnose diseases and pathologies from the skeleton, but a physiological response to stress may be visible through non-specific pathological indicators observed in an archaeological or historical context from the bone (Larsen, 2002). These may be depressions or thickening of the bone, lesion formation, porosity of the cortical bone and other diversions from a healthy presentation (Larsen, 2002). Periosteal reactions are among those that are frequently observed in samples around the world and has been correlated to times and areas experiencing increase in population growth and sedentary lifestyles (Larsen, 2002). In this study three specific periosteal reactions were scored for in the sample where possible.

Tibial shaft periostitis refers to the porosity observed predominantly on the anterior shaft of the tibia and is caused by the inflammation of the periosteum surrounding the cortical bone (Mensforth et al., 1978; Larsen, 2002). The inflammation may be as a result of a bacterial infection or by a mechanical blow to the bone itself (Eyre-Brook, 1984). Porotic hyperostosis was observed on the parietal and occipital bones of the cranium and is characterized by a porotic lesion on the outer cortical layer of cranial bones (Mensforth et al., 1978; Stuart-Macadam, 1992). It is believed to be caused by an iron deficiency anaemia due to poor diet or nutritional stress, it has also been suggested that iron deficiency can occur as the body works to adapt to a pathogen load of an environment that is chronic and thus porotic hyperostosis may not simply be an indication of dietary stress but also of pathogen presence (Stuart-Macadam, 1992). Cribra orbitalia is similarly characterized by porosity within the superior internal surface of the orbital socket (Larsen, 2002, 2006) and is mostly understood to be caused by iron deficiency anaemia caused by nutritional stress (Larsen, 2015). Other causes for the iron deficiency may include infections or parasites within the intestinal tract preventing proper nutritional uptake and potentially causing blood loss (Layrisse and Roche, 1964).

Pathological indicators were present in low frequencies in only a small percentage of the individuals for which they could be observed (Table 4.09). The poor preservation and inability to score the lesions may have presented a sample bias which would mean these numbers are not a true representation. On the other hand it is possible that the lack of presentation of periosteal reactions could indicate not a healthy group of individuals, but rather, that the infections acquired by the individuals were fast acting and resulted in death with only a short period of illness in which there would not be time enough for the response of the skeletal system (Wolff, 1892; Wood et al., 1992). This relates once again to the osteological paradox; the individuals without lesions may not have been the physiologically stronger individuals but rather those who succumbed to disease (Wood et al., 1992; DeWitte and Stojanowski, 2015) and also can be linked with the historical research which shows that in the time period for which the cemetery was open for burials, the city suffered from multiple fast acting infectious disease including the bacterial black plague and the viral Spanish influenza (Table 2.03).

Other pathologies that were noted within the sample include osteomalacia in adults known as genu varum and tibia vara in the literature and can be seen in the convex curvature of the femora and tibia and malalignment of the knee joint (Golding and McNeil-Smith, 1963). This condition may be congenial or idiopathic with the idiopathic form being caused by a prolonged deficiency of vitamin D which may occur due to poor diet, lack of sunlight exposure or digestive problems (Golding and McNeil-Smith, 1963; Holick, 2006; Binkley et al., 2007). The condition is characterized into two types, infantile which initiates in the first year of life and the adolescent unilateral type occurring between the ages of six and thirteen years approximately (Golding and McNeil-Smith, 1963). It was noted in five individuals of which two were male and all were adult with one young adult (Table 4.10).

Evidence of osteosarcoma was found in one individual affecting the pelvic bone, femoral head and the bodies of the lumbar vertebrae (Table 4.10). Another observation of the thickening of the cranial bones in fifteen individuals of which the majority were estimated female (Table 4.10). While this abnormal thickening may be indicative of an underlying pathological aetiology, it is not possible to properly identify it.

5.4.1.3 Degenerative joint disease and age-related processes

Degenerative joint disease is also often referred to as osteoarthritis although it has been suggested by Loeser et al., (2012) that this is not accurate as osteoarthritis is not as simple as a process of wear and tear but is better defined as a failure of the joint as an organ (Arden and Nevitt, 2006; Loeser et al., 2012). Osteoarthritis is categorized by the loss of articular cartilage, weakening of the muscles at the joint, inflammation, degeneration of the ligaments, abnormal remodelling of the bone and the growth of osteophytes (Arden and Nevitt, 2006; Loeser et al., 2012). In the bioarchaeological context, the bone is the only remaining evidence on which to determine whether osteoarthritis was present in an individual, and it is thus categorized by the bony outgrowths around the joint and bone resorption within the joint surfaces (Larsen, 2015). The mechanism by which the bone remodels can be attributed to Wolff's law of bone remodelling that states that bone will adapt and remodel in accordance and response to tension and direction of the applied load (Wolff, 1892).

In this study, six joint surfaces were examined for evidence of joint degeneration, including the shoulder, elbow, hip, knee, and the thoracic and lumbar vertebrae (Fig's 4.07 – 4.09) and degenerative joint disease was present at all joints with the greatest frequency in the axial skeleton with the thoracic and lumbar vertebrae having the greatest percentage of the sample affected (Fig 4.07). In addition to this, osteophytic growth was also noted on the cervical vertebrae of 8 individuals (Table 4.11) as well as to the hands and feet of 8 individuals (Table 4.10). There was no evidence for degenerative joint disease at the TMJ noted within the sample. The joints of the upper limb were the least affected within the sample with only 10% of individuals for which analysis was possible having slight degeneration of the elbow joint (Fig 4.07).

A comparison of the sexes clearly demonstrated that males were the most affected by degenerative joint disease at all 6 joints (Fig 4.08) as well as within the cervical vertebrae (Table 4.11). This suggests that there may have been a factor involved causing the increase for males irrespective of age. One such possibility is that the males were engaged in manual labour that required heavy repetitive loading on the back such as lifting and carrying heavy loads resulting in the formation of osteophytes on the vertebrae as the bones’ response to tension (Wolff, 1892) and attempt to bring stabilisation to the joint (van der Kraan and van den Berg, 2007).

Degenerative joint disease was present in all three adult age categories and while it would be expected that there would be higher frequencies within the old adult categories, as increase in age is a risk factor for osteoarthritis (Loeser et al., 2012), the greatest percentage of individuals with degenerative joint disease scored in the sample were within the young adult age category for all six joints (Fig 4.09). This suggests that there was an additional causal factor acting for the people of the time that resulted in the formation of osteophytes and joint degeneration in younger individuals. It should be noted that other causes of osteoarthritis include genetic predisposition, obesity and joint issues, including malalignment and past injuries to the joint (Felson et al., 2000; Blagojevic et al., 2010; Loeser et al., 2012). While a limited skeletal analysis could not determine whether these causes may have contributed to the presence of skeletal osteophytes for individuals in the study, it is possible that they did. Considering the high percentage of young adults with affected joints and the work environments and type of labour that the communities in question were likely engaged in, injury and overuse of the joints is a likely contributor.

In the sample, individuals were also observed with a high degree of ossification and osteophytosis at the joints to the point that the joint had fused and was immobile. This was seen in the xiphisternum, pelvis and in particular the lumbar vertebrae (Table 4.11). In the lumbar vertebrae and axial skeleton, it is possible that the fusion of skeletal elements may be due to pathologies such as ankylosing spondylitis or diffuse idiopathic skeletal hyperostosis (DISH). Ankylosing spondylitis results in fusion of the vertebrae as it is characterized by osteoproliferation and is more common in males, usually presenting at the young adult stage of life (Braun and Sieper, 2007). This may be an explanation as to why the degenerative joint disease results show a higher prevalence in young adults and males although it cannot always be accurately distinguished in the bioarchaeological context. DISH similarly results in immobility of the spine due to fusion of the vertebral bodies, however, it is characterized by the ossification of the spinal ligaments and particularly the anterior longitudinal ligament of the spine (Sarzi-Puttini and Atzeni, 2004). Unlike ankylosing spondylitis, DISH onset is most commonly in older adults and often present alongside osteoarthritis (Sarzi-Puttini and Atzeni, 2004) and may have been present in the Black River sample.

Like degenerative joint disease that can be caused by age, there were other observations on the Black River skeletal sample that may be attributed to age-related processes. Ossification of bone related structures such as ligaments, cartilage, fascial membranes and laryngeal structures can occur with age (İşcan et al., 1984; Işcan et al., 1985; Garvin, 2008). In the sample, individuals were observed to have ossification of the sternal cartilage, thyroid and interosseous membrane with the majority of them being males and of the five individuals with cartilaginous ossification, three were young adults (Table 4.11) which suggests that another process other than age may have contributed to the early ossification of these structures such as injury, and repetitive activities such as hard labour (Holguin et al., 1996; Kircher et al., 2007).

5.4.2 Evidence discussed from dental health

Dental anthropology is a major field within bioarchaeology and is often the focus of forward driving research in improving methods for understanding life history of individuals as well as lifestyles of populations (Trammell and Kroman, 2013). Humans are classified as heterodonts as we have different kinds and shapes of teeth for different purposes (Hammerl, 2013). The four tooth types that make up human dentition are incisors, canines, pre-molars and molars and the typical secondary dentition will have a total of 32 teeth separated into the mandibular and maxillary jaws with a dental formulae of 2123 for each quadrant which means that from anterior, midline of the jaw there will be 2 incisors, 1 canine, 2 pre-molars and 3 molars (Hammerl, 2013). The primary dentition in humans which is replaced later in childhood has a dental formulae of 212 with 2 incisors, 1 canine and 2 molars per quadrant accounting to a total of 20 teeth per mouth (Hammerl, 2013).

Teeth are favoured among anthropologists for multiple reasons. On the one hand the anatomy of the tooth with the heavily mineralized and thus durable outer enamel layer, means that teeth are often better preserved in taphonomic context than other skeletal elements (Trammell and Kroman, 2013). Secondly, teeth are the only part of the skeleton that are directly exposed to the external environment of an individual throughout their lifetime and are intricately related to the diet and thus may record information about the life and environment of people (Trammell and Kroman, 2013).

5.4.2.1 Dental calculus

The formation and retention of dental calculus is one way that the teeth are able to record the external environment. Dental calculus refers to a mineralized dental plaque consisting of both organic and inorganic substrates that adheres to the enamel surface of the tooth and can be examined in the bioarchaeological context (Hillson, 1996; Lieverse, 1999). The calculus is formed when a pellicle is deposited to the tooth by the saliva which is then colonised by bacteria in the oral environment (Mandel, 1986; Lieverse, 1999). The mineralisation that occurs thereafter is what allows the calculus to be preserved in the skeletonised environment (Putschar and Ortner, 1981). The aetiology for the formation and increased likelihood for the development of dental calculus is not fully understood (Lieverse, 1999), however, there are contributing factors believed to increase the severity and formation of dental calculus. The foremost of these is that an alkaline oral environment is a major driver and that diets and food types that increase the overall alkalinity of the saliva are the most likely reasons for differences amongst people (Hillson, 1996; Lieverse, 1999). In this study there was a sample of 94 individuals for which dental calculus was observed (Table 4.22).

Dental calculus percentage was compared between males and females and although the distribution for each sex is slightly different with females having a lower median percentage than males (Fig 4.42), the difference in percentage calculus per mouth was not significantly different ($p = 0.681$). There were a greater number of males in the sample (Table 4.22) which may explain the broader range of percentages and higher frequency of male individuals with 100% of teeth affected (Fig 4.42). Dental calculus was compared across age categories with the highest percentage of affected individuals being adult and young adults (Table 4.22). The comparison between age categories did not produce significant results ($p = 0.743$) and there were not specific trends observed between the age groups with a similar distribution for all categories except old adults who had the lowest median percentage (Table 4.22). The lower number for old adults may be related to ante-mortem tooth loss.

Dental calculus was shown to be present more frequently on the posterior teeth of the mouth than the anterior teeth (Fig 4.44) with testing proving this difference to be significant ($p = 0.023$) (Table 4.23). This is somewhat contradictory to the literature which says that there is a greater abundance of dental calculus on the mandibular incisors which are anterior and also on the first maxillary molars which are posterior (Friskopp, 1983; Lieverse, 1999). Subsequently, the difference between mandibular and maxillary teeth was found to be insignificant ($p = 0.867$)

(Table 4.23) with the maxillary teeth slightly skewed towards a higher percentage of calculus per tooth type although the range for both mandibular and maxillary fall within a range of approximately 10% (Fig 4.45). The final region comparing the left and right of the mouth for tooth types was also not significant (p = 0.780) (Table 4.23) and fell within a very small range of difference (Fig 4.46).

5.4.2.2 Enamel hypoplasia

Enamel hypoplasia is believed to be caused by a disruption in the growth of an individual due to a period of stress, be it nutritional or disease related (Larsen, 2002). This may occur multiple times in an individual and so long as the person is still young, and their teeth are being formed, it is biologically recorded (Larsen, 2002). This defect occurs on the enamel surface of the tooth and is characterized by a thickened band of excess enamel or disruptions to the enamel that has been deposited on the tooth (Larsen, 2002).

The majority of individuals with enamel hypoplasia were of unknown sex (72.5%) which is likely due to the fact that there were high numbers of sub-adults in the sample (Table 4.24) and sex estimation is not always possible or accurate for sub-adult skeletal remains. The male individuals had a greater range of percentage hypoplasia per mouth than the females (Fig 4.47). This suggests that the males may have been more susceptible or under greater stress than females although the difference was not deemed significant (p = 0.709) and the trend may be explained by small sample size and skewed distribution between sexes. The age categories were grouped to form two more inclusive categories, showing a higher prevalence and percentage enamel hypoplasia among sub-adults than the adults (Fig 4.48), although this difference was not proven significant (p = 0.156). Hillson and Bond (1997) argue that the 'defects of enamel hypoplasia can be understood clearly only when examined under a microscope' and thus macroscopically it is not entirely possible to understand the extent of the presence and severity of enamel hypoplasia.

The percentage enamel hypoplasia per tooth type was greater in the anterior teeth of the mouth than the posterior with majority of posterior teeth type affected in less than 2% of the teeth present while the anterior teeth types had majority tooth types between 2 - 4% with some types having up to 8% (Fig 4.49). This difference was shown to be significant (p = 2.75E-4) while the comparisons of the mandibular and maxillary (p = 0.616) as well as the left and right mouth (p = 0.381) were not (Table 4.25). The maxillary teeth showed a broader range but very similar median value to mandibular (Fig 4.50) and the left mouth had a very slightly elevated median and greater skew to a higher percentage than the right mouth (Fig 4.51). The difference seen between anterior and posterior teeth may be related to the timing of tooth formation and eruption, as the anterior teeth erupt before many of the posterior teeth (Buikstra and Ubelaker, 1994) and thus if the growth disruption occurred at a time when posterior teeth had not yet emerged, only the anterior teeth would be affected. A further consideration would be the geometry of the tooth crown and the difference in shape between anterior and posterior teeth as the greater surface area of the molar cusps could result in the defect being narrower than on the incisor and canine cusps for an equally long period of stress (Hillson and Bond, 1997).

5.4.2.3 Dental attrition

Dental attrition can provide information on not only diet but also the alternate, extra masticatory uses of the teeth that individuals may have employed (Larsen, 2002). Teeth have been used historically by people across the world for various purposes, in addition to processing food, they have been used as tools ranging from the softening of animal hides to the use as a weapon through biting an opponent (Molnar, 2011). These activities cause attritional patterns and marks to form on the dental surfaces and the high rate of preservation of enamel within the burial context means that the teeth are more often available for analysis than the rest of the skeleton and thus the understanding and interpretation of dental attrition within a bioarchaeological setting is valuable (Powell, 1985; Walker et al., 1991; Hillson, 1996; Molnar, 2011). Teeth may also present with attritional wear due to culturally specific activities such as intentional alteration/filing of the tooth and habits involved in chewing a rough item or smoking a pipe that cause wear on the teeth over time (Molnar, 2011). While all these activities do contribute to extreme or unique wear patterns, the overall degree of wear is associated with age as mastication does cause wear to the occlusal surface of the tooth and thus wear may be used in context to estimate age (Miles, 1963, 1978; Ortner, 2003). The abrasiveness of the diet and level of processing of the food before consumption will change the degree of wear afflicted on the tooth and thus attrition can speak to the diet of a group of people (Rose et al., 1985).

In this study, dental attrition was scored on a nominal scale and as an overall of the whole mouth or all the teeth available for analysis with a focus on the occlusal surface. The mean occlusal wear for the site was a score of 2 indicating slight to moderate wear (Fig 4.19, 4.21). This suggests that the sample is more reminiscent of an urban or agricultural population as the degree of attrition is fairly low so the diet likely consisted of more finely processed foods rather than what may be found within a hunter gatherer population (Smith, 1984). When a comparison of sexes was performed it showed that there was a significant ($p = 1.06E-04$) difference between the male and female sexes with regard to dental attrition and females scored dental attrition with scores more frequently indicating minimal and slight to moderate wear, while the males more frequently had scores of slight to moderate and heavy or unequal wear (Fig 4.20). Possible reasons for these differences may be that there was a skew toward males within the old adults category within this sample (see Appendix 8). A biological factor that may have an effect is that males have a greater muscle mass and would then then have stronger mastication exhibiting more occlusal abrasion (Yadav, 2011).

Across all age groups from juvenile to old adult, the score with the highest frequency was that of slight to moderate wear, however, there was a trend visible in that there was a decrease in the frequencies of minimal wear scores and an increase in the frequencies of extreme wear scores with an increase in age (Fig 4.21). This trend was also visible in Figure 4.22 as although the mean score in each age group was slight to moderate (score of 2); the juvenile age group data was skewed toward a lower score, the young adults had the broadest range spanning across all scores, adults skewed towards the higher attrition scores, and old adults with the greatest percentage of individuals relative to the other age categories reached a score of 4 indicating extreme wear. The differences between attritional scores for juveniles versus adults and old adults were the only two pairwise comparisons that were significant (Table 4.13) indicating that there was a trend in attrition and increasing age within the sample.

5.4.2.4 Dental caries

Dental caries may provide an indicator not only of lifestyle but also of health as carious lesions untreated may lead to more serious health issues, infection and death (Robertson and Smith, 2009). Dental caries form when the outer enamel layer of the tooth is degraded, and the tooth begins to decay progressing into the deeper layers of the tooth. The decay is caused by a complex interaction between bacteria that produce acid and the fermentation of carbohydrates within the environment of the mouth and saliva (Selwitz et al., 2007). All people are susceptible to the formation of dental caries around the world and at all ages as primary and secondary dentition can be affected (Selwitz et al., 2007). There are risk factors that may increase the probability of being affected by dental caries including high carbohydrate diets, poor oral hygiene, poor salivary flow, insufficient exposure to fluoride and other biological and environmental factors (Selwitz et al., 2007). Dental attrition may also contribute towards the formation of caries as it weakens the enamel surface of the crown (Katzenberg and Grauer, 2018). The frequency and intensity of carious lesions in individuals and in a population can provide data on overall health, dietary composition (Lussi et al., 2004) and can speak to the amount of teeth lost ante-mortem as tooth decay untreated would lead to the loss or extraction of a diseased tooth (Lukacs, 2007). In the study sample, dental caries was observed in the teeth of 151 individuals both male and female and within all age categories except for the baby category (Table 4.17).

Caries intensity and caries frequency were calculated per mouth for each affected individual and when a comparison was done for sex categories there was no significant difference (p = 0.382, 0.388 respectively) (Table 4.18) between males and females. There was a greater number of individuals of unknown sex with carious lesions (Table 4.17) and higher percentages for both caries intensity and frequency. However, no visible trends were seen to differentiate between males and females (Fig's 4.30 and 4.31). This shows that there was no external factor that may have differed between men and women of the time that would contribute to higher or lower rate of tooth decay and men and women were equally likely to suffer from carious lesion formation. There was also no marked difference in the Figures 4.30 and 4.31 that would show that caries intensity and frequency were different. A greater caries intensity with a lower caries frequency would suggest that less individuals in the sample were highly affected by carious lesions while the opposite would show that few individuals were minimally affected by carious lesions. The similarity in the percentages for caries intensity and caries frequency show that individuals that were sampled were similarly affected in the degree of carious lesions which is also evident in the similar trends of Figures 4.32 and 4.33. While no significant difference (p = 0.295, 0.298 respectively) was found among and between age categories for caries intensity or frequency (Table 4.19) the trends observed showed that juveniles had the highest percentages and median within the sample which was followed by the similarly distributed young adults and adults and the old adult category had the lowest median although it was also skewed toward higher percentages reaching 50% along with the other adult categories and with outliers reaching 100% caries intensity and frequency for old adults and juveniles (Fig's 4.32 and 4.33). The frequencies for old adults may be lower due to higher percentages of AMTL in the older adult's category as carious lesions may have precipitated the loss of the tooth but once lost ante-mortem is no longer available for analysis post-mortem. While frequencies may be higher in the younger categories it does not necessarily conclude that older ages were less prone or affected by tooth decay.

The regions of the mouth most affected are also of interest as it may provide more evidence as to the most likely causes of tooth decay in the sample and thus three comparisons were performed for regions of the mouth (Fig's 4.34 – 4.39). Once again there was little change in the trends for caries intensity and caries frequency showing that the numbers of carious lesions were not contributed to by a proportionately small group of tooth types but rather the sample was more equally distributed. The first comparison of tooth types by mouth regions showed that posterior teeth were significantly ($p = 0.002$, 0.003 respectively) more affected than anterior teeth (Fig's 4.34 and 4.37; Tables 4.20 and 4.21). This may be due to the factor of oral hygiene, as posterior teeth may be more difficult to keep clean and free of food particles and it may also be due to increased dental attrition of the posterior teeth due their masticatory functions (Nelson et al., 1999; Lukacs, 2007). While the difference between mandibular and maxillary teeth was not significant ($p = 0.196$, 0.210 respectively) (Tables 4.20 and 4.21), there was a broader range of percentages within the mandibular teeth than the maxillary teeth although the median percentage for maxillary teeth was slightly higher than mandibular (Fig's 4.34 and 4.38). This shows that mandibular teeth were affected at greater varying degrees while the intensity and frequency of carious lesion formation within maxillary teeth was more consistent within a small range with a few outliers (Fig's 4.34 and 4.38). The final mouth regions compared was that of the left and right mouth which showed no varying trends (Fig's 4.36 and 4.39) and was not significantly different when tested ($p = 0.468$, 0.642 respectively) (Tables 4.20 and 4.21).

When the opposing teeth in each mouth quadrant were compared (Fig 4.40 and Fig 4.41), it was evident that in the posterior quadrants, the mandibular teeth are more affected than the maxillary teeth although not deemed significant, while in the anterior quadrants, the maxillary teeth are more greatly effected with caries frequency testing significant ($p=0.0024$ and 0.045) (Fig 4.41). This observation shows that the posterior teeth are not differentially affected according to the jaw, however the maxillary anterior teeth have a higher frequency and intensity of caries than their opposing mandibular teeth. This may be related to uses of the teeth as tools or potentially the susceptibility to trauma (Lukacs, 2007).

Table 5.04: Dental caries presence of different studies.

Excavation Site	No. of individuals with caries	Percentage of dental sample	Source
Black River	151	27	This study
Marina Residence	23	79.3	Friedling (2007)
Cobern Street	31	78.5	Friedling (2007)
Riet River	19	40.9	Morris (1984)
Kakamas	8	18.8	Morris (1984)

The Black River site had the greatest number of individuals with carious lesions present when compared to other sites however as a percentage of the sample size for the study Black River site had small percentage of caries presence (Table 5.04). The Marina Residence and Cobern Street samples had a larger percentage of individuals affected by dental caries (Table 5.04), which suggests there was possibly an improvement in dental health. Both sites pre-date the Black River Cemetery, although they are from similar locations in the Cape. The percentage of individuals with caries at Black River is most similar to that of the Kakamas burials, located along a 35 km stretch of the Orange River, with an 8.2% difference and is also close in percentage to that of Riet River located north of the historic Cape Colony although both these sites had a smaller sample size (Table 5.04) which makes comparisons questionable. The relatively low frequency of dental caries in the Black River sample suggests that the diet may not have been composed mostly of highly processed foods and carbohydrates, a diet of this kind would likely lead to higher frequencies and intensities of carious lesions (Armelagos and Cohen, 1984). However, the apparent socioeconomic status of the people buried at Black River Cemetery and the urban context don’t support this and thus it is possible that the low frequency was due to a high ante-mortem and post-mortem tooth loss which would reduce the record of diseased teeth within the sample.

5.4.2.5 Ante-mortem tooth loss

Ante-mortem tooth loss (AMTL) may provide information on the behaviour, health and diet of a past population or group of people as its causes are diverse and linked to other dental processes (Hillson, 2000). Any processes that causes the tooth to weaken or decay over time may eventually result in the loss of the tooth and thus AMTL may be linked to dental attrition patterns and dental caries frequency. This can be seen in the sample as the number of individuals with caries (151) and the number of individuals with ante-mortem tooth loss (110) are both high relative to other pathologies (Table 4.14). It is likely that dental caries were a major precipitating factor in the subsequent loss of teeth while dental attrition scores were not on average very high (Fig 4.21) making it less likely, in this sample, to have been a significant factor for AMTL. Other factors that may lead to AMTL include intentional extraction for social or cultural reasons, which has been shown to be prevalent at the Cape society dating as far back as 500AD and is still practiced presently (Friedling and Morris, 2007). Loss of teeth may also be accidental through traumatic injury (Lukacs, 2007).

From the dental sample in this study 19% of the individuals had AMTL recorded (Table 4.14). When comparing the sexes, females had a slightly greater number of individuals (Table 4.15) and percentage of teeth lost per mouth (Fig 4.25) than males although this was not shown to be significant ($p = 0.60$). It should be noted that the individuals for which 100% AMTL per mouth was recorded were all either female or a few who were of an unknown sex (Fig 4.25). Although a number of male individuals did come close to 100% tooth loss the majority did not exceed 50% tooth loss per mouth and overall the average tooth loss per mouth did not exceed 25% in any sex category (Fig 4.25). It is most common for females to display greater AMTL than males (Lukacs, 2007). It is unlikely that there was a great difference in the diets between the males and females. A potential cause for the increase in AMTL for women may be in the use of teeth as tools for the kinds of work that men and women were engaged in were different (Boddington, 1984). Lukacs and Largaespada (2006) suggest that a potential cause for the differences in caries frequency and thus AMTL between sexes may be due to hormonal differences and fluctuations related to pregnancy and monthly cycles that affect oral health through the composition and rate of salivary flow.

Through the nature of time and the effect of wear and tear it is expected that there would be a greater frequency of AMTL amongst older adults than younger individuals. This trend was observed in the sample with juveniles having the lowest median percentage (<10%) AMTL per mouth with the median climbing for each ascending age category and the median for old adults reaching above 40% AMTL per mouth (Fig 4.26). Statistical tests did show that there was a difference in the age categories for percentage AMTL per mouth, although the required adjusted significance did not show that difference to be statistically significant ($p = 0.066$). The trends observed still demonstrate that AMTL is related to increase in age and this may be linked to the relationship between dental attrition and age as occlusal wear may be a cause for AMTL through the weakening of the integrity of the tooth.

While AMTL per mouth provides information on the population, it is also of interest which teeth are more greatly affected as this may also speak to potential causes or contributing factors for AMTL. For example the extraction of the anterior central and lateral incisors is a dental modification practiced for social reasons within societies at the Cape (Friedling and Morris, 2005, 2007) and posterior third molars are often intentionally extracted due to becoming impacted (Björk et al., 1956). Posterior teeth are also more difficult to clean and thus are more susceptible to carious lesion formation and the molars, primarily used in mastication, may experience greater degrees of occlusal wear as a result (Nelson et al., 1999). When comparing the anterior and posterior teeth there was shown to be a significant difference ($p = 0.024$) (Table 4.16) in the number of teeth lost ante-mortem with posterior teeth more frequently lost than anterior teeth (Fig 4.27). The reason for this may relate to dental attrition and carious lesion formation which likewise may result in AMTL if left untreated and anterior tooth loss is typically due to accidental trauma which is less frequent while posterior tooth loss is more related to oral hygiene and attrition (Lukacs, 2007). The comparison between the maxillary and mandibular teeth was also significant ($p = 3.3273E\text{-}9$) (Table 4.16) with all tooth types in the mandible being lost ante-mortem in over 5% of the sample and maxillary AMTL per tooth type below 5% (Fig 4.28). There was a similar trend in percentage AMTL when the left and right mouth teeth were compared (Fig 4.29) and the difference was not shown to be significant (Table 4.16).

Table 5.05: AMTL for individuals at different sites.

Excavation Site	No. of individuals with AMTL	Percentage of dental sample	Source
Black River	110	19	This study
Marina Residence	18	58.6	Friedling (2007)
Cobern Street	23	64.3	Friedling (2007)
Riet River	17	35.1	Morris (1984)
Kakamas	7	17.1	Morris (1984)

The Black River sample size for dental analysis was much larger than that of the comparison sites (Table 5.05). However, the percentage of AMTL is relatively low specifically in comparison to the other two historic Cape sites, Marina Residence and Cobern Street that each had percentages in excess of 50% (Table 5.05). As with the percentage of caries for different sites, the Black River sample is most similar to the Kakamas burials with only a 1.9% difference in the percentage AMTL (Table 5.05).

5.4.2.6 Dental abscess

A dental abscess typically forms as a secondary more severe infection following dental caries, dental trauma or other processes that allow infection to enter the root of the tooth such as medical intervention (Robertson and Smith, 2009). The bacterial infection enters the root and pulp chamber of the tooth and degrades the bone (Robertson and Smith, 2009). The infection may spread and become severe to the point of death. Mortality rates due to dental infections reached 10 - 40% at the start of the 20th century according to Bills of Mortality in London (Thomas, 1908). For this reason, it may be suggested that the dental abscess' recorded in this sample may have been the cause or related to the cause of death for those affected individuals.

Dental abscess was found only in 10 individuals (Table 4.26) accounting for a very small percentage (2%) (Table 4.14) of the dental sample. Comparing across both sex and age categories showed no significant difference (p = 0.145, 0.189 respectively) between the categories. The male and female categories had very similar percentages affected (Fig 4.52) and with regard to age, the adult category had greater percentages per mouth than young and old adults (Fig 4.53). Young adults made up the majority of the individuals (Table 4.26) but, they had lower percentage of teeth with dental abscess per mouth (Fig 4.53). When comparing which regions of the mouth were more greatly affected, none of the comparisons were significant (Table 4.27) and the differences (Fig's 4.54 – 4.56) are not significant to note as the sample size was very small (Table 4.26).

5.4.2.7 Other dental pathologies

Other dental pathologies were noted in the sample including 3 individuals with pitting on the tooth surface and irregularities to the enamel (Table 4.28). The pitting may occur as a part of the process related to enamel hypoplasia whereby the enamel formation is disrupted (Hillson and Bond, 1997). In addition to this there were 2 young adult individuals that were recorded to have an impacted tooth (Table 4.28) which is common when the oral space is not large enough to facilitate the normal eruption of the tooth or through other processes and the impacted tooth may cause pain and disruption to the adjacent tooth (Garvey et al., 1999).

Chapter 6: CONCLUSION

The outcomes of this study were successful in describing demography, lifestyle and disease for a group of people living at the Cape between the 18th and 19th centuries through the analysis of the skeletal remains recovered from the Black River Cemetery. A portion of history has been contextualised from the perspective of the physical human skeletal remains and its responses to the external environment.

It was evident that there was poor survivability for individuals within the community as child and juvenile mortality profiles were higher than typically expected, and old adult mortality were lower than typically expected, in a cemetery assemblage. At this site, the poor survivability may be an indicator of the effects of the epidemics and socioeconomic positions of individuals. The sex ratios showed that lifestyles likely had a greater physical stress on men as mortality was skewed toward males. Stature analysis suggested a lower health status and poor nutrition as the results showed a sexually homogenous group of people.

Historical, research suggests a lifestyle of wage labour and physically stressful work coupled with uncertain living arrangements and unsanitary conditions. These stressors were reflected in the skeletal analysis through osteophytic growths, fractures and degenerative joint disease and dental attrition. These were skewed toward males indicating a sexually dimorphic social organisation. Degenerative joint disease was greater in young adults than old adults suggesting a physically stressful lifestyle. There appeared to be a low incidence of interpersonal violence although it was not absent.

Dental analysis showed generally poor oral health that was likely a contributor to cause of death for many individuals. Periosteal reactions were recorded in low frequencies, however, that may be due to a poor health status and weakened immune system for individuals rather than a robust health. Individuals may have succumbed to the fast acting infections quickly and thus lesions and periosteal reactions would not have sufficient time to form on the skeletal material.

While the data set is limited by poor preservation of skeletal specimens and small sample sizes, it acts as a representation of the site. Another limitation was the lack of well-kept burial records, which could have provided a comparative set to confirm the identities of those at each burial and have a reference through which to attest the results of the biological profile derived from the skeletal analysis.

Future studies could include comparative studies between the Black River Cemetery's skeletal assemblage and other historic skeletal samples that are temporally and geographically contemporaneous. A study of this nature will provide a more detailed context of the Black River community and how it may have been similar or dissimilar to other communities. The possible reasons for differences will give greater context to their story and inform on skeletal processes and the effects of socioeconomic influences and post-mortem internment and preservation.

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APPENDICES

Appendix 1: Scoring and descriptions for the assessment of preservation and inventory.

Score	Completeness of skeleton	Condition of the skeletal material
1	Complete skeleton	Highly fragmented
2	Incomplete, with cranial and post-cranial	Fair condition
3	Cranium and/or mandible only	Good condition (most bones complete
4	Post-cranials only	

Appendix 2: Data collection sheet

Cemetery/Site ______________

Skeleton #_________________

Date: ______________________

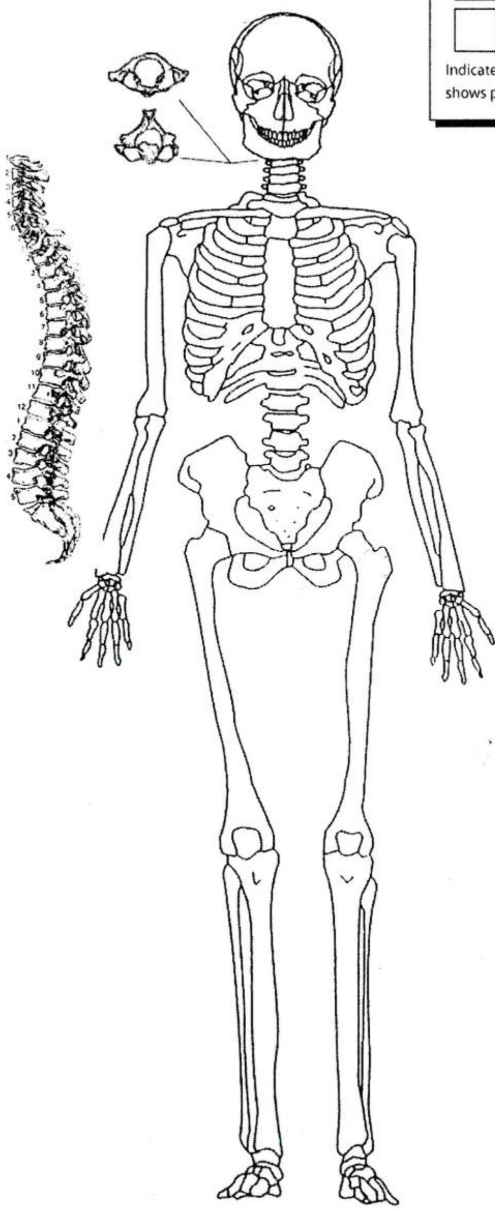
Skeleton flagged for further investigation ☐

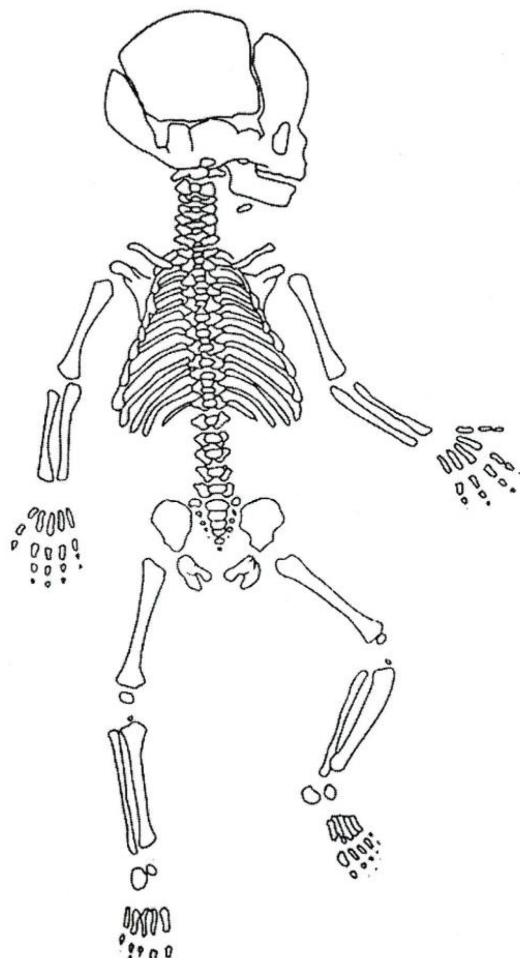
- ☐ Healed fractures
- ☐ Limb deformities
- ☐ Cut Bone
- ☐ Dental abnormalities
- ☐ Other (see comments)
- ☐ Grave goods
- ☐ Coffin
- ☐ Disturbed
- ☐ Pathology

☐ Present

☐ Absent

Indicate whether shading shows presence or absence.





Rough sketch of body + associated items. Indicate position of artefacts or Cu/Fe staining. Indicate north

Notes: Adult/ Juvenile/ Baby

#	Description	Easting	Northing	Height

Datum height:

Excavators name:

Coffin type, Stratigraphy, Nails, Plating

PRESERVATION

- ☐ Complete skeleton
- ☐ Incomplete with cranial + post cranial
- ☐ Cranium / mandible only
- ☐ Post-cranials only
- ☐ Highly fragmented
- ☐ Fair condition
- ☐ Good condition (most bones complete)

DENTAL OBSERVATIONS

1. **Juveniles**: Eruption State

Deciduous

- ☐ no milk teeth erupted
- ☐ upper / lower central incisors ONLY
- ☐ incisors, canines ONLY
- ☐ incisors, canines + dm1 ONLY
- ☐ all milk teeth erupted

Permanent

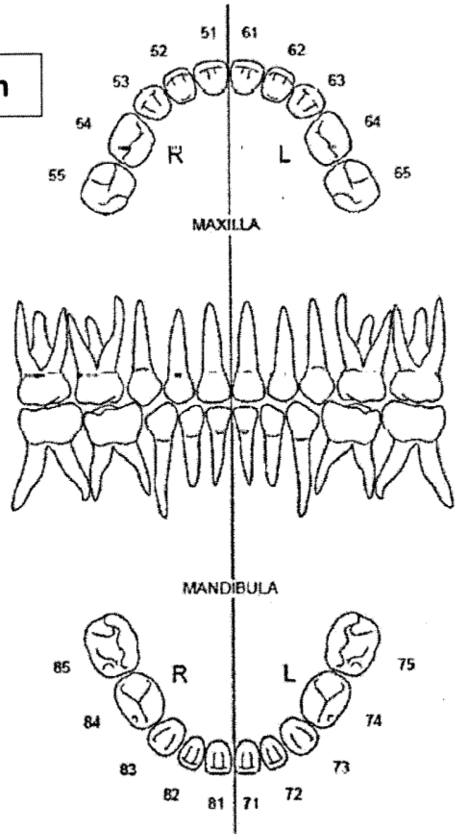
- ☐ M1 erupted
- ☐ incisors erupted
- ☐ pre-molars / canines erupted
- ☐ M2 erupted
- ☐ M3 erupted

2. **Adults**: Wear State (refer to reference pictures)

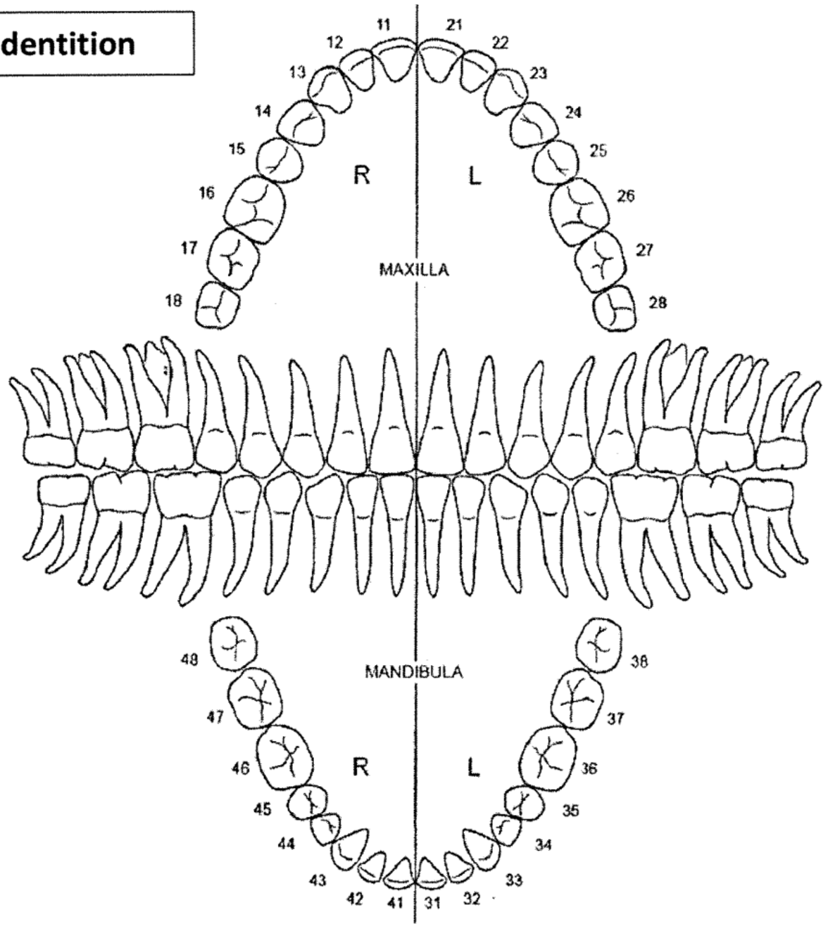
- ☐ minimal wear, polish only
- ☐ slight to moderate wear
- ☐ heavy and / or unequal wear
- ☐ extreme wear

MAXILLA	**Left**															**Right**
	M3	M2	M1	PM2	PM1	C	I2	I1	I1	I2	C	PM1	PM2	M1	M2	M3
Presence:																
Hypoplasias:																
Caries:																
Calculus:																
Abscess:																
MANDIBLE	M3	M2	M1	PM2	PM1	C	I2	I1	I1	I2	C	PM1	PM2	M1	M2	M3
Presence:																
Hypoplasias:																
Caries:																
Calculus:																
Abscess:																

Child/Juvenile: primary dentition



Adult: secondary dentition



CRANIAL OBSERVATIONS

1. Cranial Sutures	not fused	partial fusion	fully fused
Basi-sphenoid	☐	☐	☐
Saggital	☐	☐	☐
Coronal	☐	☐	☐
Lambdoid	☐	☐	☐

2. Cranial Features	Slight	Moderate	Marked
Supra-orbital development	☐	☐	☐
Supra-mastoid development	☐	☐	☐
Nuchal crest	☐	☐	☐
Mastoid size	☐ small	☐ medium	☐ large
Supra-orbital margin	☐ sharp	☐ smooth	
Gonial eversion	☐ straight/inverted	☐ slightly everted	☐ markedly everted
Chin shape	☐ pointed	☐ round	☐ square

3. Cribra orbitalia ☐ present ☐ left ☐ right

4. Porotic hyperostosis	none	slight	marked
Parietal	☐	☐	☐
Occipital	☐	☐	☐

5. Cranial measurements

g-op ______________________

eu-eu ______________________

n-midnariale ______________________

al-al ______________________

zy-zy ______________________

b-br ______________________

ecm-ecm ______________________

POST-CRANIAL OBSERVATIONS

1. Bone / epiphyseal fusion sequence	not united	united
Ischiopubic ramus	☐	☐
Acetabular tri-radiate cartilage	☐	☐
Distal humerus	☐	☐
Proximal femur	☐	☐
Proximal humerus	☐	☐
Distal femur	☐	☐
Proximal tibia	☐	☐
Distal radius	☐	☐
Iliac crest	☐	☐
Medial clavicle	☐	☐

2. Pelvic Sexual Dimorphism			
Greater sciatic notch	☐ wide	☐ medium	☐ narrow
Sub-pubic angle	☐ wide	☐ narrow	
Sub-pubic concavity	☐ present	☐ absent	
Pre-auricular sulcus	☐ absent	☐ slight	☐ marked

3. Pubic symphysis age (Suchey-Brooks Standards)

☐ Phase 1	☐ Phase 3	☐ Phase 5
☐ Phase 2	☐ Phase 4	☐ Phase 6

4. Sternal rib age

☐ Phase 0	☐ Phase 2	☐ Phase 4	☐ Phase 6	☐ Phase 8
☐ Phase 1	☐ Phase 3	☐ Phase 5	☐ Phase 7	

5. Osteoarthritis	none	slight lipping	marked lipping	eburnation
Shoulder	☐	☐	☐	☐
Elbow	☐	☐	☐	☐
Hip	☐	☐	☐	☐
Knee	☐	☐	☐	☐
Thoracic osteophytosis	☐	☐	☐	
Lumbar osteophytosis	☐	☐	☐	

6. Tibial Shaft Periostitis ☐ none ☐ slight ☐ marked

7. Measurements of long bones (in cm)

	L	R
Humerus		
Radius		
Ulna		
Femur		
Tibia		
Fibula		
Clavicle		

8. Pathologies:

9. Trauma:

ADULTS: Age Estimation using Transition Analysis *(circle the appropriate phase)*

	Left	Right
Cranial Sutures		
Coronal Pterica	- 1 2 3 4 5	- 1 2 3 4 5
Sagittal Obelica (midline)	- 1 2 3 4 5	- - - - - -
Lambdoidal Asterica	- 1 2 3 4 5	- 1 2 3 4 5
Interpalantine (midline)	- 1 2 3 4 5	
Zygomaticomaxillary	- 1 2 3 4 5	- 1 2 3 4 5
Pubic Symphysis		
Symphyseal Relief	- 1 2 3 4 5 6	- 1 2 3 4 5 6
Symphyseal Texture	- 1 2 3 4	- 1 2 3 4
Superior Apex	- 1 2 3 4	- 1 2 3 4
Ventral Symphyseal Margin	- 1 2 3 4 5 6 7	- 1 2 3 4 5 6 7
Dorsal Symphyseal Margin	- 1 2 3 4 5	- 1 2 3 4 5
Iliac Auricular Surface		
Superior Demiface Topography	- 1 2 3	- 1 2 3
Interior Demiface Topography	- 1 2 3	- 1 2 3
Superior Surface Morphology	- 1 2 3 4 5	- 1 2 3 4 5
Middle Surface Morphology	- 1 2 3 4 5	- 1 2 3 4 5
Inferior Surface Morphology	- 1 2 3 4 5	- 1 2 3 4 5
Inferior Surface Texture	- 1 2 3	- 1 2 3
Superior Posterior Iliac Exostoses	- 1 2 3 4 5 6	- 1 2 3 4 5 6
Inferior Posterior Iliac Exostoses	- 1 2 3 4 5 6	- 1 2 3 4 5 6
Posterior Exostoses	- 1 2 3	- 1 2 3

Appendix 3: Tables of phase scores, descriptions and age ranges for the pubic symphysis (Brooks and Suchey, 1990)

Phase / Score	Description	95% Range Estimation	
		Male	**Female**
I	Symphyseal face has a billowing surface (ridges and furrows) which usually extends to include the pubic tubercle. The horizontal ridges are either well-marked or in the process of obliteration. Dorsal margin may be in beginning phases of formation; ventral beveling may be commencing. Although ossific nodules may occur on the upper extremity, a key to the recognition of this phase is the lack of delimitation of either extremity (upper or lower)	15-23	15-24
II	The symphyseal face may still show ridge development. The face has commencing delimitation of lower and/or upper extremities occurring with or without ossific nodules. The ventral rampart may be in beginning phases as an extension of the bony activity at either or both extremities.	19-34	19-40
III	Symphyseal face shows lower extremity and ventral rampart in process of completion. There can be a continuation of fusing ossific nodules forming the upper extremity and along the ventral border. Symphyseal face is smooth or can continue to show distinct ridges. Dorsal plateau is complete. Absence of lipping of symphyseal dorsal margin; no bony ligamentous outgrowths.	21-46	21-53
IV	Symphyseal face is generally fine grained although remnants o the old ridge and furrow system may still remain. Usually the oval outline is complete at this stage, but a hiatus can occur in ventral rim. Pubic tubercle is fully separated from the symphyseal face by definition of upper extremity. The symphyseal face may have a distinct rim. Ventrally, bony ligamentous outgrowths may occur on inferior portion of pubic bone adjacent to symphyseal	23-57	26-70

	face. If any lipping occurs it will be slight and located on the dorsal border.		
V	Symphyseal face is completely rimmed with some slight depression of the face itself, relative to the rim. Moderate lipping is usually found on the dorsal border with more prominent ligamentous outgrowths on the ventral border. There is little or no rim erosion. Breakdown may occur on superior ventral border.	27-66	25-83
VI	Symphyseal face may show ongoing depression as rim erodes. Ventral ligamentous attachments are marked. In many individuals the pubic tubercle appears as a separate bony knob. The face may be pitted or porous, giving an appearance of disfigurement with the ongoing process of erratic ossification. Crenulations may occur. The shape of the face is often irregular at this stage.	34-86	42-87

Appendix 4: Tables of phase scores, descriptions and age ranges for the sternal rib ends (İşcan et al., 1984; Işcan et al., 1985)

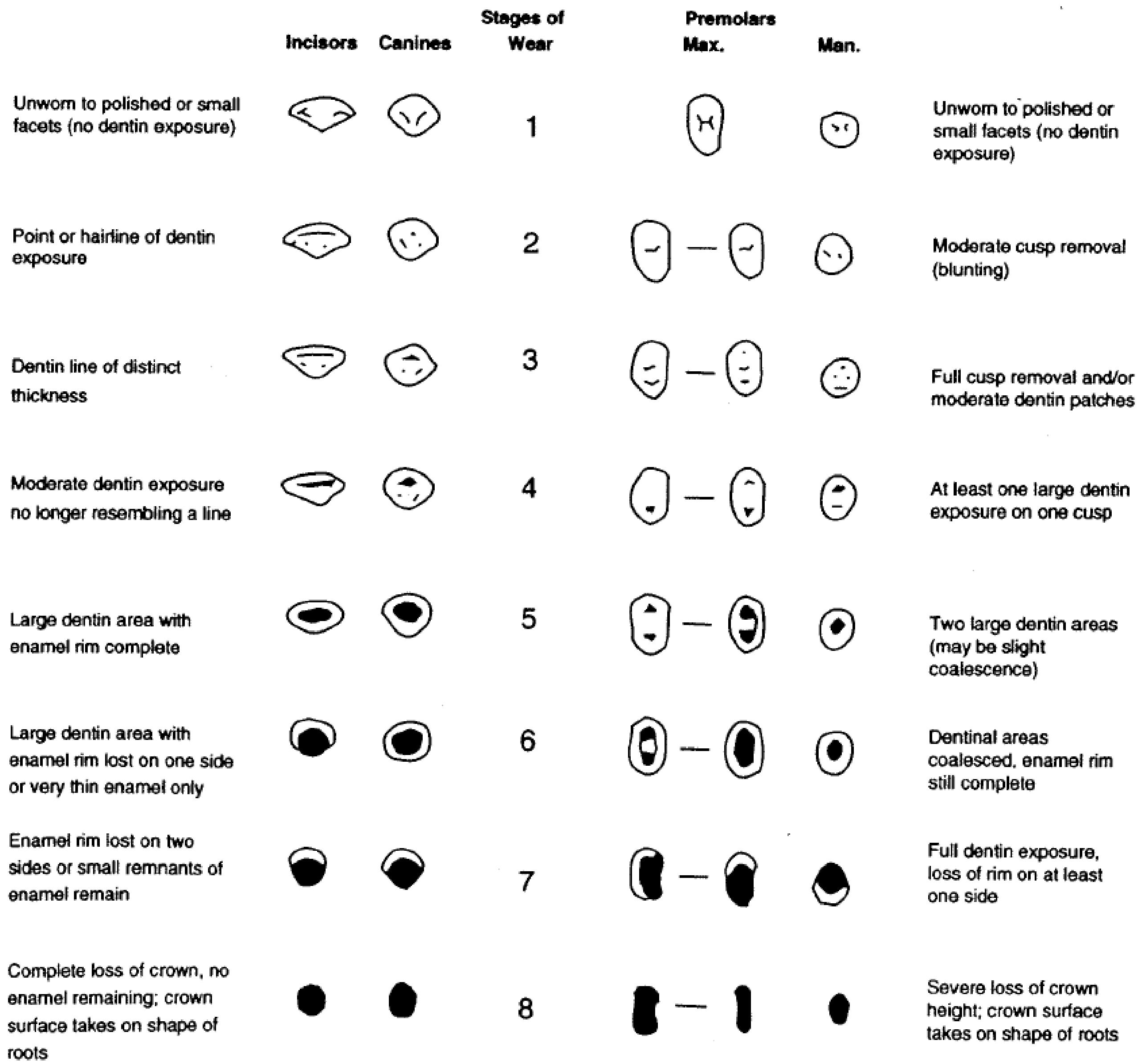
Males		
Phase / Score	**Description**	**Age Range Estimation**
0	The articular surface is flat or billowy with regular rim and rounded edges. The outer surface of the sternal rib end is bordered by an epiphyseal ring. The bone itself is smooth, firm and very solid	≤ 16
1	There is a beginning amorphous indentation in the articular surface, but billowing may also still be present. The rim is rounded and regular. The epiphyseal ring has disappeared. In some cases scalps may start to appear at the edges. The bone is still firm, smooth and solid.	17-19
2	The pit is now deeper and has assumed a V-shaped appearance formed by the anterior and posterior walls. The walls are thick and smooth with a scalloped or slightly wavy rim with rounded edges. The bone is firm and solid.	20-23
3	The deepening pit has taken on a narrow to moderately wide U-shape. Walls are still fairly thick with rounded edges. Some scalloping may still be present but the rim is becoming more irregular. The bone is still quite firm and solid.	24-28
4	Pit depth is increasing, but the shape is still a narrow to moderately wide U. The walls are thinner, but the edges remain rounded. The rim is more irregular with no uniform scalloping pattern remaining. There is osme decrease in the weight and firmness of the bone, however, the overall quality of the bone is still good.	26-32
5	There is little change in pit depth, but the shape in this phase is predominantly a moderately wide U. Walls show further thinning and the edges are becoming sharp. Irregularity is increasing in the rim. Scalloping pattern is completely gone and has been replaced with irregular bony projections. The condition of the bone is fairly good, however, there are some signs of deterioration with evidence of porosity and loss of density	33-42
6	The pit is noticeably deep with a wide to very wide U-shape. The walls are thin with sharp edges. The rim is irregular and exhibits some rather long bony projections that are frequently more pronounced at the	43-55

	superior and inferior borders. The bone is noticeably lighter in weight, thinner and more porous, especially inside the pit.	
7	The pit is noticeably deep with a wide to very wide U-shape. The walls are thin and fragile with sharp, irregular edges and bony projections. The bone is light in weight and brittle with significant deterioration in quality and obvious porosity.	54-64
8	In this final phase the pit is very deep and widely U-shaped. In some cases the floor of the pit is absent or filled with bony projections. The walls are extremely thin, fragile and brittle with sharp, highly irregular edges and bony projections. The bone is very lightweight, thin, brittle, friable and porous. "Window" formation is sometimes seen in the walls.	≥ 65

Females		
Phase / Score	**Description**	**Age Range Estimation**
0	The articular surface is nearly flat with ridges or billowing. The outer surface of the sternal rib end is bordered by an epiphyseal ring. Thee rim is regular with rounded edges, and the bone itself is firm, smooth, and very solid.	≤ 13
1	A beginning, amorphous indentation can be seen in the articular surface and the epiphyseal ring has disappeared. Ridges or billowing may still be present. The rim is rounded and regular with a little waviness in some cases. The bone remains solid, firm and smooth.	14 - 15
2	The pit is considerably deeper and has assumed a V-shaped between the thick, smooth anterior and posterior walls. Some ridges or billowing may still remain inside the pit. The rim is wavy with some scallops beginning to form at the rounded edge. The bone itself is firm and solid.	16 – 19
3	There is only slight if any increase in pit depth, but the V-shape is wider, sometimes approaching a narrow U as the walls become a bit thinner. The still rounded edges now show a pronounced, regular scalloping pattern. At this stage, the anterior or posterior walls may first start to exhibit a central, semicircular arc of bone. The rib is firm and solid.	20 – 24

4	There is a noticeable increase in the depth of the pit, which now has a wide V- or narrow U-shape with, at times, flared edges. The walls are thinner but the rim remains rounded. Some scalloping is still present, along with the central arc; however, the scallops are not as well defined and the edges look somewhat worn down. The quality of the bone is fairly good but there is some decrease in density and firmness.	24 – 32
5	The depth of the pit stays about the same, but the thinning walls are flaring into a wider V- or U- shape. In most cases, a smooth, hard, plaque-like deposit lines at least part of the pit. No regular scalloping pattern remains and the edge is beginning to sharpen. The rim is becoming more regular, but the central arc is still the most prominent projection. Bone is noticeably lighter in weight, density and firmness. The texture is somewhat brittle.	33 – 46
6	An increase in pit depth is again noted, and its V- or U-shape has widened again because of pronounced flaring at the end. The plaque-like deposit may still appear but is rougher and more porous. The walls are quite thin with sharp edges and an irregular rim. The central arc is less obvious and, in many cases, sharp points project from the rim of the sternal extremity. The bone itself is fairly thin and brittle with some signs of deterioration.	43 – 58
7	In this phase, the depth of the predominantly flared U-shaped pit not only shows no increase, but actually decreases slightly. Irregular bony growth are often seen extruding from the interior of the pit. The central arc is still present in most cases but is now accompanied by pointed projections, often at the superior and inferior borders, yet may be evidenced anywhere around the rim. The very thin walls have irregular rims with sharp edges. The bone is very light, thin, brittle, and fragile, with deterioration most noticeable inside the pit.	59 – 71
8	The floor of the U-shaped pit in this final phase is relatively shallow, badly deteriorated, or completely eroded. Sometimes it is filled with bony growths. The central arc is barely recognizable. The extremely thin, fragile walls have highly irregular rims with very sharp edges, and often fairly long projections of bone at the inferior and superior borders. “Window” formation sometimes occurs in the walls. The bone itself is in poor condition – extremely thin, light in weight, brittle, and fragile.	≥ 70

Appendix 5: Occlusal surface wear for incisors, canines and pre-molars (modified from Smith, 1984) obtained from Buikstra and Ubelaker (1994)



Appendix 6: Table of the number of skeletal elements used when estimating sex

Number of skeletal sex indicators used for the estimation	Female estimation	Male estimation	Unknown estimation	Total
0	0	2	2	4
1	28	26	20	74
2	22	27	16	65
3	18	14	5	37
4	9	16	6	31
5	15	9	3	27
6	14	12	5	31
7	13	7	1	21
8	7	12	4	23
9	4	5	0	9
10	0	1	0	1
11	0	1	0	1

Appendix 7: Tables indicating the dental eruption scoring and age estimations

Score	**Deciduous Dentition (erupted)**	**Age Estimation**
0	No milk teeth	-
1	Upper/lower central incisors only	6 – 16 months
2	Incisors and canines only	13 – 23 months
3	Incisors, canines and dm1 only	13 – 19 months
4	All milk teeth	23 – 33 months
5 *	Milk teeth present but unerupted	0 – 6 months

*. Indicates that the score was not on the initial data collection sheet but added during data capturing as it was deemed necessary to distinguish.

Score	**Permanent Dentition**	**Age Estimation**	**Simplified Age**
1	M1 erupted	6 – 7 years	Juvenile
2	Incisors erupted	7 – 10 years	Juvenile
3	Pre-molars / canines erupted	10 – 12 years	Juvenile
4	M2 erupted	13 – 17 years	Juvenile
5	M3 erupted	21 + years	Adult
6 *	M3 present but unerupted	17 – 21 years	Juvenile
7 *	Unerupted crowns present	(coupled with deciduous score)	-

*. Indicates that the score was not on the initial data collection sheet but added during data capturing as it was deemed necessary to distinguish.

Appendix 8: Sex and age estimation counts for the total sample.

Age estimation	Sex estimation:					
	Female	Probable Female	Male	Probable Male	Unknown Sex	Total
Baby	-	-	-	-	284	**284**
Child	-	-	-	-	133	**133**
Juvenile	6	8	2	5	148	**169**
Young Adult	29	9	38	8	43	**127**
Adult	53	6	62	6	419	**546**
Old Adult	9	4	10	-	11	**34**
Unknown Age	-	-	-	-	12	**12**
Total	**97**	**27**	**112**	**19**	**1050**	**1305**

Appendix 9: Quadrant A burial numbers and photographs

A1

A2

A3

A4

A5

A6a

A6b

A7


BLACK RIVER
A 7
17/05/2017

A8


BLACKRIVER
A8

A9a & A9b


BLACK RIVER
A9 - A
JUNE 2017
BLACK RIVER
A9-B
JUNE 2017

A10

A11a

A11b

A11c


BLACK RIVER
A 11
18/05/2017

A12


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #: A12


A12/3 (lower)
Black River
June 2017

A13


Black River
Fragments (pm)
24/5/17

A14


A14
Black River
18 May 2017

A15

A15a


Black River Parkway
18-05-2017
A15 Island

A15b

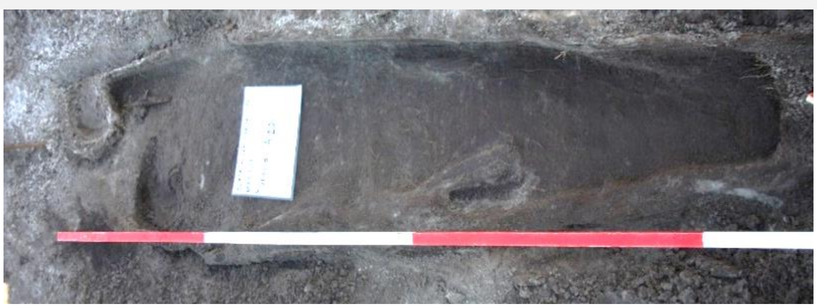
A16

A17

A18

A19

A20



A21

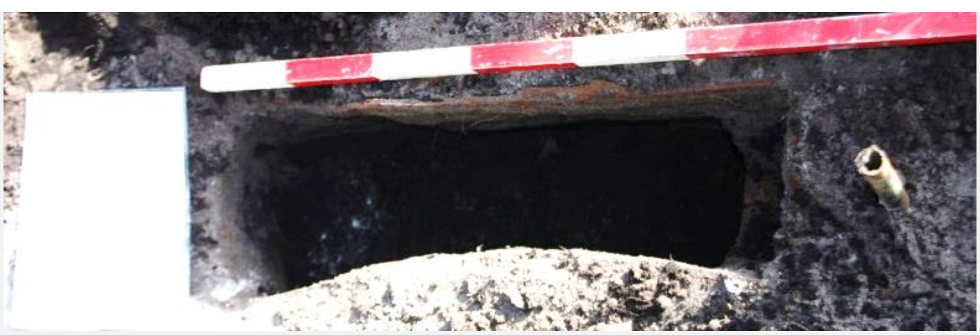
A22

A23

A24

A25

A26



A27

A28a

A28b

A29

A30


A30
Black River

A31


A31
BLACK RIVER
May 2017


A31
BLACK RIVER
May 2017

A32

A36

A37

A38

A39


MAY 2017
BURIAL #: A39


Blackriver
A39

A40


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #: A40


A40

A41


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #: A41


Black River
A41
23/5/2017

A42

A43

A43

A44

BLACK RIVER BURIAL SITE
MAY 2017
Burial #: A44

BLACK RIVER
A44

A45

A46

A47

A48

A49

A50

A51

A52

A53

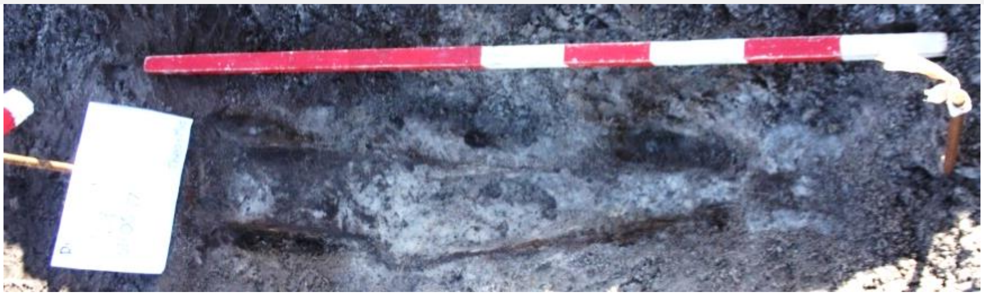
A55

A56

A57

A58

A59




A59 Black River
31-05-2017

A60


BLACK River
A60
June 2017


A60
Black River

A61

A62

A63

A64


BLACK RIVER
A64
31/05/17

A65


BLACK RIVER
A65
31/05/17


BLACK RIVER
A65

A66


Black River
A66

A67

A68

A69

A70


BLACK RIVER
A70
JUNE 2017


RIVER
2017

A71


A71
Black River
2 June 2017

A72

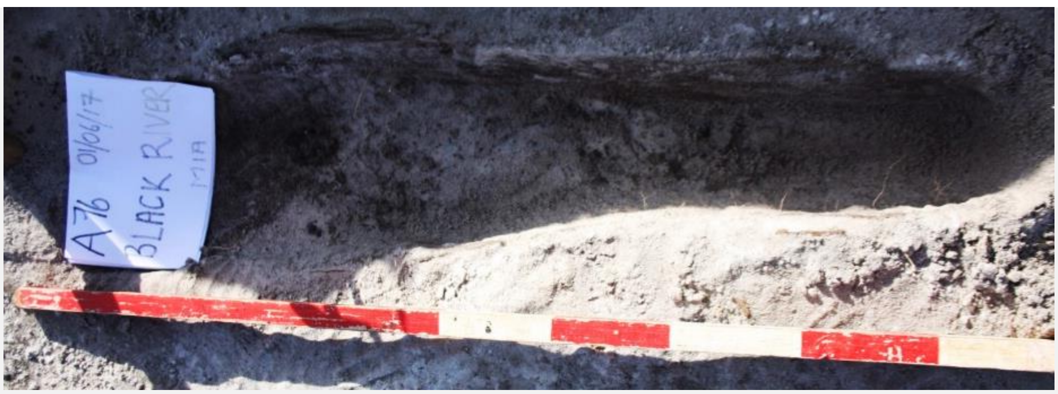
A73

A74

A75b


Black River
A75
02/06/2017

A76


A76 01/06/17
BLACK RIVER


BLACK RIVER
A76
JUNE 2017

A77

A78

A79

A80

A81


A81
BLACK RIVER


BLACK RIVER
A81


BLACK RIVER
A81

A82


A82


A82
Black River
June 2017

A83

A84

A85

A86

A87

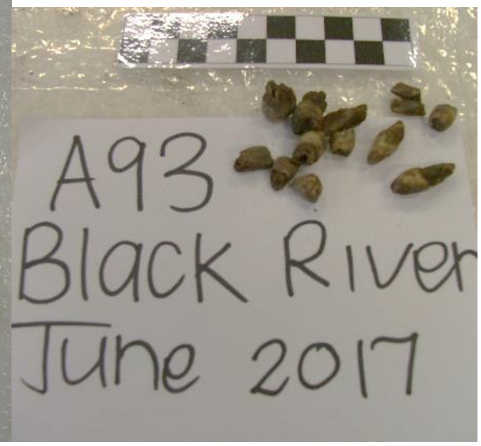
A89

A90

A91

A92

A93


A93
Black River
June 2017

A93
Black River
June 2017

A94



BLACK RIVER
A94

A95

A96

A97

A98

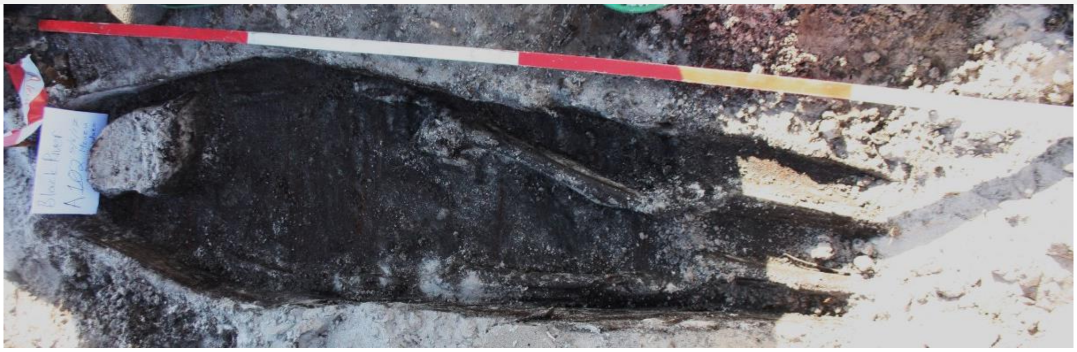
A99

A100

A101a

A101b

A102



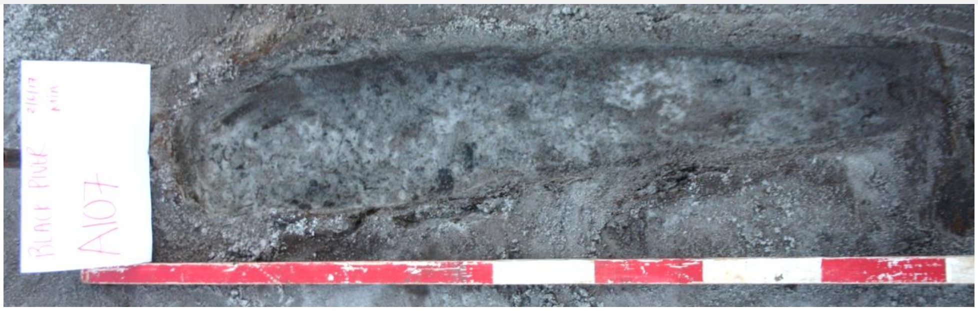
A103

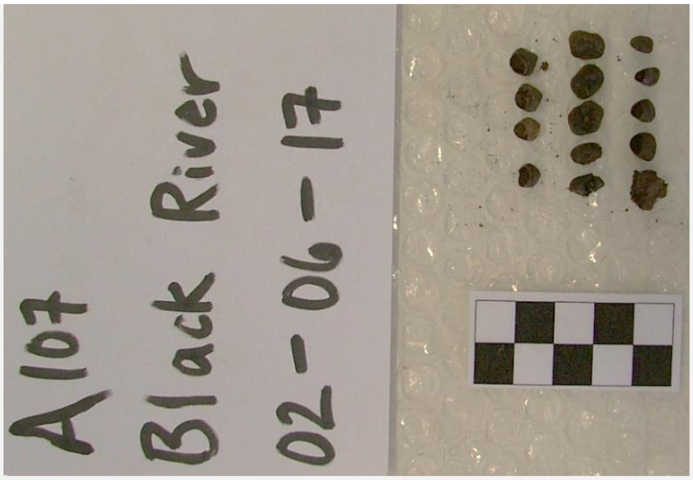
A104

A105

A106

A107





A108

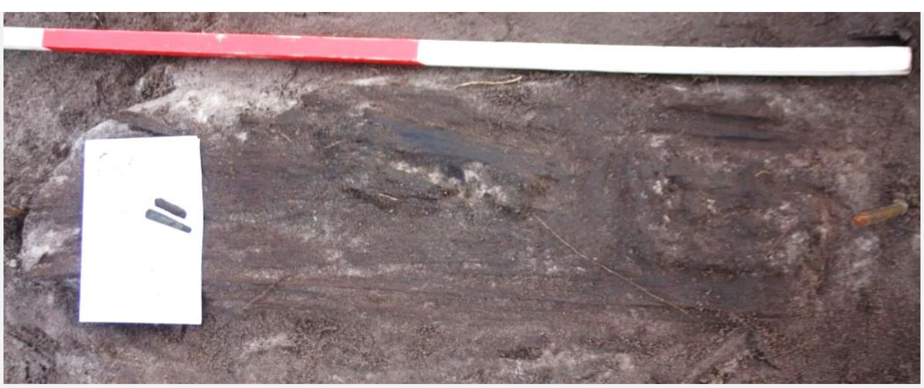
A109

A110

A111

A112

A113



A114

A Pending

A Found on Surface

A Scattered remains

A Fragments

A1I

A2I

A3I

A4I

A5I

A7I


BLACK RIVER
A7I
17-05-2017

BLACK RIVER
A7I
17-05-2017

A11aI


BLACK RIVER
A11 I - TOP
JUNE 2017

A11I

A12I (a,b,c)

A12bI

A13I

A14aI

A14bI

A15I


Black River Pathway
A15 Island
17-05-2017

A16I


BLACK RIVER
A16 ISLAND
17 MAY 2017
BLACK RIVER
A16 ISLAND
17 MAY 2017

A17bI

A18I

A20I

A21I

A22I

A23I


A23 Island
Black River
19 may 2017
A23 Island
Black River
19 may 2017
A23 Island
Black River
19 may 2017

A24I


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #: A24 ISLAND


BLACK RIVER
A24 ISLAND
19/05/2017

A26I


BLACK RIVER
A26 I
JUNE 2017

A27I


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #: A27 ISLAND


BLACK RIVER
A27 I
JUNE 2017

A28I


A28 Island
Black River
19/05/17
A28 Island
Black River
19/05/17
A28 Island
Black River
19/05/17

A29I


BLACK RIVER BURIAL SITE
MAY 2017
Burial #: A29


A29 Island
Black River
June 2017
A29 Island
Black River
June 2017

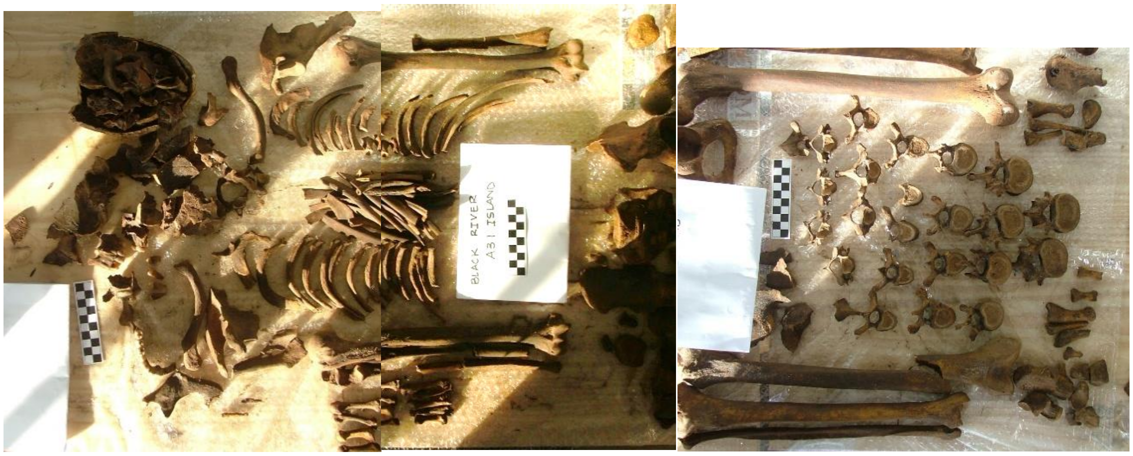
A30Ia


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #: A30 ISLAND


A30 ISLAND
BLACK RIVER

A30Ib

A31I



A32I

A33I

A34I

A35I


A35I
Blackriver
23/05/2017

A36I


A36I
22/05/2017
Blackriver


A36I
22/05/2017
Blackriver


Blackriver

A37I

A38I

A39I

A40I

A41I


Black river
A 41/ISLAND

A42I


Black River
A42I
24/05/2017
Black River
A42I
24/05/2017

A43I


BLACK RIVER
BLACK RIVER

A44I


A-15
44


Black river
A44/I
24/05/17
Black river
A44/I
24/05/17

A46I


BLACK RIVER
A 46 ISLAND

A47I


A-IS
47


Black River
A47/I
24/05/2017
Black River
A47/I
24/05/2017

A48I

A49I


BLACK RIVER
A 49 I
BLACK RIVER
A 49 I

A50I


A-15
50


BLACK RIVER
A50 ISLAND

A51I


51


BLACK RIVER
A51 I
BLACK RIVER
A51 I

A52I


52


A52 I
Black River
24/5/17

A53I


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #: A53


A53I
Black river
25/05/2017


A53I

A54I


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #: A54

A55I


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #: A55I


BLACK RIVER
A55 ISLAND
A55 ISLAND

A56I

A57I

A58aI

A58bI

A59I


BLACK RIVER BURIAL SITE
MAY 2017
BURIAL #:
A-15
59


BRBS
A59I
25/05/17

A60I


A60I
BRBS
25/05/17

A61I


A-1S
61i


BLACK RIVER
A61 Island
BLACK RIVER
A61 Island

A62I


A-1S
62i


Black river
A62/I
25/05/2017

A63I

A64I

A65I

A66I


BLACK RIVER BURIAL SITE
MAY 2017
A-15
BURIAL #: 66 i
MARY


A66I
Black River
May 26/2017

A67I


A-15
67 i

A68I

A69I


BLACK RIVER
A69 I


BLACK RIVER
A69 I

A70I


A-15
70


BLACK RIVER
A 70 ISLAND


BLACK RIVER
A 70 ISLAND

A71aI

A71bI

A71cI

A72I


A72 Island
Black River
May 2017


A72 Island
Black River
May 2017

A73I


A73I
Black River
May 2017
River
2017

A78I


Black River
A78/I
May 2017
River
2017

A79I


BLACK RIVER
A79I
29/05/17


Black River
A79/I
29/05/17


Black River
A79/I
29/05/17

A80I


BLACK RIVER
A80 I
May 2017


BLACK RIVER
A80 I
May 2017

A81I


Black River
30/05/17
A81 i

A82I

A83I

A84I

A85I

A86I

A87I

A88I

A89I


Black River
A89/I
May 2017

Black River
A89/I
May 2017

A90aI


BLACK RIVER
A 90 I
MAY 2017

BLACK RIVER
A 90 I
MAY 2017

A90bI

A91I

A92I

A93I


BLACK RIVER
A 93 I

A94I


BLACK RIVER
A 94 I
BLACK RIVER
A94 I
BLACK RIVER
A94 I

A95I


Black River
A95I


Blackriver
A95I
May 2017


Blackriver
A95I
May 2017


Blackriver
A95I
May 2017

A96I


BLACK RIVER
A96I


BLACK RIVER
A96I

A97I

A98I


A98I
BLACK RIVER
Kris & Christie
30/05/17

A99I


BLACK RIVER
A99I
30/05/17

A100I


BLACK RIVER
A101 I


A100I
Black River
May 2017

A100I
Black River
May 2017

A101I


BLACK RIVER
A101I

A101I
Black River
Baby

A102I

A103I

A104I

Appendix 10: Quadrant B burial numbers and photographs

B1

B2

B3

B4


BLACK RIVER
19/06/17 B4


B4
Black River
19/6/17

B5


BLACK RIVER
19/06/17 B5

B6


BLACK RIVER
19/06/17 B6


B6
Black River
19/6/17

B7


BLACK RIVER
19/06/17 B7

B8


BLACK RIVER B8
19/06/17

B9


BLACK RIVER B9
19/06/17

B10


BLACK RIVER B10
19/06/17


B10
Black River
19/6/17

B11


BLACK RIVER
19/06/17 B11


B10
Black River
19/6/17

B12


BLACK RIVER
19/06/17 B12

B13


BLACK RIVER
20/6/17 B13


B13
Black River
20/6/17

B13
Black River
20/6/17

B14


BLACK RIVER
B14
19/06/17

B15a


BLACK RIVER
B15
19/06/17


B15
Black River
19/6/17

B15b


BLACK RIVER
4/7/17
B15b


B15b #2
Black River

B16


BLACK RIVER
19/06/17
B16

B17


BLACK RIVER
B17
19/06/17


B17
Black River
19/6/17

B18


BLACK RIVER
B18
19/06/17

B19


BLACK RIVER
B19
20/6/17


Black River
B19 20/06
Black River
B19 20/06

B20


BLACK RIVER
2016/17 B20

B21


BLACK RIVER
2016/17 B21


B21
Black River
2016/17

B22


BLACK RIVER B22
2016/17

B23


BLACK RIVER B23
2016/17


B23
Black River
20/6/17

B24


BLACK RIVER B24
20/6/17


B24
Black River
20/6/17

B25


BLACK RIVER
2016/17 B25

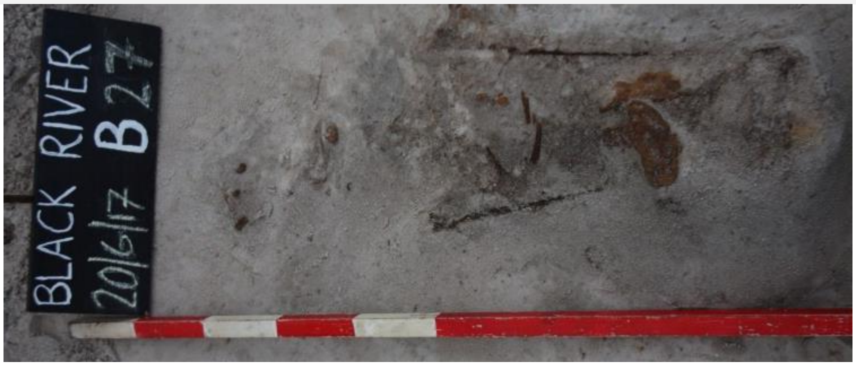

B25
Black River
2016

B26


BLACK RIVER
2016/17 B26


Cemetery/Site BR
Skeleton # B26

B27



B28

B29

B30

B31

B32

B33a

B33b

B34


BLACK RIVER
B34

B35


BLACK RIVER B35
19/7/17


B35
Black River
19/7/17 (20/6/17)

B36


BLACK RIVER B36
20/6/17

B37

B39


BLACK RIVER
B39


B39
Black River
21/6/17

B40


BLACK RIVER B 40
21/06/17


B40
Black River
21/6/17

B41


BLACK RIVER
21/06/17
B 41

B42


BLACK RIVER
21/06/17
B 42

B43


BLACK RIVER
21/06/17
B 43


B43
Black River
21/6/17
B43
Black River
21/6/17

B44ac


BLACK RIVER
21/06/17
B44

B44b


BLACK RIVER
21/06/17


B44b
Black River
21/06/17

B44a


B44a
Black River
21/6/17

B45


BLACK RIVER
B45
21/06/17

B46a

B46b


B46b
Black River
21/6

B47


BLACK RIVER
B47
21/06/17


B47
Black River
22/6/17
B47
Black River
22/6/17

B48

B49


B49
Black River
21/6/17

B50


BLACK RIVER
23/6/17


B50
Black River
23/6/17


B50

B51


BLACK RIVER
22|6|17 B51


B51
Black River
23|6|17

B52


BLACK RIVE
22|6|17 B52


B52
Black River
23/6/17

B53


BLACK RIVER B53
22/6/17

B53a


B53
Black River
23/6/17

B53b


B53b
Black River
23/6/17

B54


BLACK RIVER
23/6/17
B54


B54
Black River
22/6/17

B55


BLACK RIVER
B55
23/6/17


B55

B56


BLACK RIVER
B56
23/6/17

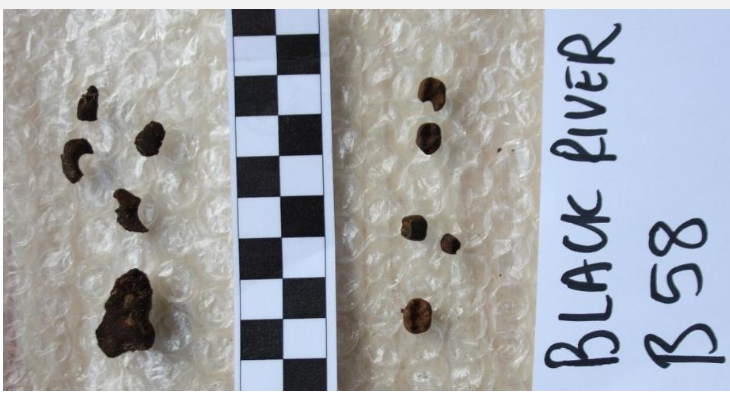

B56
Black River

B57


BLACK RIVER
B57
23/6/17

B58


BLACK RIVER
B58
23/6/17


BLACK RIVER
B58

B59a


BLACK RIVER
B59
23/6/17


B59
Black River

B59b


BLACK RIVER


BLACK RIVER
B59 b

B60


BLACK RIVER B60
23/6/17


B60
Black River
23/6/17

B61


BLACK RIVER B61
23/6/17

B62


BLACK RIVER B62
23/6/17


B62
Black River

B63


BLACK RIVER
B63
23/6/17


B63
Black River

B64


BLACK RIVER
B
23/6/17


B64
BLACK RIVER
23/06/17

B65


BLACK RIVER
B65
23/6/17


B65
Black River
23/6/17

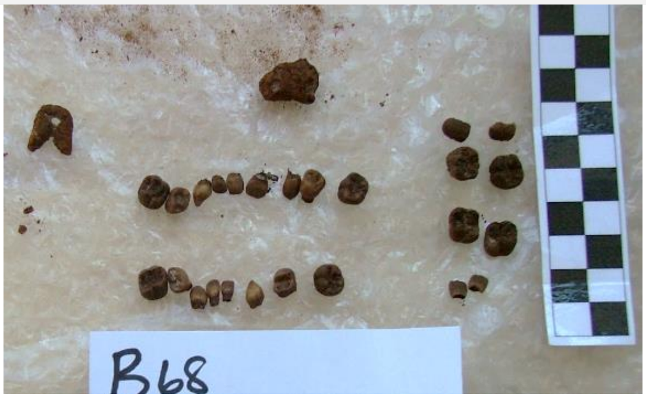
B66


BLACK RIVER
B66
23/6/17

B67

B68


BLACK RIVER
23|6|17
B68


B68

B69


B69
Black River
23|6|17

B70


BLACK RIVER
23|6|17
B70


B70
Black River
23/6/17

B71


BLACK RIVER B71
23/6/17

B72


BLACK RIVER B72

B73


BLACK RIVER B73
26/6/17

B74

B75


B75
Black River
26/6/17

B76


BLACK RIVER
B 76
26/6/17

B77


BLACK RIVER
B 77
26/6/17


B77
Black River
26/6/17

B78

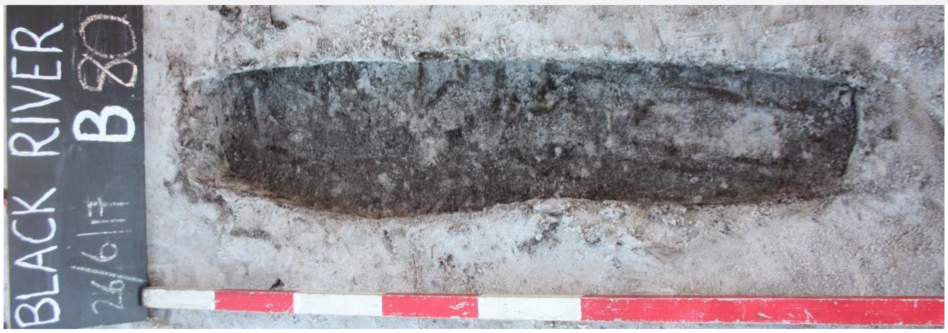

BLACK RIVER
B 78
26/6/17


B78
Black River

B79


BLACK RIVER
26/6/17

B80


BLACK RIVER B80
26/6/17


B80
Black River
26/6/17

B81


BLACK RIVER B81
26/6/17


B81
Black River
26/6/17

B82


BLACK RIVER B82
26/6/17


B82
Black River
26/6/17

B83


BLACK RIVER B83
27/6/17


B83
Black River
27/6/17

B84

B85


BLACK RIVER
26/6/17 B85

B86


BLACK RIVER B86
26/6/17

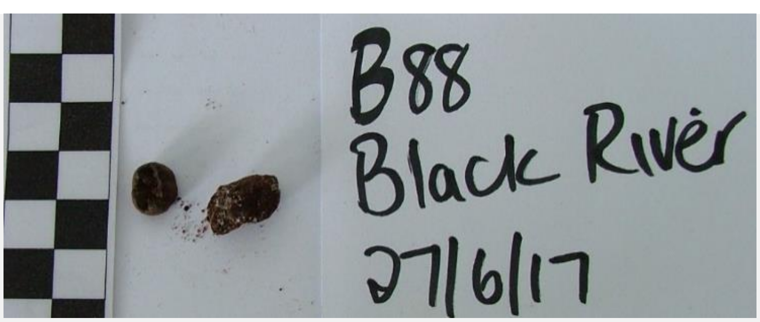
B87


BLACK RIVER
B87
26/6/17


B87
Black River
26/6/17

B88


BLACK RIVER
B88
27/6/17


B88
Black River
27/6/17

B89


BLACK RIVER
27/6/17 B89


B89
Black River
27/6/17

B90


BLACK RIVER
27/6/17 B90


B90
Black River
27/6/17

B91


BLACK RIVER
27/6/17 B 91

B92


BLACK RIVER
27/6/17 B 92


B92
Black River
27/6/17

B93


BLACK RIVER
27/6/17 B 93

B94


BLACK RIVER
27/6/17 B 94

B95


BLACK RIVER
27/6/17 B 95


B95
Black River

B96


BLACK RIVER
27/6/17 B 96


B96
Black River

B97


BLACK RIVER
27/6/17 B97


B97
Black River

B98


BLACK RIVER
27/6/17 B98


B98

B99

B100

B101

B102


B102
Black River
27/6/17

B103


BLACK RIVER
28/6/17 B 103

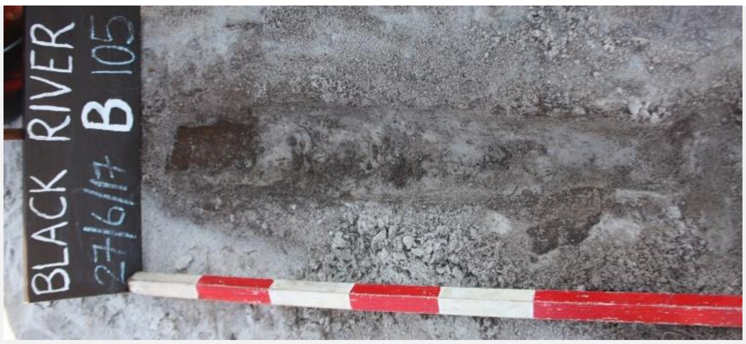

B103
Black River
28/6/17

B104


BLACK RIVER
27/6/17 B


B104
Black River

B105


BLACK RIVER
27/6/17 B 105


B 105
Black River

B106


BLACK RIVER
27/6/17 B 106

B107

B108

B109


B109
Black River
27/6/17

B110


BLACK RIVER
B110
28/6/17


B110
Black River
28/6/17

B111


BLACK RIVER
28/6/17 B111


B111
Black River
28/6/17

B112


BLACK RIVER
28/6/17 B112


B112
Black River
29/6/17

B113


BLACK RIVER
B113


B113
Black River
29/6/17

B114


BLACK RIVER
B114
29/6/17

B115


BLACK RIVER
29/6/17 B115


B115
Black River
29/6/17

B116


29/6/17 B116


B116
Black River
29/6


B116
Black River
29/6

B117

B118


B118
Black River
29/6/17

B119


BLACK RIVER
29/6/17 B119


B119
Black River
29/6/17

B120


BLACK RIVER
29/6/17 B120


B120
Black River
29|6|17

B121


BLACK RIVER
03/7/17 B121


B121


B121

B122


BLACK RIVER
03/7/17 B122


BLACK RIVER
B122
03/07/17

B123


BLACK RIVER
03/7/17 B123


B123
Black River
3/7/17

B124


BLACK RIVER
03/7/17 B124


B124
Black River
3/7/17

B125


BLACK RIVER
03/7/17 B125


B125
Black River
3/7/17

B126


BLACK RIVER
03/7/17 B126


B126
Black River
3/7/17

B127


BLACK RIVER
03/7/17 B127


B127
Black River
3/7/17

B128


BLACK RIVER
03/7/17 B128

B129

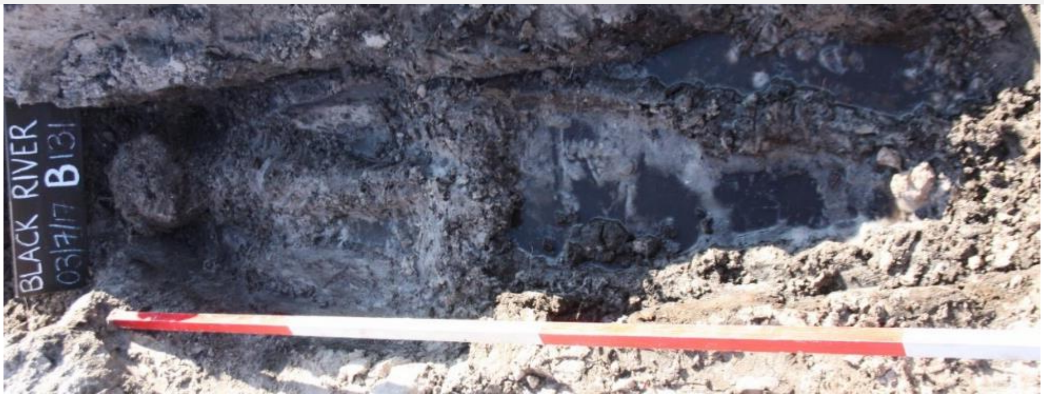

BLACK RIVER
03/7/17 B129


Black River
03/07/17
B129

B130


BLACK RIVER
03/7/17 B130

B131


BLACK RIVER
03/7/17 B131


B131
Black River
3/7/17

B132


BLACK RIVER
03/7/17 B132

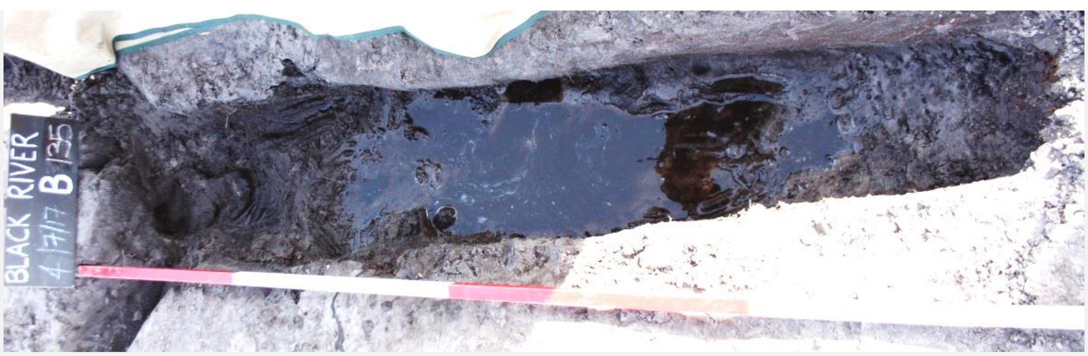
B133

B133a

B133b

B134

B135




B135
Black River
4/7/17

B136


BLACK RIVER
4/7/17 B136


B136
04/07/17
Black River

B137


BLACK RIVER
4/7/17 B137


B137
Blackriver
05/07/2017

B138


BLACK RIVER
4/7/17 B138


B138
Black River
4/7/17

B139


BLACK RIVER
5/7/17 B139


B139
Black River

B140


BLACK RIVER
5/7/17 B140

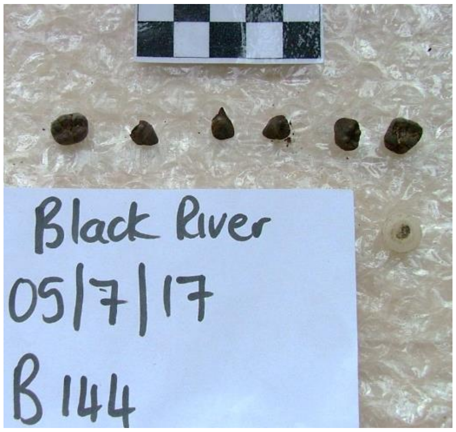

B140
Black River

B141

B142

B143

B144


Black River
05/7/17
B144

B145


BLACK RIVER B145
5/7/17


B145
Black River
5/7/17

B146

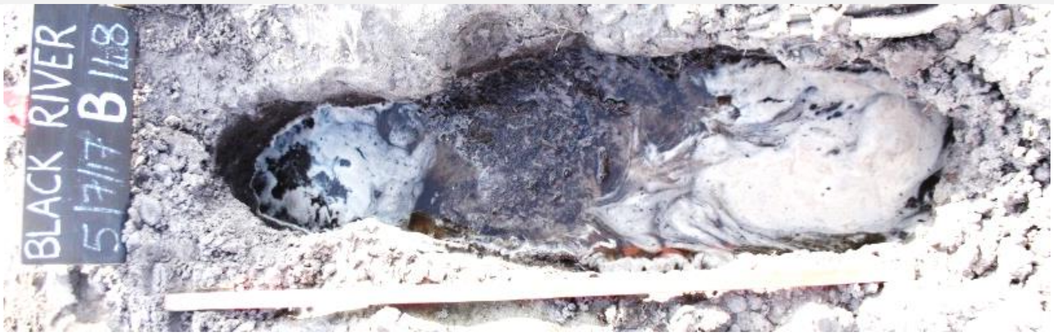

BLACK RIVER
5/7/17 B146


B146
Black River
5/7/17

B147


BLACK RIVER
5/7/17 B147

B148


BLACK RIVER
5/7/17 B 148


B148

B149


BLACK RIVER
5/7/17 B 149


B149
Black River
5/7/17

B150

B151

B152


B152
Black River
6/7/17

B153


BLACK RIVER
5/7/17 B 153

B154


BLACK RIVER
5/7/17 B 154


Black RIVER
06/07/17
B154

B155


BLACK RIVER
6/7/17 B155


B155
Black River
6/7/17

B156


BLACK RIVER
6/7/17 B156


B156
Black River
6/7/17

B157


BLACK RIVER
6/7/17 B157


Black River
B157
6/7/17

B158


BLACK RIVER
6/7/17 B B158


Black River
B 158
6/7/17

B159


BLACK RIVER
6/7/17 B B159


Black River
B159
06/07/17

B160


BLACK RIVER
6/7/17 B160

B161


BLACK RIVER
6/7/17 B161

B162

B163

B164

B165


B165
Black River
6/7/17

B166


BLACK RIVER
6/7/17 B166


B166
Black River
6/7/17

B167

B168

B169


B169
Black River
6/7/17

B170


BLACK RIVER
10/7/17 B 170

B171


BLACK RIVER
10/7/17 B 171

B172

B173

B174

B175

B176

B177

B178

B179

B180

B181

B182

B183

B184

B185

B186

B187

B188

B189

B190

B191

B192


Black River
B192
11/07/17
TEETH

B193


BLACK RIVER
11/07/17
B193


B193
11/07/17
TEETH + CRANIAL FRAGM
12/07/2017

B194


BLACK RIVER
11/07/17
B194

B195

B196

B197

B198

B199


BLACK RIVER


Black River
B199
11/7/17

B200


BLACK RIVER
B200


B200
Black River
10/7/17

B201

B202

B203

B204


BLACK RIVER
12/7/17 B.204


B204
Black River
12/7/17

B205

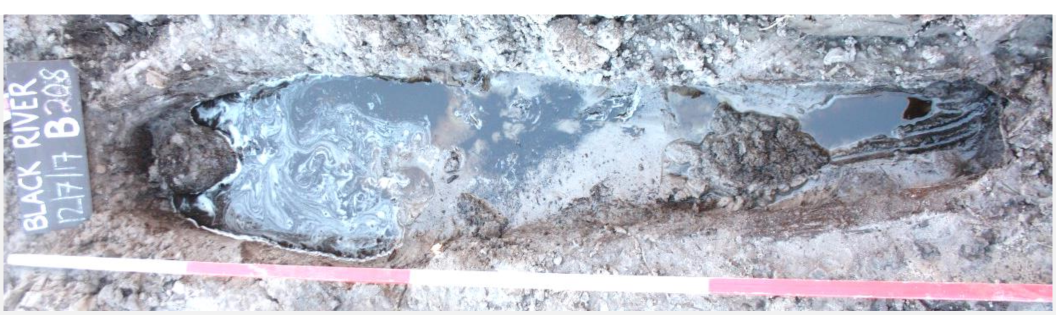

BLACK RIVER
12/7/17 B205


B205
Black River
12/7/17

B206

B207

B208




B208
Black River
11/7/17

B209


BLACK RIVER
13/7/17 B209


B209
Black River
13/7/17

B210

B211

B212


B212
Black River
12/7/17

B213


BLACK RIVER
12/7/17 B213


B213
Black River
12/7/17

B214


BLACK RIVER
13/7/17 B214


B214
Black River
13/7/17

B215


BLACK RIVER
13/7/17 B215

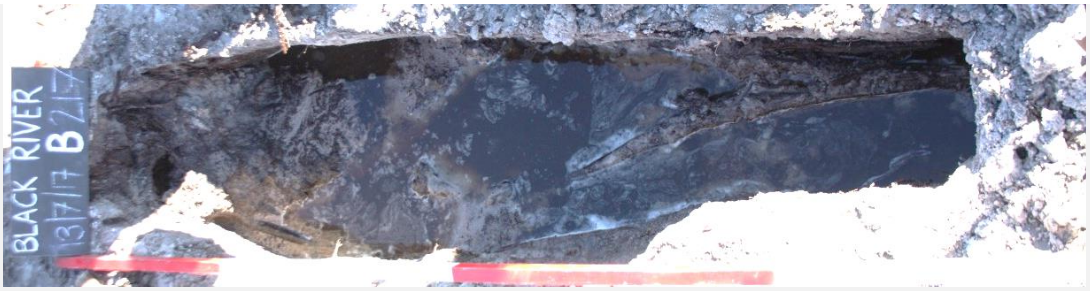

B215
Black River
13/7/17

B216


BLACK RIVER
13/7/17 B216


B216
Black River
13/7/17

B217


BLACK RIVER
13/7/17 B217


B217
Black River
13/7/17

B218


BLACK RIVER
13/7/17 B218


Black River
13/07/17
B218

B219


BLACK RIVER
13/7/17 B219


Black RIVER
B219
13/07/17

B220


BLACK RIVER
13/7/17 B220


B220
Black River
13/7/17

B221


BLACK RIVER
B221
17/7/17

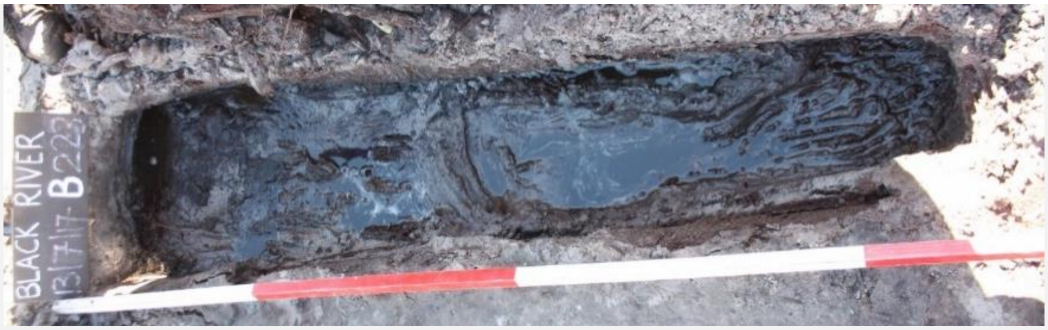

BLACK RIVER
B221
17/07/17

B222


RIVER
B222

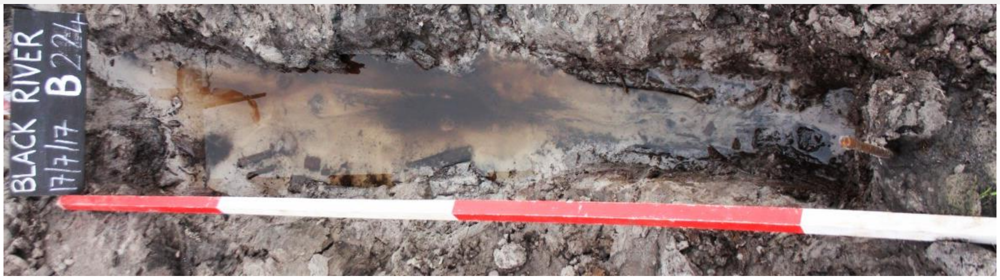

B222
Black River
13/7/17

B223


BLACK RIVER
13/7/17 B223

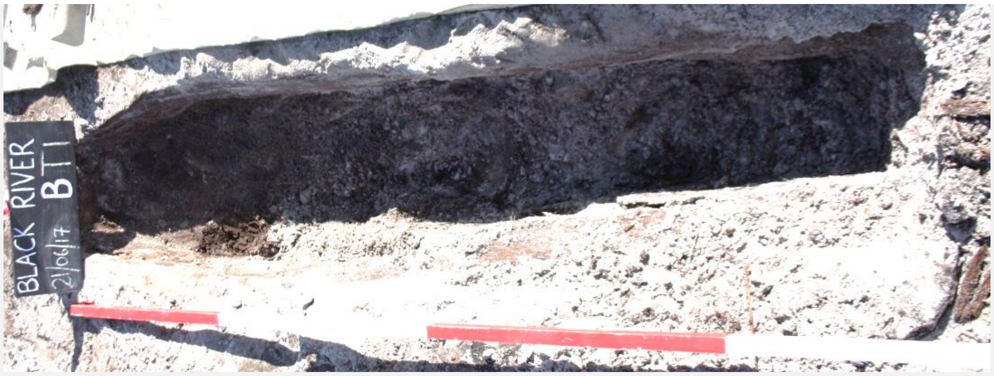

B223
Black River
13/7/17

B224


BLACK RIVER
17/7/17 B224

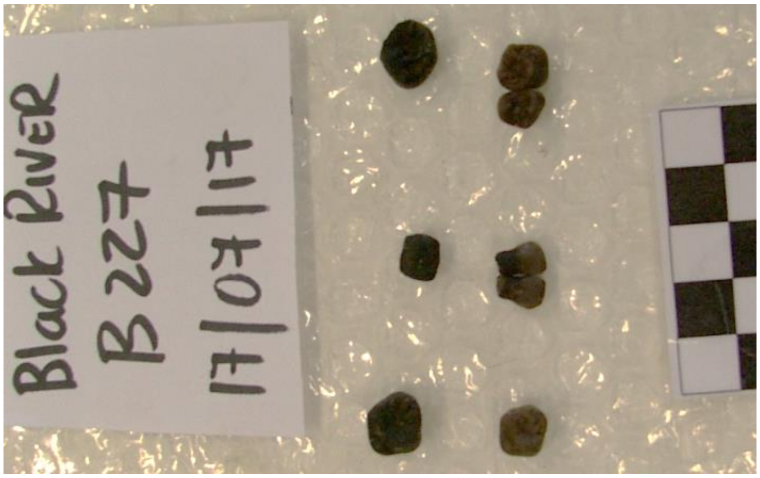

B224
Black River
17/7/17

B225



B226

B227


Black River
B227
17/07/17

B228


RIVER B 228
17/7/17

B229


BLACK RIVER B 229
20/7/17

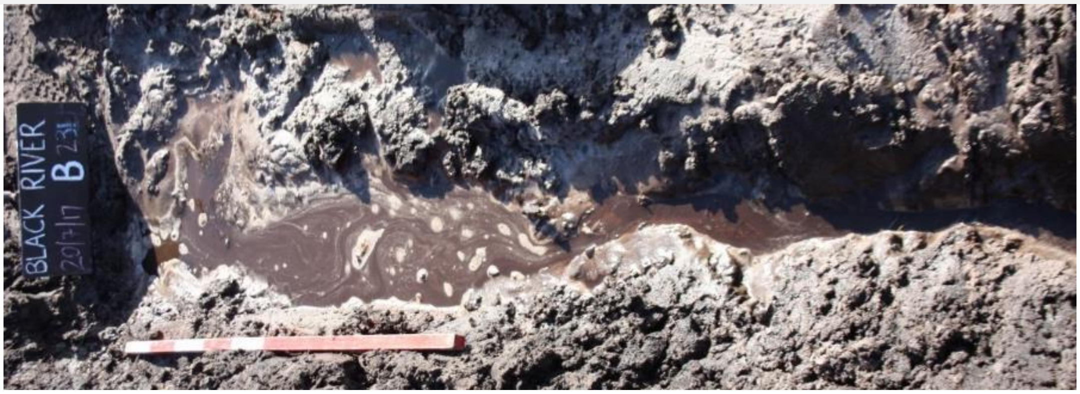

Black River
B229

B230


BLACK RIVER
20/7/17 B 230


Black River
B230
20/07/17

B231



B231a

B231b

B232

Bfragments


COLLECTED
ON 11/07/17
← BONE | WOOD/H →
12/0

Appendix 11: Quadrant C burial numbers and photographs

C1

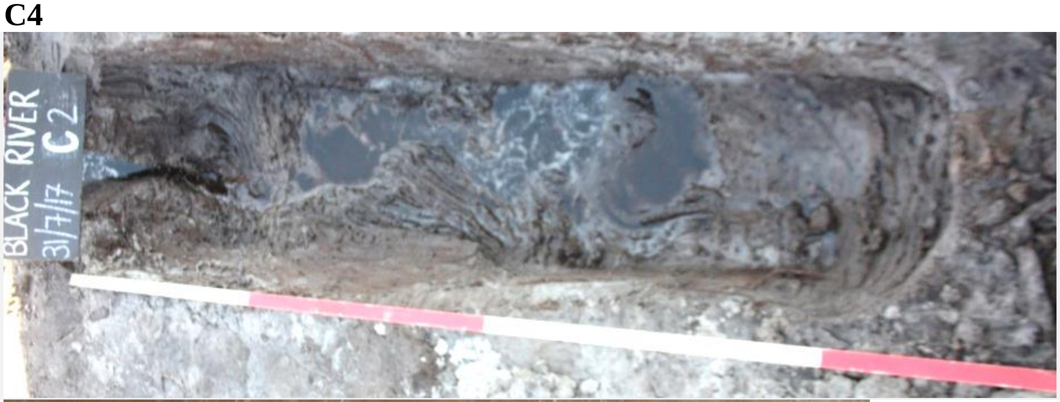
C2

C3


BLACK RIVER C3
31/7/17


C3
Black River
31/7/17

C4


BLACK RIVER C2
31/7/17


Black RIVER
C4

C5


BLACK RIVER C4
31/7/17


C5
Black River
31/7/17

C6


BLACK RIVER C6
31/7/17

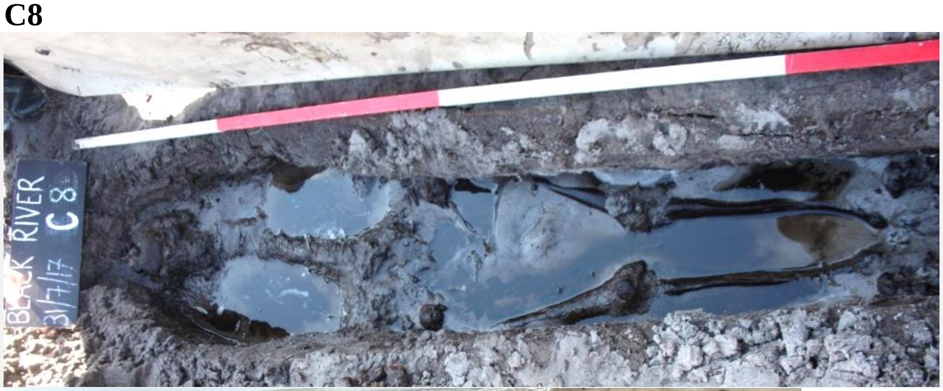

Black River
C6
31/07/17

C7


BLACK RIVER
C7
31/7/17


C7
Black River
31/7/17

C8


BLACK RIVER
C8
31/7/17

C9

C10


BLACK RIVER
31/7/17
C10


C10
Black River
31/7/17

C11


BLACK RIVER
31/7/17
C11


C11
Black River
31/7/17

C12


BLACK RIVER
C12
3/8/17


Black River
C12
03/08/17

C13


BLACK RIVER
C13
3/8/17


Black River
C13
03/08/17

C14


BLACK RIVER C14
3/8/17


Black River
C14
03/08/17

C15


BLACK RIVER C15
3/8/17


Black River
C15
03/08/17

C16


BLACK RIVER C16
3/8/17


Black River
C16
03/08/17

C17


BLACK RIVER C17
3/8/17

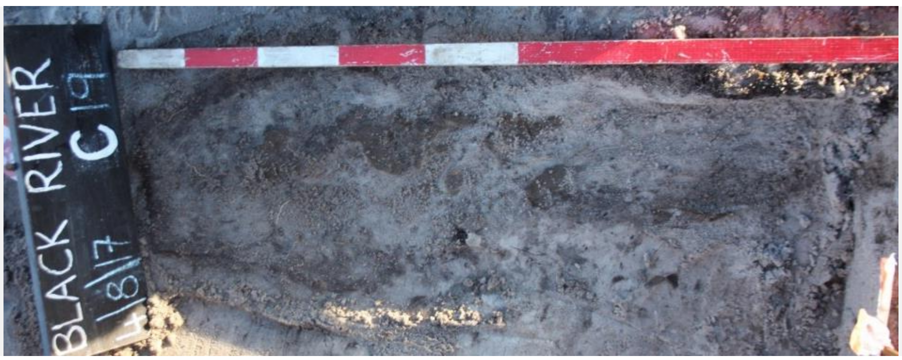
C18a


BLACK RIVER C18
4/8/17


Black River
C18
04/08/17

C18b

C19



C20

C21


C21
Black River
4/8/17

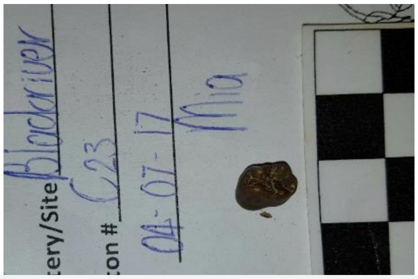
C22


BLACK RIVER C22
4/8/17


Black River
C22
04/08/17

C23


BLACK RIVER C23
4/8/17


Blackriver
C23
04-07-17
Mia

C24


BLACK RIVER
C24
4/8/17


Black River
C24
04/08/17

C25


BLACK RIVER
C25
4/8/17

C26


BLACK RIVER
C26
4/8/17

C27

C28a

C28b

C28c


BLACK RIVER
4/9/17 C 28c


Blackriver
C28c
04-09-17

C29


BLACK RIVER
4/8/17


Black River
C29
07/08/17

C30


BLACK RIVER C30
7/8/17


C30
Black River
7/8/17

C31


BLACK RIVER
7/8/17 C31


Black River
C31
8 Aug 2017

C32


BLACK RIVER
7/8/17 C32


Black River
C32
7 Aug 2017

C33


BLACK RIVER C33
7/8/17


C33
Black River
7/8/17

C34


BLACK RIVER C34
7/8/17


C34
Black River
7/8/17

C35


BLACK RIVER C35
7/8/17


C35
Black River
7/8/17

C36


BLACK RIVER C36
7/8/17


C 36
Black River

C37


BLACK RIVER C37
7/8/17

C38


BLACK RIVER
7/8/17 C38

C39a


BLACK RIVER
7/8/17 C39


C39a
Black River
7/8/17

C39b

C40a

C40b

C41

C42a

C42b

C42c

C43


BLACK RIVER PAD
C43
8/8/17

C44


BLACK RIVER C44
7/8/17

C45


Black River
C45
8/8/17
08/08/2017 15:25

C46


BLACK RIVER C44

C47

C48

C49


Black River
C49
10/8/17
10/08/2017 11:49

C50


BLACK RIVER C50

C51


BLACK RIVER C51
3/8/17


Black River
C51

C52


BLACK RIVER
C52
3/8/17


BLACK RIVER C52
08/08/17

C53


BLACK RIVER
C53
3/8/17


BLACK RIVER PARK
C53
03/8/17

C54


BLACK RIVER
10/8/17


Black River
C54 a/b
10/08/17

C55a


BLACK RIVER
10/8/17


10/08/2017 15:04
Black River
C55
10/08/17

C55b


BLACK RIVER

C56


BLACK RIVER
10/8/17 C56


Black River
C56
10/08/17

C57a


14/08/2017 16:0
Black River
C57
14/08/17

C57b


BLACK RIVER PARK
C57b
14/08/17

C58a


BLACK RIVER
10/8/17 C58a


Black River
C58a
10/08/2017

C58b


BLACK RIVER
10/8/17 C58b

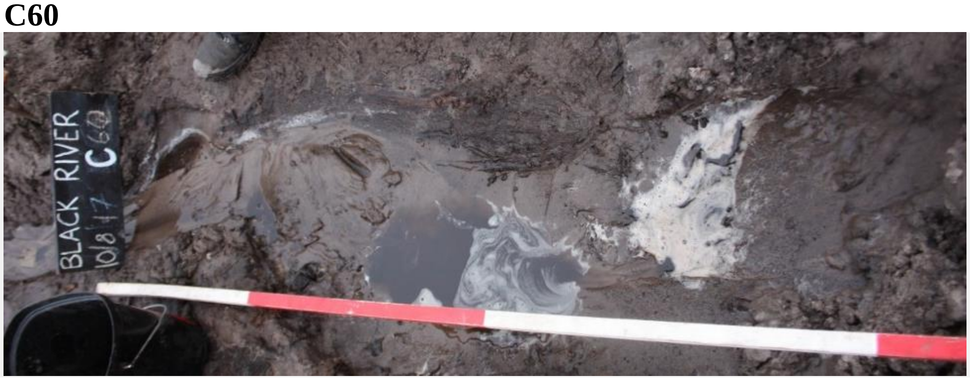

Black River
C58b
10/08/2017
11/08/2017 10:19

C59

C59a

C59b

C60

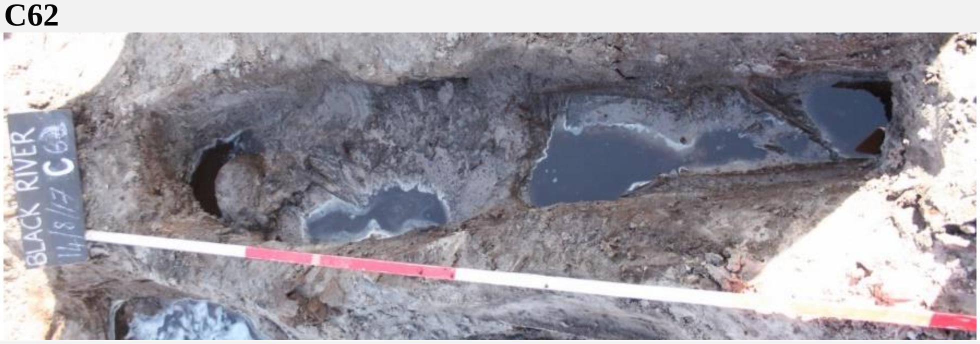



C 60
Black River
10/8/17

C61


BLACK RIVER
14/8/17

C62


BLACK RIVER
14/8/17

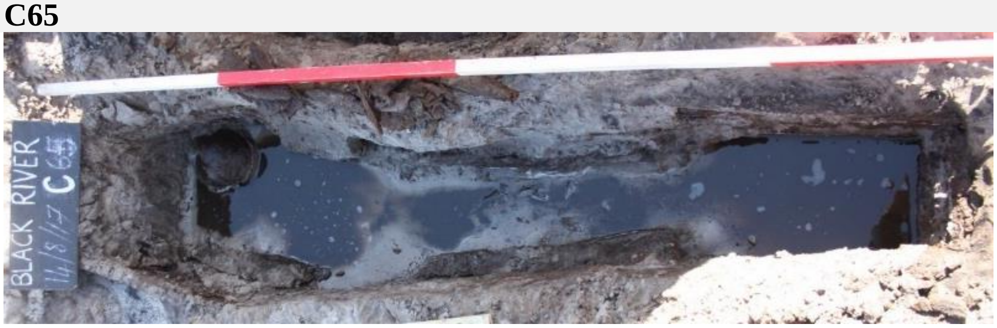
C63


BLACK RIVER
14/8/17

C64a

C64b

C65




15/08/2017 10:19

C66


BLACK RIVER
14/8/17

C67


BLACK RIVER
14/8/17


Black River
C67
14/08/17
15/08/2017 10:34

C68

C69

C70

C71

C72


23/08/2017 11:28
Black River
C72
21/08/17

C73


BLACK RIVER
21/08/17 C73

C74


BLACK RIVER
21/08/17 C 74

C75

C76


Black River
C76
21/08/17

C77


BLACK RIVER
23/08/17 C77


C 877
Black River
23/8/17

C78a


BLACK RIVER
23/08/17 C78


Blackriver
C78/a
23-08-17

C78b


BLACK RIVER
C 78b


Black River
C78b
23/8/17

C79a


BLACK RIVER
C 79


C79
Black RIVER
23/08/17

C79b


BLACK RIVER


Blackriver
C79/b
23-08-17

C80


BLACK RIVER


Black River
C80
23/08/17

C81


Black River
C81
23/8/17

C82


C82
Black River
23/8/17

C83


BLACK RIVER C83


Black River
C83
25/8/17

C84


BLACK RIVER C84
23/08/17


Black River
C84
23/08/17

C85


C85
Blackriver
23-08-17

C86


C 86
Blackriver
23 08-17

C87


C 87
Black River
23/8/17

C88


BLACK RIVER
25/8/17
C88


C 88
25/08/17

C89


C 89
Black River
23/8/17

C90


BLACK RIVER
25/8/17
C90


Blackriver
C90
25/8/17

C91

C92

C93


BLACK RIVER
C 93


BLACK RIVER
C93
28-08-2017

C94


BLACK RIVER
C 94

C95


BLACK RIVER
C 95


C95
Black River
25/8/17

C96


BLACK RIVER
C 96


C96
Black River
25/8/17

C97


BLACK RIVER
28/8/17
C 97


C97
Black River
28/8/17

C98


BLACK RIVER
28/8/17 C98


C98
BLACKRIVER
28-08-17

C99


C99


C99
Black River
28/8/17

C100

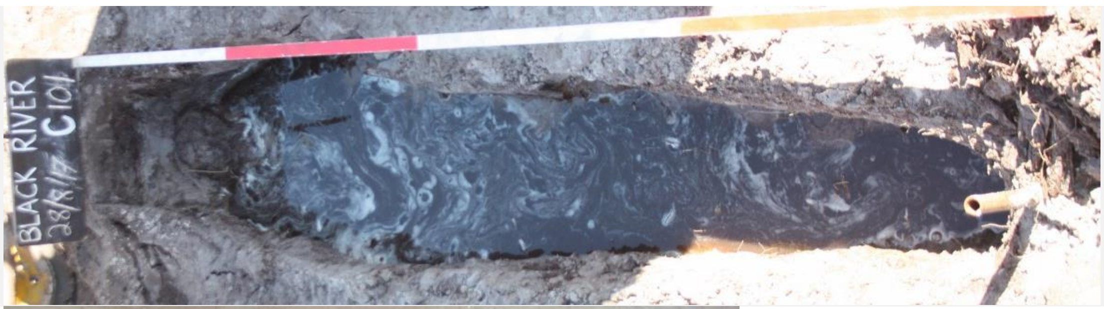

BLACK RIVER
28/8/17 C100

C100a


C100 a
Black River
28/8/17

C100b

C101



C102


C102
Black River
28/8/17

C103


BLACK RIVER C103
28/8/17


C103
Black River
28/8/17

C104ab


BLACK RIVER C104
28/8/17


C 104
Black River
28/8/17

C105


BLACK RIVER C105
28/8/17


Blackriver
C 105
28-08-2017

C106


BLACK RIVER C106
28/8/17


C106
Black River
28/8/16

C107


C107


Black River
C107
31/08/17

C108a


BLACK RIVER
28/8/17 C108

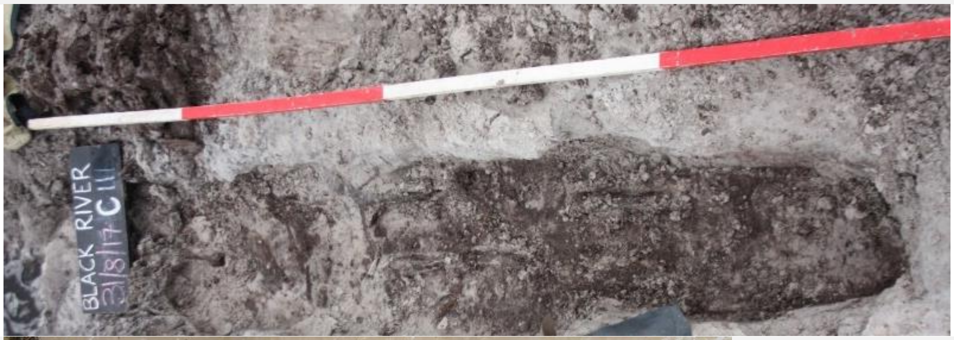
C108b

C108ab

C109

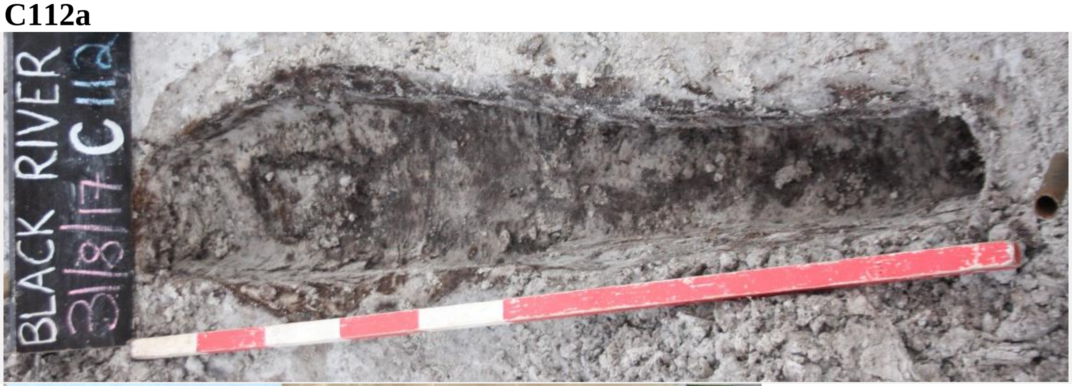
C110

C111


BLACK RIVER
31/8/17 C111


C111
Black River
31/8/17

C112a


BLACK RIVER
31/8/17 C112


Black RIVER
C 112
31/08/17

C112b

C113

C114


Blackriver
C114
01-09-17

C115


BLACK RIVER
31/8/17 C116


Blackriver
C115

C116


C116
31/8/17

C117


BLACK RIVER
31/8/17 C117


Black River
C117
31/08/17

C118


BLACK RIVER
4/9/17 C118


Black River
C118b
4/9/17

C119

C120

C121a

C121b

C121c

C122

C123a


C123
Black River
31/8/17

C123b


BLACK RIVER!
25/10/17 C123b


Blackriver
C123b
20-10-17

C124


BLACK RIVER
1/9/17 C124


Black River
C124
01/09/17

C125


BLACK RIVER C125
1/9/17


C125
Black River
1/9/17

C126


BLACK RIVER
1/9/17 C126


Black River
C 126
4/9/17

C127

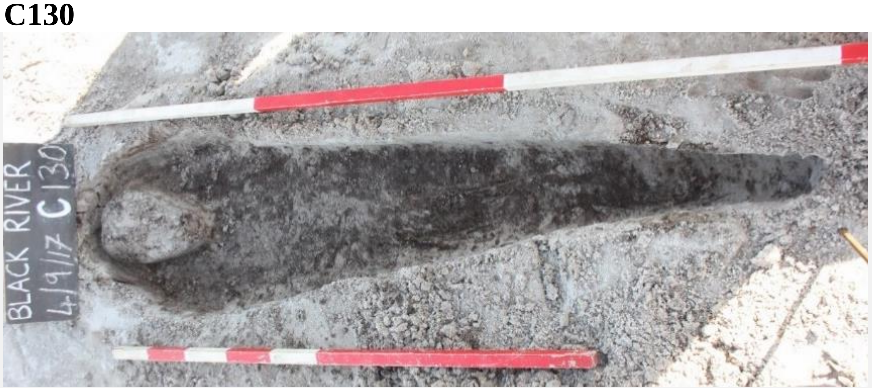

BLACK RIVER
1/9/17 C127


Black River
C127
01/08/17

C128

C129

C130




Blackriver
C130
04-09-17

C131


BLACK RIVER
4/9/17 C131


Black RIVER
C131
04/09/17

C132

C133ab

C133a

C133b

C134


BLACK RIVER
4/9/17 C 134


Blackriver
C134
04-09-17

C135


BLACK RIVER
4/9/17 C 135


Blackriver
C135
04-09-17

C136


4/9/17 C136


Blackriver
C136
04-09-17

C137


4/9/17


Blackriver
C137
04-09-17

C138


BLACK RIVER
4/9/17 C138


Black River
C138
04/09/17

C139


BLACK RIVER
4/9/17 C139


Blackriver
C139
04-09-17

C140

C141

C142

C143


BLACK RIVER
4/9/17 C 143


Blackriver
C 143
04-09-17

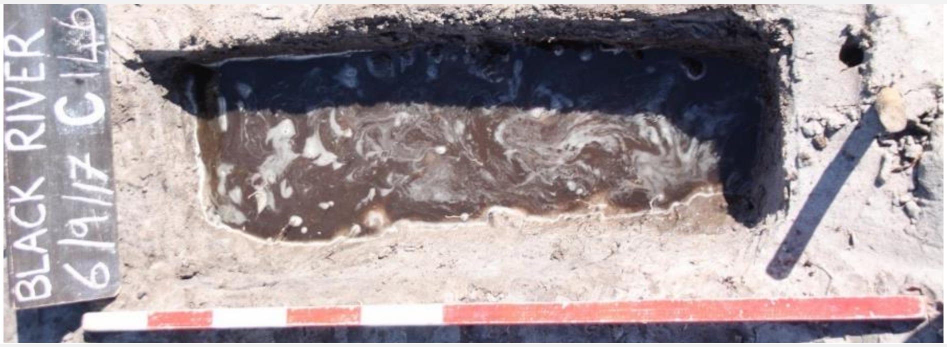
C144


BLACK RIVER
5/9/17 C 144


Blackriver
C144
05-09-17

C145

C146



C147

C148


CK RIVER
6/9/17 C148

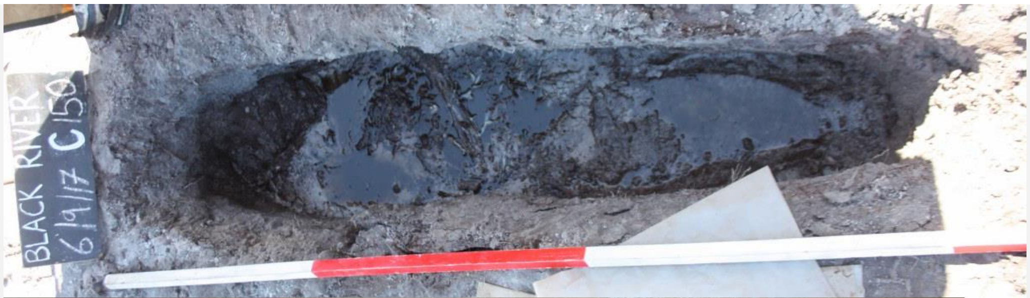

C148
Black River
6/9/17

C149


BLACK RIVER
6/9/17 C149


Blackriver
C149
06-09-17

C150


BLACK RIVER
6/19/17 C150


Black River
C150
06/09/17

C151

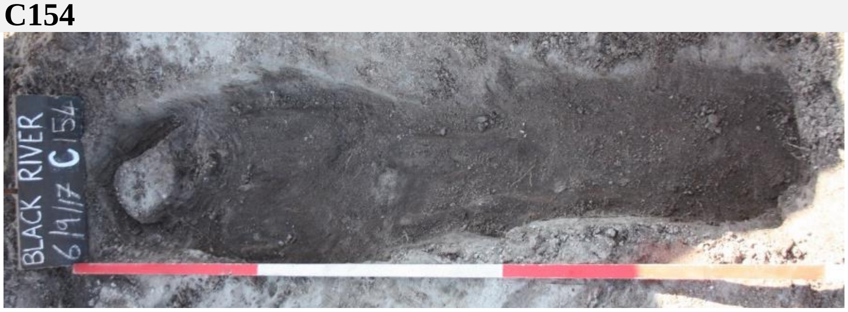

BLACK RIVER
6/19/17 C151


Black River
C151
6/9/17

C152

C153

C154




Blackriver
C154
08-09-17

C155


BLACK RIVER
8/9/17 C 155


Blackriver
C155
08-09-17

C156


BLACK RIVER
11/9/17 C 156

C157


BLACK RIVER
11/9/17 C157


Blackriver
C157
11-09-17

C158


BLACK RIVER
11/9/17 C158


Black RIVER

C159


BLACK RIVER
11/9/17 C159


Black River
C159
11/09/17

C160


BLACK RIVER
11/9/17 C160


Black River
C160
11/09/17

C161

C162a

C162b

C163

C164

C165

C166


BLACK RIVER
11/9/17 C166


Black River
C166
11/09/17

C167


BLACK RIVER
11/9/17 C167


C167
Black River
11/9/17

C168a

C168b

C169

C170


BLACK RIVER
11/9/17 C170


C170
Black River
11/9/17

C171


BLACK RIVER
11/9/17 C171


Black River
C171
12/09/17

C172

C173

C173a

C173b

C173c

C174

C175

C176


Black River
C176
12/09/17

C177


BLACK RIVER
12/9/17 C177


C177
Black River
13/9/17

C178


BLACK RIVER
12/9/17 C178


Blackriver
C178
12-09-17

C179


BLACK RIVER
12/9/17 C179


Black River
C179
12/09/17

C180


BLACK RIVER
12/9/17 C180

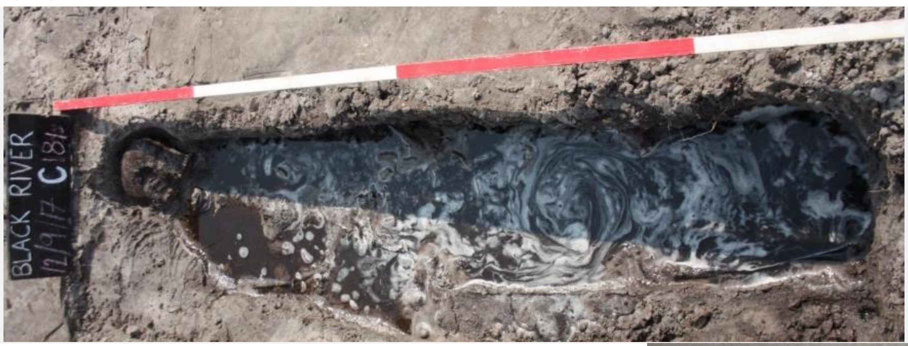
C181

C182

C183


C183
Black River
14/9/17

C184a


BLACK RIVER
12/9/17 C184


Blackriver
C184a
15-09-17

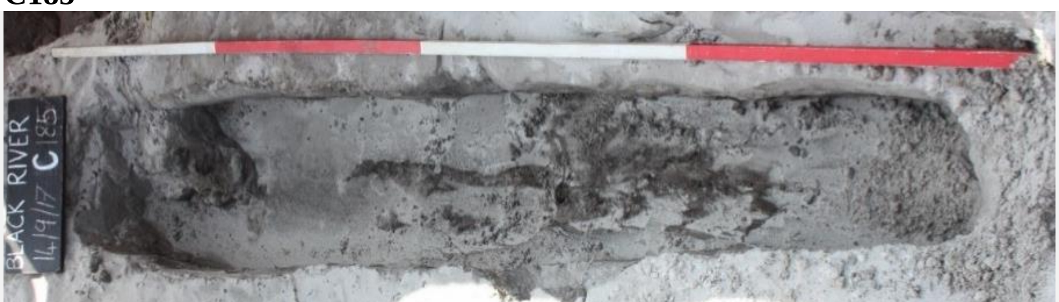

Blackriver
C184a
15-09-17

C184b


BLACK RIVER
14/9/17 C184


Blackriver
15-09-17

C185


BLACK RIVER
14/9/17 C185


Blackriver
C185
14-09-17

C186


BLACK RIVER
15/9/17 C186


Black River
C186
15/9/17

C187a


BLACK RIVER
19/9/17 C187


C187a
Black River
19/9/17

C187b


BLACK RIVER
19/9/17 C 187b


C ~~200~~ 187b
Black River
20/9/17

C188


BLACK RIVER
19/9/17 C188


Blackriver
C188
19-09-17

C189


BLACK RIVER
C189


Blackriver
C189
19-09-17

C190a


BLACK RIVER
19/9/17
C190


C190a
Black River
19/9/17

C190b


BLACK RIVER
20/9/17 C190


C190b
Black
River
20/9/17

C191


BLACK RIVER
19/9/17 C191


Black River
C191
19/09/17

C192

C193

C194

C195


BLACK RIVER
20/9/17 C195


Blackriver
C195
20-09-17

C196


BLACK RIVER
20/9/17 C196


C196
Black River
20/9/17

C197a

C197b

C198


Blackriver
C198
20-09-17

C199


BLACK RIVER
20/9/17 C198

C200


BLACK RIVER
20/9/17 C200


C200
Black River
20/9/17

C201


BLACK RIVER
20/9/17 C 201


Black River
C [redacted] 201
20/09/17

C202a


BLACK RIVER
21/9/17 C 202


Black River
C 202 a
21/09/17

C202b

C202c

C203


C203
Black River
20/9/17

C204


BLACK RIVER
20/9/17


Black River
C204
20/09/17

C205


BLACK RIVER


Black River
C 205
21/9/17

C206


BLACK RIVER
22/9/17 C 206

C207a

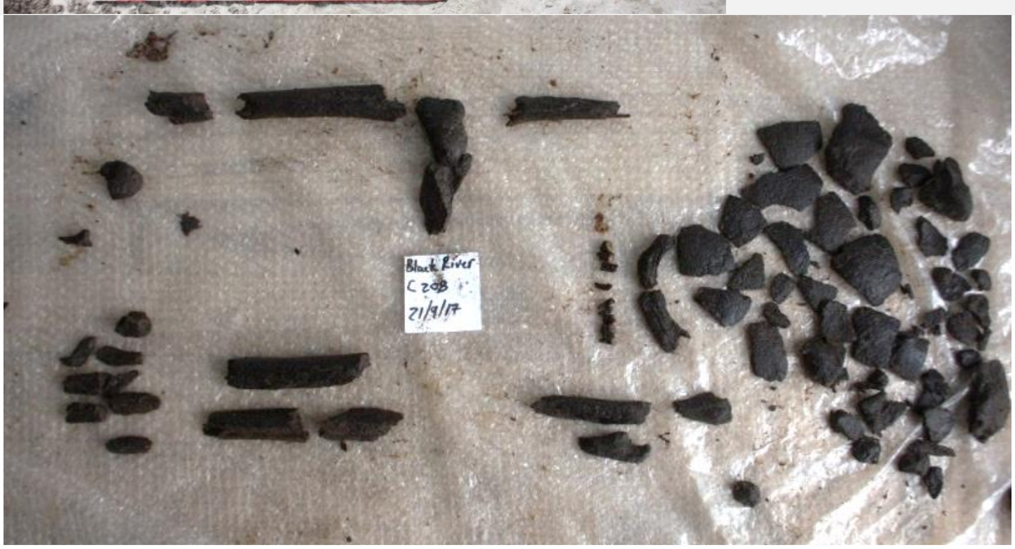

BLACK RIVER
22/9/17 C 207


Blackriver
C207a
22-09-17

C207b

C207c

C208



C209

C210

C211a

C211b

C212

C213


C213
Black River
26/9/17

C214


BLACK RIVER
26/9/17 C214


C214
Black River
26/9/17

C215


BLACK RIVER
26/9/17 C215


C 215
Black River
26/9/17

C216


BLACK RIVER
26/9/17 C216


C126
Black River
26/9/17

C217ab


BLACK RIVER

C217a

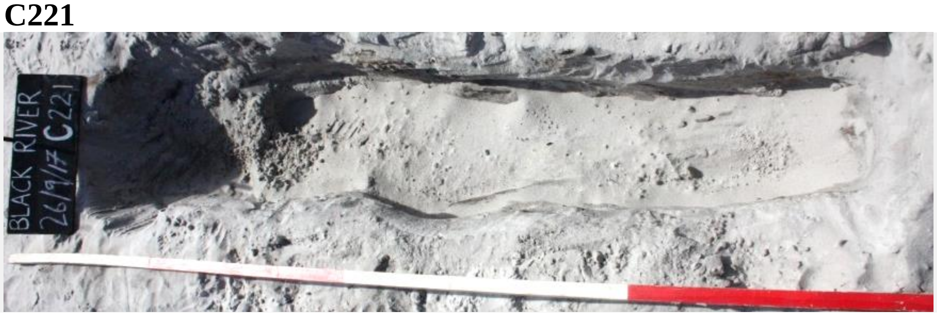
C217b

C218

C219

C220

C221




Blackriver
C221
26-09-17

C222


BLACK RIVER
26/9/17 C222


C222
Black River
26/9/17

C223


BLACK RIVER
26/9/17 C223


C223
Black River
26/9/17

C224


BLACK RIVER
26/9/17 C224

C225


BLACK RIVER
26/9/17 C225


Blackriver
C225
26-09-17

C226


BLACK RIVER
26/9/17 C226


Blackriver
C226
26-09-17

C227


BLACK RIVER
27/9/17 C227


Blackriver
C227
27-09-17

C228


BLACK RIVER
27/9/17 C228


BLACK RIVER
C228
27/09/17

C229


BLACK RIVER
27/9/17 C229

C230


BLACK RIVER
27/9/17 C230


Blackriver
C230
27-09-17

C231

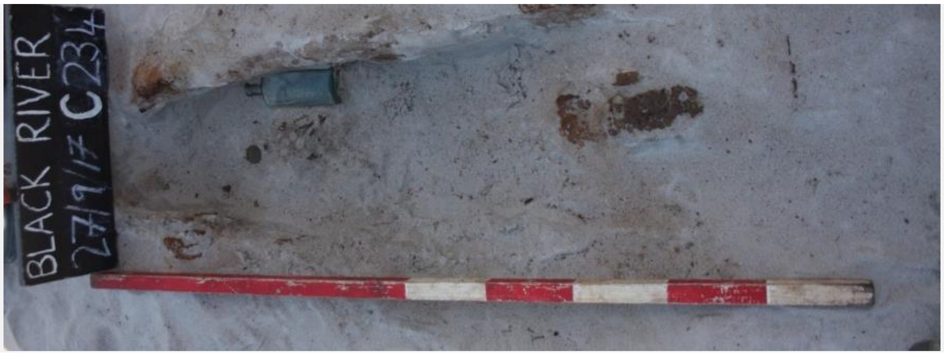

BLACK RIVER
27/9/17 C231


Blackriver
C231
27-09-17

C232

C233

C234



C235

C236

C237a


Blackriver
C237a
27-09-17

C237b


BLACK RIVER
27/9/17 C237b


Blackriver
C237b
27-09-17

C237c


BLACK RIVER
27/9/17 C237c


Blackriver
C237c
27-09-17

C238


BLACK RIVER
27/9/17 C238


Black River
C238
27/09/17

C239


BLACK RIVER
27/9/17 C239


Blackriver
C239
27-09-17

C240a


BLACK RIVER
27/9/17 C240


Black River
27/9/17

C240b

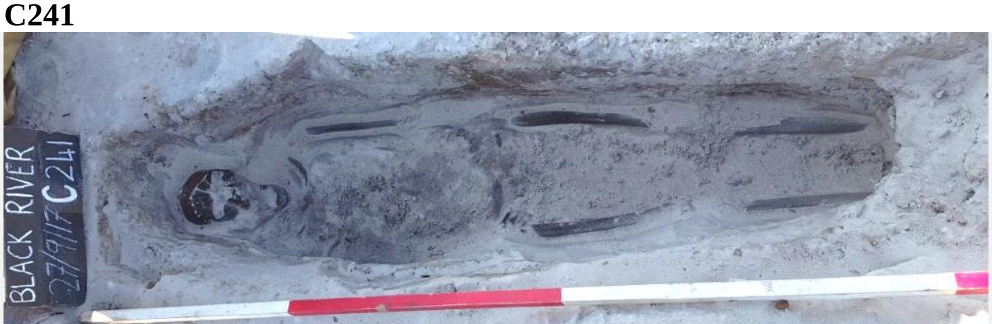

BLACK RIVER
28/9/17 C240b


C240b
Black River
28/9/17

C240c


Black River
28/9/17

C241


BLACK RIVER
27/9/17 C241


C241
Black River
27/9/17

C242


BLACK RIVER
28/9/17 C242


Black River
C242
28/09/17

C243


BLACK RIVER
29/9/17 C243


Blackriver
C243
29-09-17

C244ab

C244a

C244b

C245


BLACK RIVER
29/9/17 C245


Black River
C245
29/09/17

C246


BLACK RIVER
29/9/17

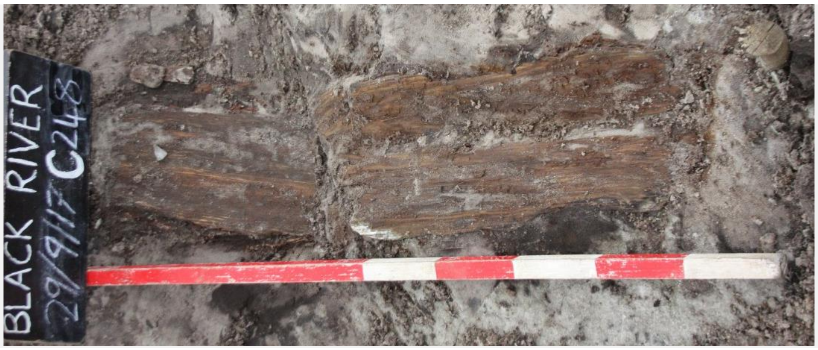

BLACK RIVER
C246
29/09/17

C247


BLACK RIVER
29/9/17 C247


Blackriver
C247
29-09-17

C248



C249a

C249b

C250a

C250b

C251

C252

C253

C254

C255

C256

C257

C258

C259

C260

C261

C262

C263

C264

C265

C266

C267

C268

C269


C269
Black River
4/10/17

C270a


BLACK RIVER
04/10/17 C270


Black River
C270a
04-10-17

C270b


BLACK RIVER
5/9/17 C270b


C270b
Black River
5/10/17

C271


BLACK RIVER
5/9/17 C271


Blackriver
C271
05-10-2017

C272

C272a

C272b

C273


BLACK RIVER
5/9/17


C273
Black River
5/10/17

C274


BLACK RIVER
5/9/17 C274


Black River
5/9/17

C275


BLACK RIVER
5/9/17 C275


Black River
C275
5/10/17

C276


BLACK RIVER
5/9/17 C276


BLACK RIVER
05/10/17
C276

C277

C278

C279a

C279b

C280


BLACK RIVER
5/9/17 C280

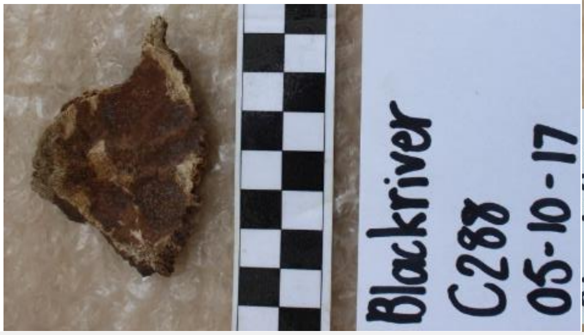

C280
Black Rive
5/10/17

C281


BLACK RIVER
5/9/17 C281


Black River
C281
05/10/17

C282

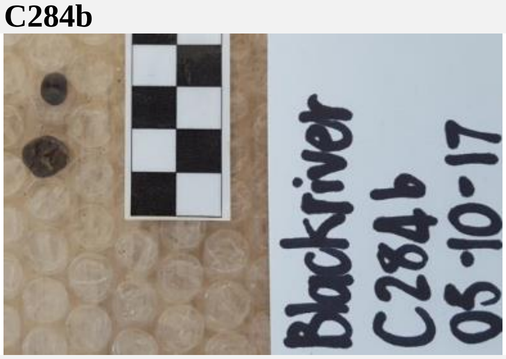


C283a

C283b

C284a

C284b



C284c

C284d

C285a

C285b

C286

C287

C288

C289


Blackriver
C289
06-10-17

C290


BLACK RIVER
6/10/17


C290
Black River
6/10/17

C291


BLACK RIVER
6/10/17

C291a

C291b

C292

C293

C294

C295

C296


C296
Black River
9/10/17

C297


BLACK RIVER
9/10/17 C297


Black river
C297
09-10-17

C298

C299

C300

C301

C301a

C301b

C301c


Black River
C301c
9/10/17


Black River
C301c
9/10/17

C302


BLACK RIVER C302
9/10/17


C 302
Black River
9/10/17

C303

C304

C305

C306

C307

C308ab

C308b

C309

C310

C310a

C310b

C311

C312

C313a

C313b

C314


Blackriver
C314
11-10-17

C315


BLACK RIVER
11/10/17 C315


C315
Black River
11/10/17

C316


BLACK RIVER
11/10/17 C316

C317

C318

C319

C320


BLACK RIVER
11/10/17 C320


Blackriver
C320
11-10-17

C321


BLACK RIVER
11/10/17 C321


Blackriver
C321
11-10-17

C322


BLACK
12/10/17


Black River
C 322
12/10/17

C323


BLACK RIVER
12/10/17 C323


Blackriver
C323
13-10-17

C324


Blackriver
C324
13-10-17

C325


Blackriver
C325
13-10-17

C326

C327

C328

C329

C330

C331

C332

C333

C334

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C336

C337

C338

C339

C340

C341

C342

C343a

C343b

C344

C345

C346

C347

C348

C349

C350

C351a

C351b

C352

C353

C354

C355

C356

C356a

C356b

C357

C358


BLACK RIVER
23/10/17 C358


Blackriver
C358
23-10-17

C359ab


Blackriver
C359
24-10-17

C360a

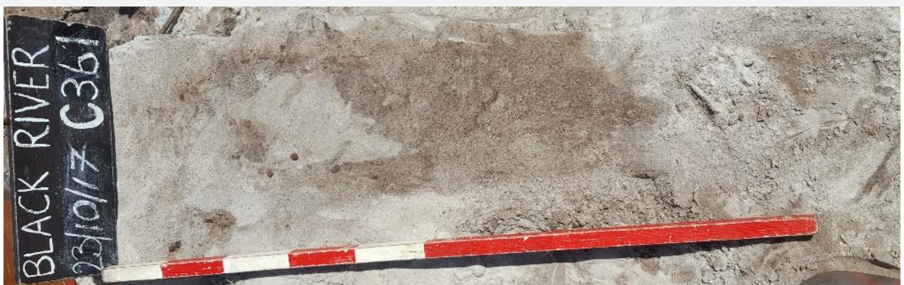

BLACK RIVER
23/10/17 C360


Blackriver
C360a
23-10-17

C360b


BLACK RIVER
23/10/17 C360

C361


BLACK RIVER
23/10/17 C361


Blackriver
C361

C362


BLACK RIVER
23/10/17 C362

C363

C364

C365

C366

C367

C368

C369

C370

C371

C372

C373a

C373b

C374

C375

C376

C377

C378

C379

C380

C381

C382

C383

C384

Cscatter

Appendix 12: Quadrant D burial numbers and photographs

D1X

D2X

D3X

D4X

D1

D2

D3

D4a

D4b

D5

D6

D7a

D7b

D8a

D8b

D9

D10

D11

D12a

D12b

D13a

D13b

D14

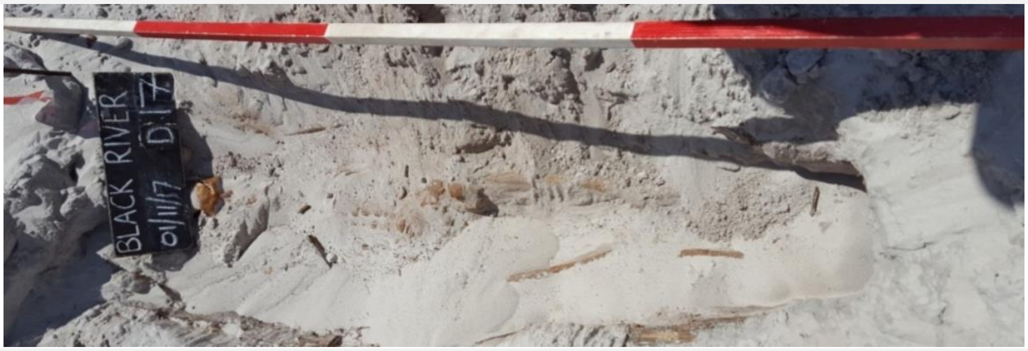
D15

D16

D16a

D16b

D17


BLACK RIVER D17
01/11/17

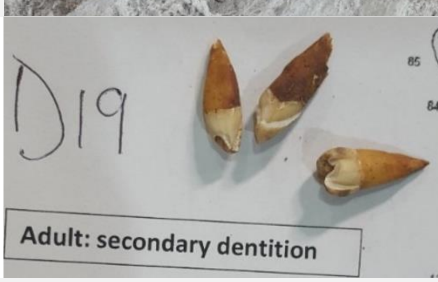
D18


BLACK RIVER D18
01/11/17


Cemetery/Site Black River
Skeleton # D18
Date:

D19


BLACK RIVER D19
02/11/17


D19
Adult: secondary dentition

D20


BLACK RIVER
02/11/17
D20


D20
Black River
2/11/17


D20
Black River
2/11/17

D21a


BLACK RIVER
02/11/17
D21


D21a
Black River
2/11/17

D21b

D22a

D22b

D23


BLACK RIVER
02/11/17 D23

D24


BLACK RIVER
02/11/17 D24


BLACK RIVER
D24
02.11.2017

D25a


BLACK RIVER
02/11/17 D25


Blackriver
D25a
2-11-17

D25b


BLACK RIVER D25b
02/11/17

D26


BLACK RIVER D26
02/11/17


BLACK RIVER
D26
02.11.2017

D27

D28ab

D28b

D29


BLACK RIVER
02/11/17 D29


Black River
D 29
02/11/17

D30


BLACK RIVER
13/11/17 D 30

D31


BLACK RIVER
02/11/17 D31

D32a


BLACK RIVER D32
02/11/17


BLACK RIVER
D32a
02.11.2017

D32b


BLACK RIVER D32b
02/11/17


BLACK RIVER
D32b
02.11.2017

D33


BLACK RIVER
02/11/17 D33


Black River
D33
02.11.2017

D34


BLACK RIVER
02/11/17 D34

D35


BLACK RIVER
02/11/17 D35

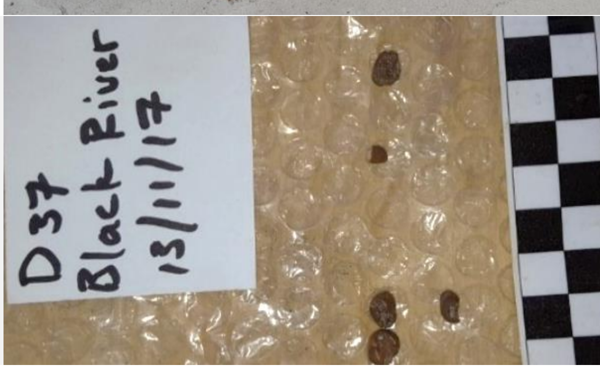

D35
Black River
2/11/17

D36


BLACK RIVER
13/11/17 D36

D37a


BLACK RIVER
13/11/17 D37


D37
Black River
13/11/17

D37b

D38a

D38b


D38b
Black River
13/11/17

D39


BLACK RIVER
13/11/17 D39


D39
Black River
13/11/17

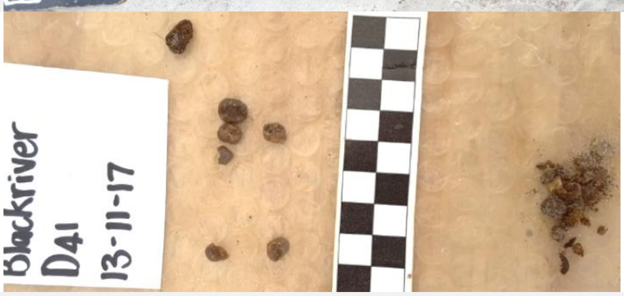
D40


BLACK RIVER
13/11/17 D40


D40
Black River
13/11/17

D41


BLACK RIVER
13/11/17
D4


Blackriver
D41
13-11-17

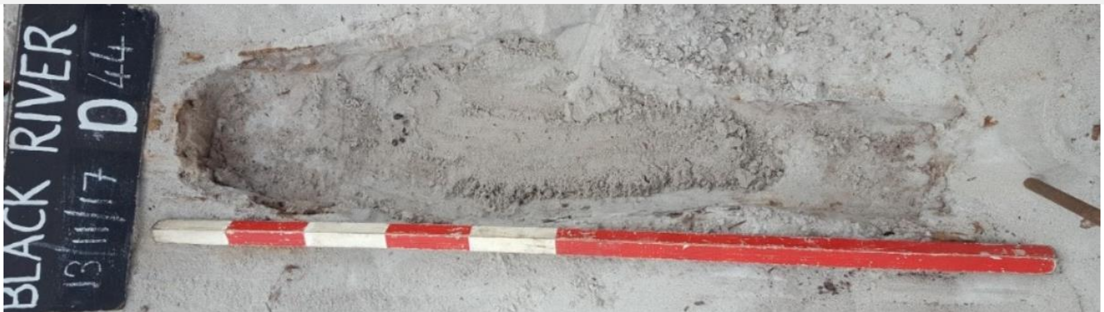
D42

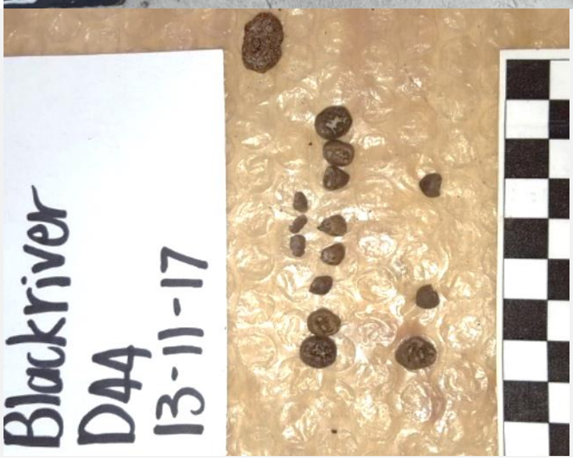

BLACK RIVER
13/11/17
D42

D43


BLACK RIVER
13/11/17
D43

D44





D45

D46ab

D47


BLACK RIVER
14/11/17 D47


Blackriver
D47
13-11-17

D48


BLACK RIVER
14/11/17 D48

D49


BLACK RIVER
14/11/17 D49

D50

D51a

D51b

D52

D53


BLACK RIVER
14/11/17 D53

D54


BLACK RIVER
14/11/17 D54


Black River
D54
14/11/17

D55


BLACK RIVER
14/11/17 D55

D56a

D56b

D57

D58

D59

D60

D61

D62

D63a

D63b

D64

D65

D66a

D66b

D67ab

D68

D69


BLACK RIVER
15/11/17 D69


D69
Black River
15/11/17

D70


BLACK RIVER
15/11/17 D70

D71a

D71b

D72

D73

D74

D75a

D75b

D76

D77

D78

D79a

D79b

D80

D81ab

D81b

D82

D83

D84a

D84b

D85

D86

D87a

D87b

D88

D89

D90

D91

D92

D93

D94

D95

D96

D97

D98

D99

D100

D101

D102

D103a

D103b

D104

D105ab

D106

D107

D108

D109

D110

D111

D112

D113

D114a

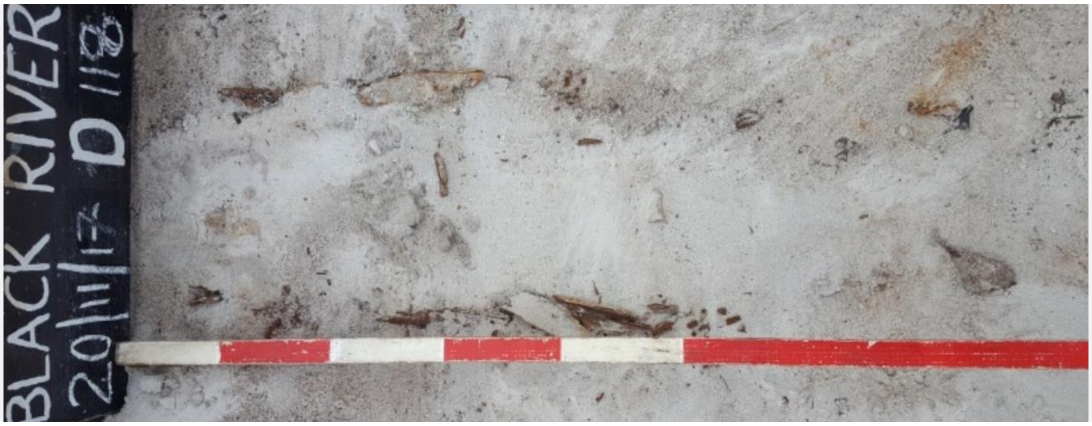
D114b

D115

D116

D117

D118



D119

D120

D121

D122

D123

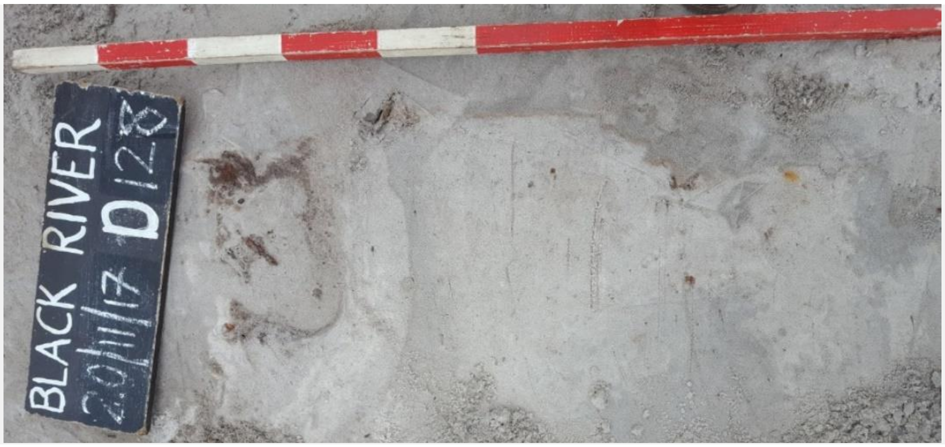
D124

D125

D126

D127

D128



D129

D130

D131

D132

D133a

D133b

D134

D135

D136

D137

D138a

D138b


RIVER


BLACK RIVER
D138b

D139


BLACK RIVER
D139

D140


BLACK RIVER
20/11/17 D140

D141

D142

D143

D144

D145

D146

D147

D148

D149

D150

D151

D152

D153

D154

D155

D156

D157

D158

D159

D160a

D160b

D161a

D161b

D162

D163

D164

D165

D166ab


BLACK RIVER
D166
22.11.2017

D167


BLACK RIVER D167
22/11/17


D167
Black River
22/11/17

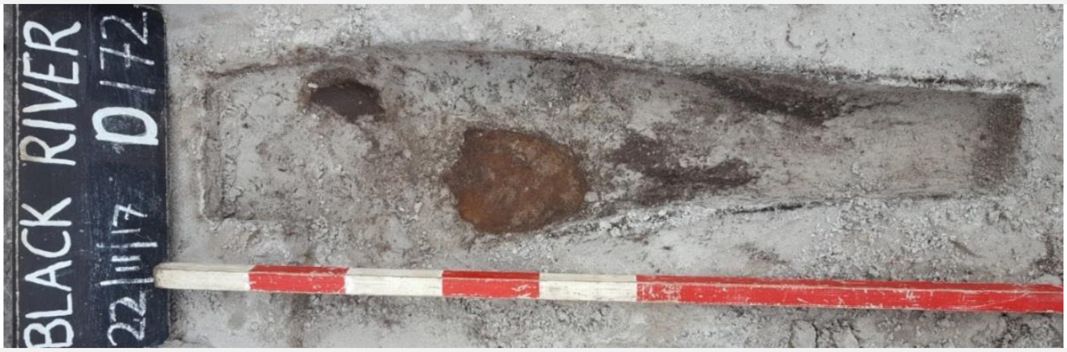
D168

D169

D170

D171

D172



D173

D174

D175

D176

D177

D178

D179a

D179b

D180

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D182

D183

D184

D185

D186

D187

D188

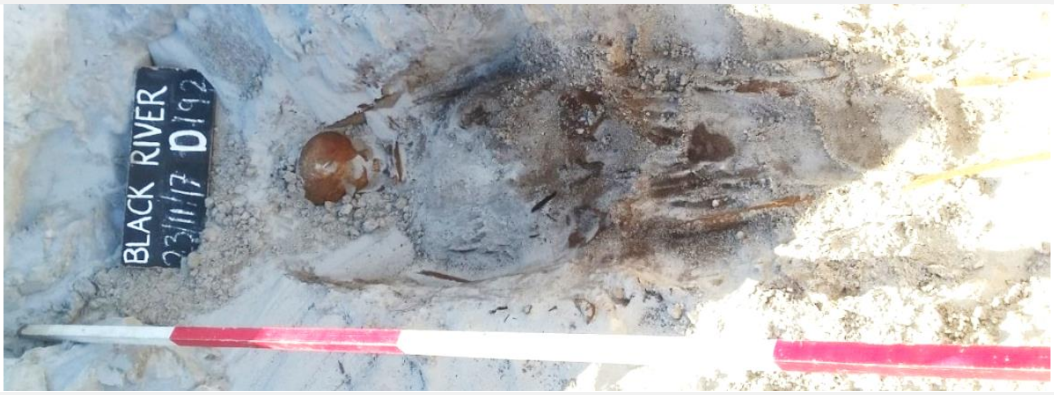
D189a

D189b

D190

D191

D192



D193

D194

D195

D196

D197

D198ab

D199

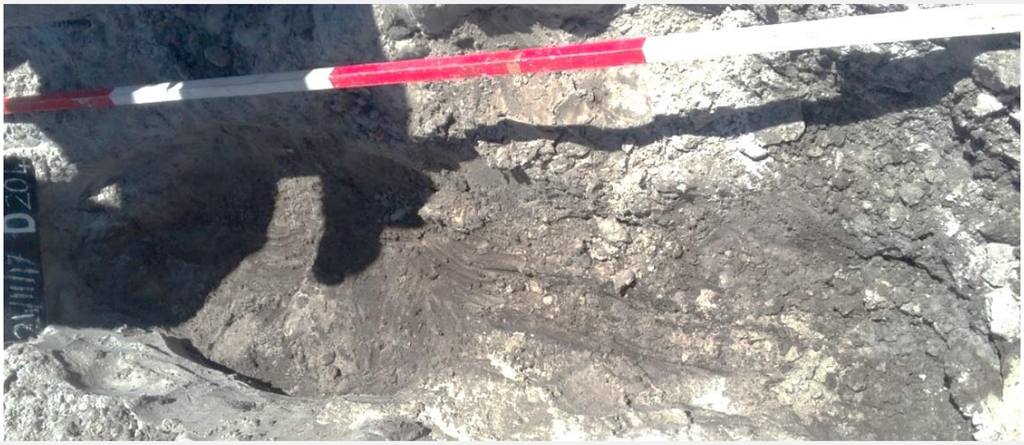
D200

D201

D202

D203

D204



D205

D206

D207

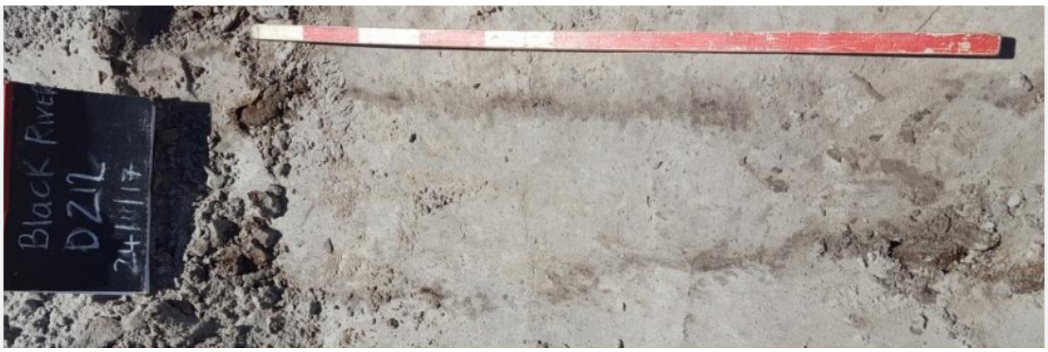
D208

D209

D210

D211

D212



D213a

D213b

D214

D215

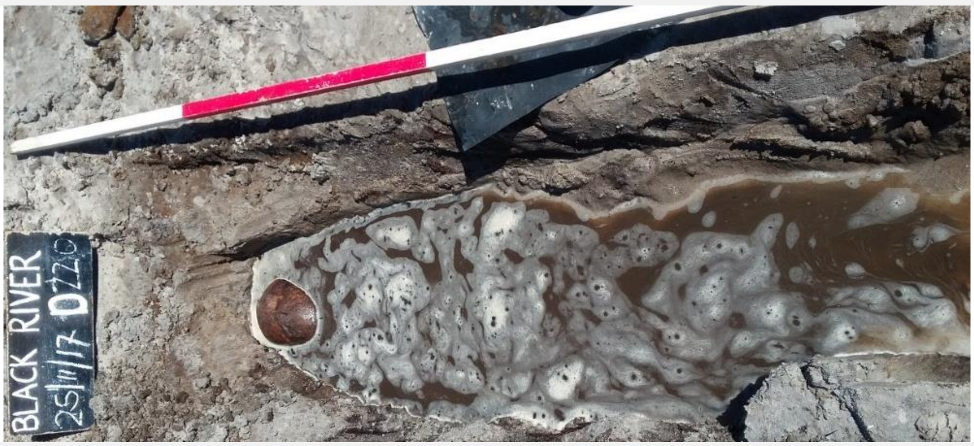
D216

D217

D218

D219

D220



D221

D222

D223

D224

D225

D226

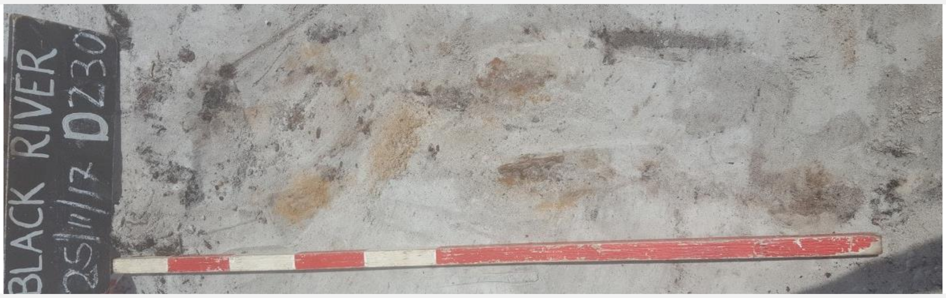
D227

D228

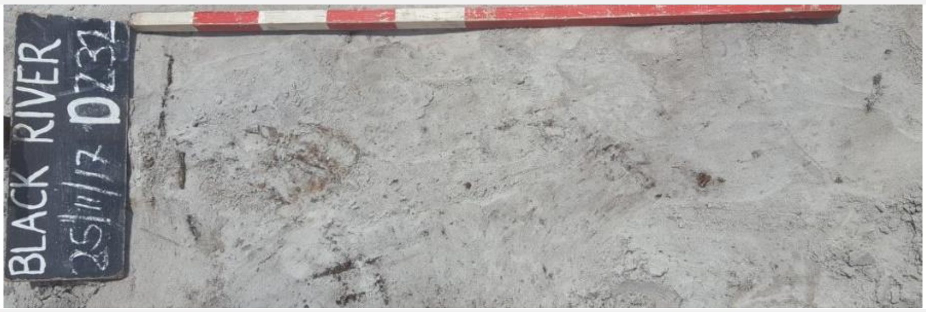
D229a

D229b

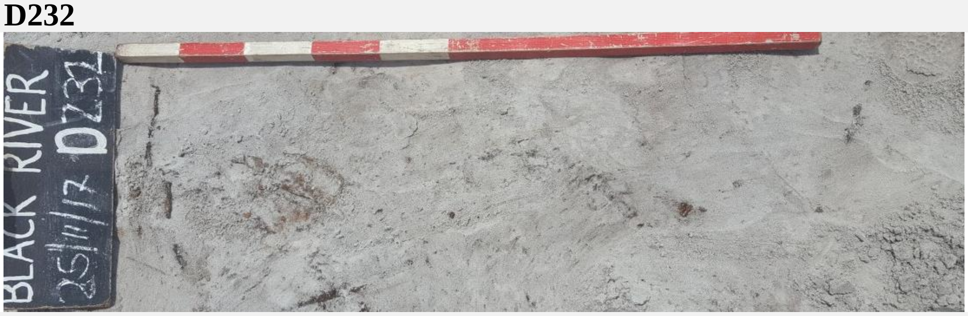
D230



D231



D232



D233

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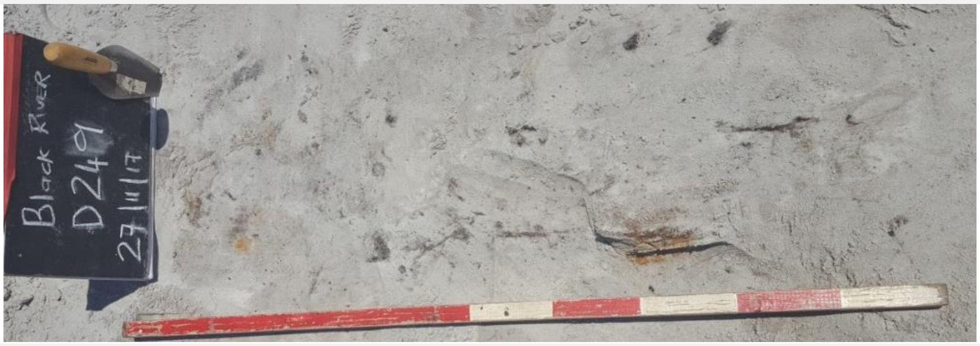
D249



D250

D251

D252

D253

D254

D255

D256a

D256b

D257

D258

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D260

D261

D262a

D262b

D263

D264

D265

D266

D267

D268

D269

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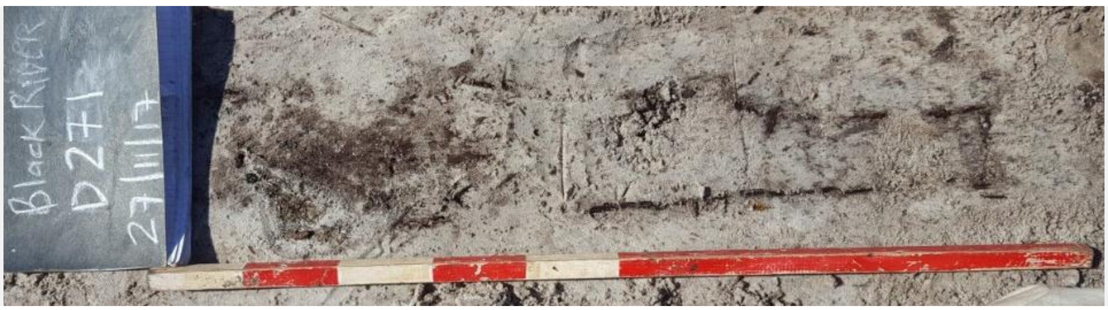
D271



D272

D273

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D286

D287

D288

D289

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D291

D292

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D302

D303

D304

D305a

D305b

D306

D307

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D317


BLACK RIVER
01/12/17 D 317


Black River
01/12/17
D317

D318


BLACK RIVER
01/12/17 D 318

D319

D320

D321

D322


Black River
D 322 01/12/17

D323


BLACK RIVER
04/12/17 D 323


Black River
D 323 04/12/17

D324

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D336 & D337

D338

D339