WEAPONS, WARFARE AND SKELETAL INJURIES DURING THE IRON AGE IN THE ANCIENT NEAR EAST

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Weapons, warfare and skeletal injuries during the Iron Age in the Ancient Near East

I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

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Dr Johan Pretorius 30 October 2020
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ABSTRACT

Due to the nature of war, persons are killed with various types of weapons. Throughout the history of humanity, weapons were used in this regard and these weapons left injuries on the victims that are distinguishable. The type of force conveyed by the ancient weapons effected injuries that enable modern-day bioarchaeologists to extrapolate which weapons caused which injuries. The Assyrians depicted their wars and battles on reliefs. An analysis of these depictions, with an extrapolation of the lesions expected in skeletal remains, could contribute to better understanding of the strategies of war in ancient times. This dissertation will discuss how the evaluation of human remains in comparison to Assyrian reliefs may contribute to the chronological knowledge of war and warfare in the Iron Age Ancient Near East – especially at Lachish. A discourse of the approaches available to researchers regarding access to data in the forensic bioarchaeological field will be presented.

Keywords:

Ancient Near East; Assyrian reliefs; bioarchaeology; blunt force trauma; chronology; forensic anthropology; human remains; Iron Age; Lachish; Lachish reliefs; radiocarbon dating; sharp force trauma; skeletal remains; war; warfare; weaponry; wound patterns.

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1. INTRODUCTION

Aggression, interpersonal conflict and interpersonal violence are part of human nature from time immortal. According to the story of Cain and Abel in the first book of the Bible[1] (Gn 4), *one of only four* humans 'overcome' this interpersonal conflict with violence – Cain murdered his brother. *Homo sapiens* is, like other social mammals, a xenophobic creature. *Sapiens* instinctively divide humanity into two parts, 'we' and 'they' (Harari 2015:171, 195). Differences between humans may lead to violence. Differences between individuals may lead to crime – assault and/or murder. Differences between groups, states or nations may precipitate and lead to war.

Military force has been the final arbiter in nations' differences throughout the ages. Warfare, with its consequences inflicted on the 'common man', was and remains a core characteristic of human nature (Human 2006: summary). In 1968, Will and Ariel Durant calculated that in the previous 3 421 years there had been only 268 years of peace in the world. This is probably less, because they were not able to incorporate places without written history, such as prehistoric sub-Saharan Africa, Australasia and the Americas. Making war is the norm in the life of mankind throughout all dispensations of the world (Human 2006:40). Keeley (1996:x) goes further and is of the opinion that the notion of *prehistoric* and primitive warfare is not an oxymoron.

Powerful nations' political and economic initiatives, expressed and settled in war, influenced the history of adjacent nations, noticeable in changes in their material culture, which are evident in archaeological excavations (*inter alia* bioarchaeology) and surveys (Leonard 1989:5). An intrusive culture (eg Assyrian, Babylonian and Persian) must be distinguishable from the contemporary indigenous (eg Israelite) culture and the 'event' should be clarified. Invasions, such as the Assyrian and Babylonian invasions of Israel, are examples of an 'event', which presents synchronous discontinuities of 'pure' past cultures in the invaded area. Archaeologists see this in evidence of destruction and abandonment of sites, destruction and resettlement of some sites by a new population or settlements founded *de novo* initially after and following the invasion (Stager 1995:332). These invasions exacted its toll on both the attackers and the defenders with many

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[1] All biblical references are from the King James Version.

casualties, such as at Lachish, which bioarchaeologists can study to enrich the knowledge about Ancient Near Eastern warfare. An additional source in the analysis of ancient warfare is the rich treasure of depictions of Assyrian warfare. Bioarchaeology can augment this knowledge, more than ever, with new methodology, which can elucidate the violent event of death and its circumstances.

The Iron Age's duration in the Ancient Near East was *circa* 1 200-332 BCE, including the Assyrian, Babylonian and Persian periods. These periods represent the last four hundred years in this view of the Iron Age in the Ancient Near East: from 732 BCE, with the rise of the Assyrian empire, to 332 BCE, ending the Persian period the year of the conquest of Alexander the Great. Stern (2001:xv) sees this as a single period in terms of material culture during which the region was under control of three Mesopotamian powers, while King and Stager (2001:xxiii) include the Assyrian rule in Iron Age IIC. The policies applied by the occupying powers, however, resulted in considerable differences in other areas, reflected in archaeological finds. From a forensic point of view, the injuries from weaponry prior to the use of gunpowder are all similar, irrespective whether bronze or iron weapons were used. A sharp force injury (stab wound) from a bronze, iron or modern steel knife looks the same (İşcan & Steyn 2014:339; Shwär, Olivier & Loubser 1984:46). Other factors than the metal (eg iron) weapons were made of, such as design and decorations, should be taken into account to determine a period more specifically. The Iron Age, in particular the time of the Assyrian Empire (c 911-612 BCE), will be evaluated in this dissertation regarding an aspect of the material culture, namely weaponry, and its consequent effects on the Iron Age people, as seen in human remains. A further extrapolation of the type of injuries, which may be present in human remains, will be explored in correspondence with depictions, particularly the Lachish reliefs,[2] from this period.

Human remains provide an independent dataset that may be studied to investigate the types of weaponry used in the Iron Age in Palestine, 1 200-332 BCE (King & Stager 2001:xxiii; Scheepers & Scheffler 2000:351), to evaluate age and gender

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[2] **Relief – 'Projection from surface**: the elevation of figures or shapes from a flat surface, as seen in sculpture, or their apparent elevation, as seen in painting' (Encarta Dictionaries 2009: *sv* relief).

differences in risk during war, anatomical patterns of injuries and to contribute to the interpretation of other sources of evidence, especially the Assyrian reliefs.

Reconstructing human behaviour from physical evidence is a multidimensional jigsaw puzzle (Scott & Connor 1997:27). The discovery of skeletal remains prompt the following sequence of questions that must be answered to complete this puzzle (Dupras *et al* 2012:6-7):

- Is this material indeed bone?
- If the material is bone, it must be determined whether the bone is from human or non-human origin.
- Although not paramount at an excavation in the Ancient Near East, the question whether the human remains are from a modern medicolegal context or not, must be determined. However, time of death is important in an archaeological setting, because that provides chronological relevance.
- The next task is to ascertain the minimum number of individuals.
- Subsequently the biological profile following the osteological analysis must be constructed, including:
    - Age
    - Sex
    - Ancestry
    - Stature
    - Individualising traits
    - Cause of death
        - Antemortem trauma/disease
        - Perimortem trauma/disease
        - Postmortem trauma
- Determine whether modifications to the bones are the result of possible postmortem modifications.

Skeletal analysis provides us with the opportunity to chronologically study warfare and acts of violence without relying on extant weaponry, as it is possible to identify injuries caused by blunt instruments and sharp-bladed weapons of various sizes, as well as to arrange it in a very accurate chronological order. With the development and application of new and more sensitive techniques, such as strontium isotope analysis, it is even possible to posit an area of origin regarding individual remains, determining the ‘us’ and ‘them’ of a conflict (Schats *et al* 2014:464-468). George R Milner (2014:xli) is of the opinion that ‘skeletons provide the most direct evidence for the existence of potentially lethal conflict within and between societies, and who took part in it’.

1.1. RESEARCH METHODOLOGY

There are three main sources of information apropos weaponry. Archaeological excavations provide the principal source of weapons (or parts thereof) that were made of durable materials. Secondly, pictorial images such as reliefs, wall paintings and models, provide information about weapons, even those made of perishable materials, and the way they were used in battle. Thirdly, there are written documents from antiquity to elucidate the ancient instruments of war (Negev 1996: *sv* weapons and warfare). Today there is an additional rich source to elucidate weaponry and war: human skeletal remains with a thorough forensic analysis thereof.

When presumed human remains, especially skeletal remains, are discovered during an excavation, a number of questions arise. The answers to these questions may require the expertise of pathologists, anthropologists, odontologists, radiologists and scientists from other fields (eg radiocarbon dating) (Payne-James *et al* 2011:38).

Due to the author’s lack of access to primary sources, a great number of secondary sources will be examined, which include articles, internet sources and books. Articles covering bioarchaeology from all over the world will be used due to the author’s inability to find specific articles discussing injuries and the cause thereof, originating in Palestine. Photographs of the Assyrian reliefs from the British Museum, accessible via the British Museum’s website, are a valuable source of depictions of the period in the Ancient Near East.

1.1.1. Literary approach

The dissertation will focus on the weapons of the Iron Age Ancient Near East and the resulting injuries inflicted during battle. A great number of written material are available regarding weaponry. However, there is a limited pool of resources available regarding injuries detected in human remains, specifically in Iron Age

Israel, but in general in the Ancient Near East. Resources discussing the method of injury and correlation between which weapons probably inflicted the injuries to the human remains are even more limited.

The available literature regarding palaeoanthropology, including literature from the above mentioned disciplines regarding human remains, will mainly be researched and other authors' ideas will be presented and critically evaluated. The lack of available sources *vis-à-vis* human remains and detailed forensic anthropological analysis concerning ancient Israel, will prompt the use of sources all over the world, with specific focus on periods where the same weaponry were utilised during situations of war and warfare.

The British Museum exhibits many depictions of Assyrian warfare and weapons used. Images will be presented and discussed, with emphasis on the probable injuries which could have resulted from the actions on display.

1.1.2. Archaeological approach

The injuries sustained during war/battle, Assyrian depictions of weapon use, as well as the weapons which caused the injuries, are set aside for research mainly by reviewing empirical research publications that appear in archaeological and scientific bioarchaeological literature, following excavation site reports and publications *vis-à-vis* human remains, injuries, weaponry and warfare in the Ancient Near East.

1.2. LITERATURE REVIEW

The focus of the research will mainly be on secondary sources and these will include articles, internet sources, electronic sources (eg DVD's) and books. The electronic Logos Library System (1996) has extensive sources covering weaponry in the Iron Age Ancient Near East. In Logos Library System, *inter alia*, Negev's (1996) *The archaeological encyclopedia of the Holy Lands* and Pfeiffer's (1975) *Wycliffe Bible Encyclopedia* comprehensively cover the weaponry used by the different peoples during their struggle to dominate the trade and communication routes through Iron Age Palestine. King and Stager's (2001) *Life in biblical Israel* provides the Hebrew words for the various weapons mentioned in the Bible, which were also discovered during archaeological excavations in Israel. In their book, *From Dan to Beersheba: An archaeological tour book through ancient Israel*, Scheepers and Scheffler (2000) provide an overview of important archaeological sites in Israel, while providing data about some of the major finds during the archaeological excavations at these sites. The dissertation of Human (2006), *Military fortifications, weaponry, warfare and military strategy in ancient Syro-Palestine (Iron Age IIA)*, will be used for his insights regarding warfare in Palestine and the weaponry used during the Iron Age. The renowned Yigael Yadin's (1963) pictorial book, *The art of warfare in biblical lands*, portrays the weaponry, as well as paintings and reliefs from the Ancient Near East vividly.

Chronology, where personal interpretation played an important role to determine specific dates, was initially an art form until Libby developed radiocarbon dating techniques. In order to clarify general scientific terminology and processes, *Microsoft Student* (2009) and *Encyclopædia Britannica Ultimate Reference Suite* (2012) are used in this dissertation. Libby's own explanations regarding radiocarbon dating, including his lecture when he received the Nobel Prize on 12 December 1960 (available on the Internet) are used regarding the initial development of radiocarbon dating. Various articles from internet sources describe the developments and latest refined techniques, especially processes to accurately date skeletal material, which was until the development of refined techniques, regarded as a relative inaccurate method to establish chronology.

Archaeology, anthropology and forensic medicine were separate disciplines, each independently operating in its own field. Today, an amalgamation of these areas enhances the effectivity in all these fields. Various sources elucidate the changes a body undergoes, from the time of death until the time the remains are examined by an expert. The discussion regarding trauma and the mechanism of energy transfer to cause wounds is covered in the books of Payne-James *et al* (2011: *Simpson's Forensic Medicine 13th ed*), Shwär, Olivier and Loubser (1984: *Die ABC van Geregtelike Geneeskunde*) and İşcan and Steyn (2014: *The human skeleton in forensic medicine 3rd ed*). These authors provided the principles applicable to techniques utilised in forensic medicine and forensic anthropology to determine the difference between blunt force trauma and sharp force trauma – the main causes of trauma during war in the Iron Age Ancient Near East. The principles of excavation, analysis and interpretation of skeletal remains are put forth in Ubelaker's (1978) book, *Human skeletal remains*, as well as numerous of his contributions in various other publications. Because there are few publications regarding forensics and human remains without reference to one or more of Ubelaker's works, he might be regarded as the Flinders Petrie of his field. Black and Ferguson (2011) edited a comprehensive volume, *Forensic anthropology*, which gives an overview of the themes regarding anthropology, *inter alia* skeletal trauma. In this volume they identify present trends in research and suggest areas in which future research could be developed. Each chapter is concluded with an extensive bibliography. Haglund and Sorg (1997) edited a landmark volume, *Forensic taphonomy, the postmortem fate of human remains*, regarding forensic taphonomy to discern between natural and other than natural deaths, such as due to interpersonal violence. In *Forensic recovery of human remains*, Dupras *et al* (2012) produced a current description of the techniques and resources available to excavate human remains with modern equipment. Knüsel and Smith (2014) edited one of the most useful books for the study of human remains *vis-à-vis* trauma, namely: *The Routledge handbook of the bioarchaeology of human conflict*.

Redfern (2009), who examined 80 sexed skulls (*crania*) and their injuries in Iron Age Dorset (first century BCE to first century CE, England), discussed the evidence of projectile injuries to understand warfare as well as age/sex differences in combatants in Iron Age Dorset. Notwithstanding the different time and space, the scenario is applicable to the scopus of this dissertation. Aranda-Jiménez, Montón-Subías and Jiménez-Brobeil (2009) showed that the analysis of skeletons might, other than the conclusions of excavations before injury patterns were taken into account, posits new understandings regarding the weapons used during warfare in the Argaric society in Iberia. Although an Iberian Bronze Age site has been analysed, their conclusions are applicable to the Iron Age Ancient Near East. The author could not access similar data from the Iron Age Ancient Near East, hence the use of data from Iron Age Dorset and Bronze Age Iberia to posit possible circumstances regarding the Iron Age Ancient Near East during warfare with comparable weaponry. It seems as if Redfern (2009:404) encountered the same problem during her research: 'A limited number of clinical studies have addressed injuries … and these data are crucial to the identification of trauma in past populations, as they provide information about the context and mechanism of the injury and the weapon used to inflict it.'

European strontium isotope analysis was utilised *vis-à-vis* the Alkmaar mass graves from the Eighty Years' War (1568-1648) between the Dutch and the Spanish (Schats *et al* 2014:456, 464-468). Although these graves are from the Age of Gunpowder, the same comparisons to the siege of Lachish are twofold in regard to this dissertation.

1.3. SUMMARY

War, as part of human nature, is excessively researched and numerous academic works focusing on war are available. The effect of interpersonal violence on the human body is similarly documented. Both are also separately incorporated in the field of archaeology. The Iron Age in the Ancient Near East is a well-researched era with furthermore exceptional contemporary depictions, *inter alia* regarding the siege of Lachish. Fortunately, the combination of these fields regarding biblical archaeology is starting to emerge. At Lachish, some of the available scientific evaluations and tests have been conducted. The dissertation will combine the fields of forensic medicine, natural science and biblical archaeology, as presented in the above mentioned sources, to elucidate ancient war in the Ancient Near East by positing additional available tests and examinations that may be conducted.

2. WAR, WARFARE AND INTERPERSONAL VIOLENCE

War is defined as a subset of human aggression involving the use of organized force between politically independent groups. This ensues in intergroup aggression with sanctioned use of lethal weapons by members of one society against members of another, which results in the deaths of others, whose killings are envisioned in advance (Haas 1990:1; Knüsel & Smith 2014a:12; Selover 2015:10). War is furthermore an integral part in the forming and development of advanced forms of government (Haas 1982:27-28). In a Clausewitzian proposition, as a form of statecraft, warfare is simply a continuation of political discourse by means of another form of language or communication (Human 2006:1).

Tom Clancy was not only a renowned fiction writer, but also an authority on military issues. Clancy (1994:1162) described war as such:

> War was always about economics … just greed … an armed robbery writ large. At the nation-state level, the terms were couched in terms such as Manifest Destiny or *Lebensraum* or other political slogans to grab the attention and ardor of the masses, but that's what it came down to: *They have it. We want it. Let’s get it* (author’s italics).

Most wars also presuppose a contestation of landscape, that is, space that assumes a symbolic meaning of ownership, ritualized power or historical significance. Once those symbolic principles (with the slogans) of appropriation, ownership and possible attack/defence have been established, society needs to recruit men in order to fight. Although in most wars men are recruited from within, it is also possible to pay outsiders to fight on behalf of others, thus providing the recruitment of mercenaries (Aguilar 2006:245). If human remains are uncovered, it is currently possible to determine the geographic origin of these remains, resulting in the possible identification of different peoples participating in the battle and even posit the probability of the utilisation of mercenaries during a conflict.

Keeley (1996:3) is of the opinion that:

> War remains the most theatrical of human activities, combining tragedy, high drama, melodrama, spectacle, action, farce and even low comedy. War displays the human condition in extremes.

War is even more brutal than gladiator contests in antiquity (Kanz & Grossschmidt 2006:207). Consequently, it is not surprising that the oldest examples of recorded written history are that of war. The oldest Egyptian hieroglyphs, Sumerian cuneiform writing, Mayan hieroglyphs, Chinese, Greek and Roman annals are concerned with war (Keeley 1996:3-4). Apart from written and depicted records, war left its enduring marks on the physical world as well as the contemporary people. These marks are there for the archaeologist to decipher, thus garner much better information about the age and physical characteristics of the people who participated in these wars. Events that are primarily familiar to us as dates, places, names of principal leaders and battle outcomes, gets a human face with better understanding of the people involved (Milner 2014:xliv).

In view of the use of even ancient weapons, for example, in the current brutal Near East conflict (Fig 2.1), the words of General Sir Richard Gale (1968:135) regarding ancient war and warfare are unequivocally true:

> The military and political lessons of those ancient times are as applicable today as when they were enacted. Weapons, equipment, transport and methods of communication may differ, but the frailty and the strength of human nature remain unaltered.

Figure 2.1: The sling, an Iron Age weapon used in a modern-day conflict in Israel (Beeld: 18 Desember 2017 [Photo: Reuters]; Rapport Weekliks: 20 Mei 2018 [Photo: Getty Images]).

Although human nature remains the same, Martin and Harrod (2015:116) are of the opinion that the value of the bioarchaeological examination of interpersonal violence is important because:

> (T)he findings also suggest variability, nuance, and unevenness in the type, use, and meaning of violence across time and space and therefore defy generalizations or easy quantification. Documenting violence-related behaviors provides an overview of the often unique and sometimes patterned cultural use of violence.

The examination of human remains related to a specific event during a specific time may give a window of understanding regarding war, warfare and interpersonal violence of peoples of the past.

2.1. THE GEOGRAPHICAL IMPORTANCE OF PALESTINE

The geographical location of Israel, as a land bridge (Longstreth 1962:21), constitutes the crossroads connecting Europe, Asia and Africa, and places it between, *inter alia*, Egypt and Mesopotamia: the *Via Maris*, meaning the Way of the Sea, and the *Via Regia*, meaning the King's Highway (Fig 2.2).

Figure 2.2: The *Via Maris* and the *Via Regia* (Perego 1998:28).

The *Via Maris* was the more important of the two thoroughfares that cut across Palestine. These major overland trade and communication routes gave Palestine a bigger importance according to their 'imperial' neighbours than their natural resources warranted and although Palestine was subjected to wars for its own richness, it was especially conquered for control over these international routes (Gale 1968:1-7; Herzog & Gichon 1978:9, 13-15; Human 2006:116-118; King & Stager 2001:252; Röthlin 2009:115).

One constant fact in military history is that a crossroad is always contested by somebody. The rise of Christianity, followed 700 years later by the rise of Islam, had not changed matters very much, though it had redefined the teams somewhat and gave wider religious significance to the crossroads already contested for three millennia. Religion only made the wars all the more ferocious (Fig 2.1).

The Assyrian Empire conquered and ruled Palestine from 732-604 BCE. The Babylonian Period followed from 604-539 BCE, with the Persian period from 539-332 BCE (Stern 2001:xlx, 2, 301 & 351). This ancient 'imperial era' introduced an era of new warfare with new weaponry, demonstrable in the material culture of the region, beginning with the 'new' *blitzkrieg* and siege-warfare of the Assyrians (Human 2006:268-269). The analysis of the distribution of the weaponry in settlements and fortresses excavated along these routes, especially the *Via Maris* (Fig 2.2), gives an indication of how important the imperial powers deemed the control of traffic between Egypt and Mesopotamia (Perego 1998:28; Stern 2001:3).

2.2. CONCLUSION

Due to the nature of war, soldiers inflict injuries on the enemy. These moments in time of violence may have been captured in the signs left on the injured body. The forensic analysis of these injuries is a rich source of knowledge to the field of archaeology regarding war and warfare of ancient peoples. The perpetual struggle for the control over this intercontinental crossroad in the Ancient Near East, most probably the area in the world with the best documented history of this unending war and warfare, left a rich source of data to be gained, *inter alia*, from human remains.

3. HUMAN REMAINS IN ARCHAEOLOGY

Death is the final stage for every human being. The remains from ages past are there for the archaeologist to elucidate the past of *Homo sapiens*. Harrington and Blakely (1995:105) contributes the following quotation to Peebles: ‘A human burial contains more anthropological information per cubic metre of deposit than any other type of archaeological feature.’ Human casualties of violence, in particular those of war, are such a rich source of knowledge. To scrutinize these remains, modern science bestows the researcher with an abundance of tools from diverse fields. To gain the knowledge amassed in the remains, prior to and in the instance of death, a profound understanding is essential regarding the processes a human body undergo from the moment life ends until those remains are uncovered.

Prior to death (antemortem) everybody’s day to day living is ‘recorded’ in the skeleton. When a life is violently ended, as is common during war, significant markers may be left on the skeleton during the time of death (perimortem). Unfortunately, the ‘recording’ in or on the skeleton does not stop at the time of death, but continues until the collecting and/or exposure of the remains (postmortem). It is essential to recognise and understand this postmortem period as well as the effect of various factors on the remains during this phase, because taphonomic processes may present, erroneously, as injuries sustained during interpersonal violence. This phenomenon must be taken into account when studying biological material, including human remains, before the ante- and perimortem influences on the body are determined. Taphonomy is the study of these processes that a body undergoes from death until the remains are uncovered. *Forensic* taphonomy also includes the event of death (Haglund & Simmons 2004?:159; Haglund & Sorg 1997:18).

3.1. TAPHONOMY

In the 1940’s, taphonomy was first introduced by the Russian geologist, Efremov, as the study of death assemblages, or the ‘laws of burial’. The word taphonomy is derived from the Greek *taphos*, meaning ‘burial’, and *nomos*, meaning ‘law’ (Black & Ferguson 2011:279; Haglund & Sorg 1997:3). The initial focus was predominantly on fossilised remains. In the 1960-80’s Olsen developed a slightly different perspective, focusing on reconstructing the life history of a fossil from the time of death to the time of recovery, thus all aspects of the passage of organisms from the biosphere to the lithosphere (Black & Ferguson 2011:279; Haglund & Sorg 1997:3). Haglund and Sorg (1997:14), with a broader view, define taphonomy consequently as:

> … the study of postmortem processes which affect (1) the preservation, observation, or recovery of dead organisms, (2) the reconstruction of their biology or ecology, or (3) the reconstruction of the circumstances of their death.

Forensic anthropology broadens the field. Archaeology and forensics were two unconnected fields with minimal association. Each developed independently without 'cross-pollination' in practice or in the literature. Fortunately, the practice changed and archaeologists, anthropologists and forensic investigators recognise the necessity to combine these diverse fields and apply them to investigations, whether in modern forensic or ancient archaeological matters. This prompts a shift from focusing on populations to the focus on the individual regarding a specific event (Haglund & Sorg 1997:14). Furthermore, Lyman is of the opinion that 'archaeological analogy often lacks the required causal relations between processes and effects' (Haglund & Sorg 1997:15). In forensic taphonomy a neotaphonomic approach is followed. Neotaphonomy or actualistic taphonomy, concentrates on the modern environment and applies its results to the past by analogy (Black & Ferguson 2011:281). Thus present-day researchers demonstrate causality through experiments and case experience, with the result that inferences in archaeology may become highly probable. For example, present-day tooth marks left by a hyena on bones in a zoo are similar to those left on carcasses in the wild. Thus, when analogous marks are found in an archaeological setting there can be inferred with a high probability that similar marks were left by a hyena (Haglund & Sorg 1997:15-16).

There are three major classes of taphonomic processes that may influence the state of preservation of remains (Nawrocki 1995:50):

- Cultural factors – the people involved with the body;
- Environmental factors – external 'natural' factors;
- Individual factors – factors intrinsic to the body itself.

As a result of these processes the final stage of preservation may range from pristine to no trace at all. It is important to keep in mind that the final sample available to the researcher, due to the accumulated effects of all the taphonomic processes, may represent only a tiny and distorted reflection of the original organism in its original environment (Haglund & Sorg 1997:17). In the archaeological setting, where interpersonal violence is present, the analysis must take into consideration all the taphonomic processes, however, with the emphasis to distinguish human activity – a forensic approach (İşcan & Steyn 2014:11).

3.1.1. Cultural factors

The handling of a body postmortem may play a crucial role in the preservation thereof. Certain funerary processes, such as embalming, are an active effort to curtail the normal decay after death and to preserve the remains. Egyptian mummies, with a culture where elaborate preservation techniques were applied by their embalmers, are on the end of the spectrum with remarkable preservation. Crucifixion victims, on the other end, were handled with a disregard to any ceremony and left almost no trace. Gibson (2009:107-115) describes how the bones of a crucifixion victim, Yehohanan, were discovered in 1968 in Giv’at ha-Mivtar in North Jerusalem. This single *calcaneus* (heel bone) is the only evidence of a crucifixion in the region of Jerusalem, despite the thousands crucified between 103 BCE – 70 CE.

The cultural attention and care, or lack thereof, bestowed on a body after death plays a crucial role in the effect natural factors play in the taphonomic processes on the body. Again the differences between the care taken with mummies versus the careless disposal of crucifixion victims are an example (Fig 3.1). Egyptian mummies were placed in a controlled environment, *inter alia* a sealed sarcophagus, while those crucified were unceremoniously discarded with exposure to the elements and animals. Places where people were crucified were, for example, favourite feeding grounds for vultures (Gibson 2009:116). Aside from consuming soft tissue quickly, with random distributing of the inarticulate bones, some vultures, like the bearded vulture (*Gypaetus barbatus*), consumes bones as 70% of its diet (Hockey, Dean & Ryan 2005: *sv* bearded vulture). The single sample of a crucifixion victim is furthermore an exceptional example due to postmortem human care of the remains – the bones were found in a stone ossuary (Gibson 2009:110; Perego 1998:88).

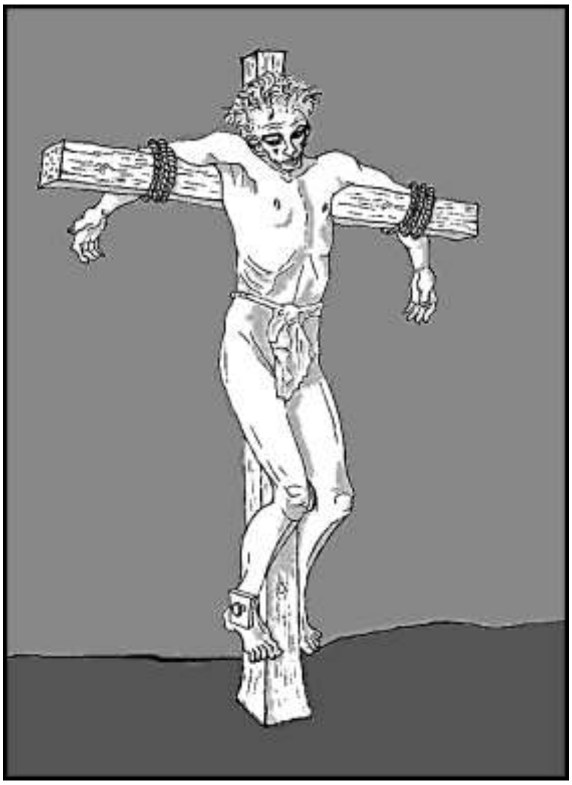

Figure 3.1: Reconstruction drawing showing the way the man from the Giv'at ha-Mivtar tomb was possibly crucified (Gibson 2009:114).

Unfortunately, ritualistic and/or dedicated human care for the dead may also destroy the remains – cremation, with the eventual scattering of the ashes, leaves the investigator with nothing.

War, bringing out the extremes of human nature, leads to diversion from normal cultural practices, particularly regarding the losing side (Keeley 1996:3; Milner 2014:xlii). The disregard or intentional desecration of the conquered side's fallen (Fig 8.4) resulted in poor preservation of the remains. The reason being that environmental influence could continue the decomposition of the body unabated.

3.1.2. Environmental factors

Environmental factors are external factors that influence the degree of preservation of remains, which can be divided into two categories (Nawrocki 1995:51):

- biotic and;
- abiotic.

The biotic factors involve the presence and/or action of living organisms and can further be divided in big carnivores and scavengers, plants, insects and micro-organisms. Abiotic environmental factors are those not ascribed to living organisms, which include temperature, exposure to water and sunlight, soil and depth below surface (Nawrocki 1995:51-52).

3.1.2.1. Biotic factors

Carnivores and scavengers, such as hyenas and jackals, as well as carrion birds, such as vultures and crows, may do considerable damage to human remains. Apart from consuming bones, they cause fractures, disarticulation and dispersion of the skeleton. Postmortem marks left on bones by animals must be recognised as such and must not be confused with interpersonal violence and/or trauma. Rodents, with sharp incisor teeth, may also be culprits regarding postmortem marks on remains. Animals, including rodents, may furthermore be responsible for exposing remains to other environmental factors by breaching a burial enclosure (Nawrocki 1995:51).

Plant activity may have profound effects on skeletal preservation. Apart from mechanical damage to the skeleton, roots may have an effect on the pH of the soil in its proximity. Acid from roots in close proximity to bones may result in etching of the bone surfaces (Nawrocki 1995:51).

Insects are one of the most important factors in modern-day forensic taphonomy, with a significant contribution to the postmortem interval, where the time since death is important in a medico-legal setting. Insects are capable of modifying soft tissue to the point of exposing the skeleton (Clark, Worrell & Pless 1997:156). Damage inflicted by insects and their larvae *vis-à-vis* bone is relatively rare (Schultz 1997:209). Except for their part in disarticulating skeletons, where large masses of maggots may result in ‘tumbling’ of the thoracic bones as well as scattering of ribs (like a surfboard on a wave), insects rarely leave consequential marks on the bony remains and are usually long gone in the archaeological setting (Dupras *et al* 2012:245; Nawrocki 1995:51; Scott & Connor 1997:31). An example of such an exception was cranial ‘lesions’ diagnosed as syphilis on skeletons from Naga-ed-der in Egypt. These ‘lesions’ were later determined to be the result of beetles (Henderson 1987:49).

Micro-organisms, either bacterial or fungal, are organic, therefore part of the carbon cycle. Their short-term effect regarding taphonomy is in the medico-legal significance for the forensic investigator. In the archaeological setting, perimortem infection with effect on the skeleton must be identified. The presence of fungi and/or bacteria postmortem may interfere with carbon dating (*infra*), which initially led to the reluctant use of bone to determine chronology (Higham, Jacobi & Bronk Ramsey 2006:179; Stafford *et al* 1987:24).

3.1.2.2. Abiotic factors

In addition, the abiotic environmental context regarding the final resting place for human remains, plays a critical role in the taphonomy thereof. Abiotic environmental factors have a profound effect on the biotic factors, which are responsible for the major taphonomic changes in mainly the soft tissue of the body (*supra*). These factors include temperature, exposure to water and sunlight, soil pH and depth below surface (Greeff 2005:72; Nawrocki 1995:52). Water is especially critical in the preservation equation, because dry, well-drained soil leads usually to better preservation. However, extreme environmental conditions often lead to remarkable preservation. Examples of these extreme conditions are (Boddington *et al* 1987:5; Dupras *et al* 2012:69; Levine, Campbell & Rhine 1984:91; Micozzi 1997:171-172; Ubelaker 1995:42):

- Mummification due to hot and dry conditions;
- Bog bodies due to tannic acid produced in peat bogs;
- Frozen bodies in glaciers and permafrost/arctic conditions;
- Adipocere development in extremely wet environments.

In the Ancient Near East the only process likely to be encountered is mummification.

Unfortunately, human remains in the same locality present various states of preservation, notwithstanding exposure to the same biotic and abiotic factors. This phenomenon is attributed to the part where the specific individual body plays a role in its own degree of preservation – the individual factors.

3.1.3. Individual factors

Individual factors are those that stem from the body of each subject at the time of death (Nawrocki 1995:52). In addition to the normal variances in healthy persons, pathology may play a vital role in the potential for preservation of bones. The normal physiology of the living body ceases, at the moment of death, to keep the body in homeostasis. The perimortem condition of the body, whether healthy or not, injured or not, determine the taphonomy of the individual and the ultimate condition of the skeletal remains. Boddington, Garland and Janaway (1987:4) state:

> The intrinsic physical characteristics of the bone are the preserving agencies in this context, set against the destructive chemical and physical factors and biological agents within the burial environment.

In a healthy person the characteristics of the bones are determined by age and sex. The differences between the individual bones of the body, as well as the composition of different parts of these bones influence the degree of preservation (Boddington *et al* (1987:4).

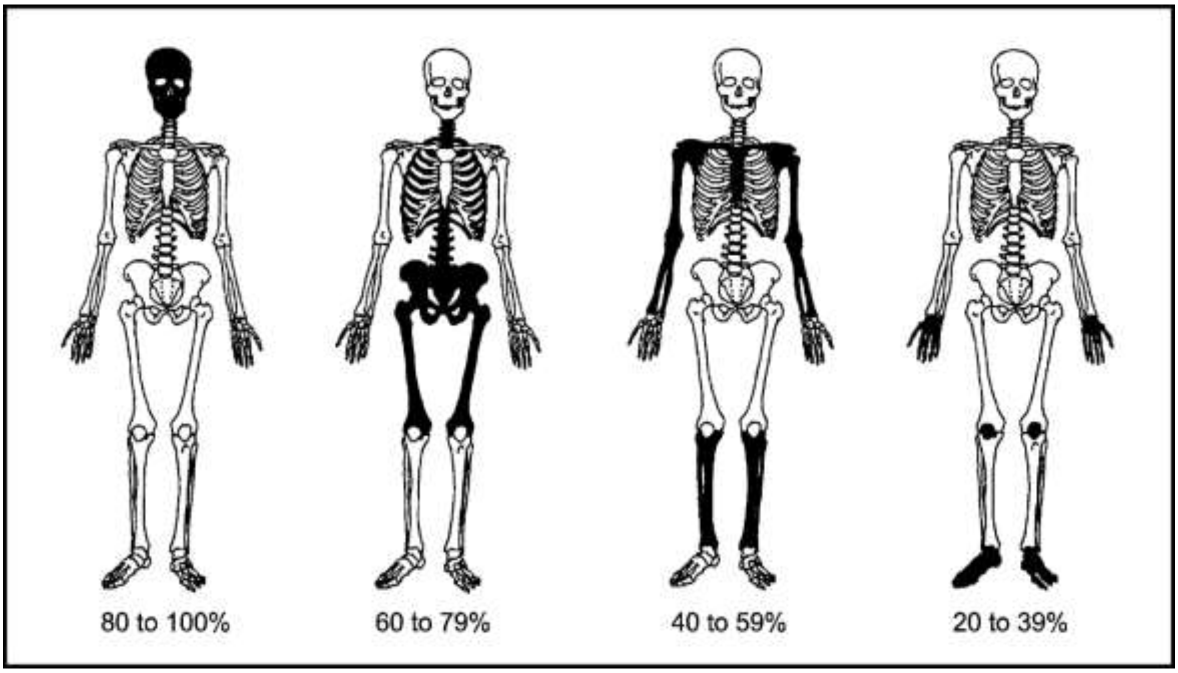

Figure 3.2: Frequency ranges for the recovery of skeletal units from cases (N=53) in a sample of scavenged remains (Haglund 1997:376).

The amount and distribution of cortical (dense) and trabecular (spongy) bone, in addition to the presence of cartilage, especially in young individuals, are crucial in skeletal preservation. Cortical bone is denser, thus present a smaller area than trabecular bone to the destructive chemical, physical and biological factors responsible for the taphonomic process (Greeff 2005:73). The preservation of cortical bone is superior to trabecular bone and therefore more likely to be encountered during archaeological excavations. Bigger bones (eg skull and femur) are better preserved than small bones (eg fingers), as seen in Figure 3.2.

In the young and the old, bone density is reduced. Unfortunately, this results in poorer preservation than the bones of healthy individuals in their prime (Boddington 1987:31). Infants (0-1 year) form the group with the lowest presentation in the skeletal remains, with some studies coming up with a 0% presentation (Greeff 2005:75). Although infants, women and older people are regular victims during hostile times (more so during the Iron Age), men in their prime are the usual active participants in war. Warriors, as a group of healthy young men, is thus the most likely to leave skeletal remains with good preservation in the archaeological environment.

A healthy body with normal physiology is a hostile environment for taphonomic agents. Perimortem pathology and trauma reduce the body's 'resistance' to the taphonomic processes (Nawrocki 1995:53). Bony tissue is particularly limited in how it can respond to changing stimuli, whether pathology or trauma: New bone can be added, existing bone can be removed, or a combination of both activities will most likely occur, although one will frequently predominate (Lockyer, Armstrong & Black 2011:238). Diseases, which reduce bone density and/or infections causing increased bacterial activity in the body, particular osteitis (inflammation of bone), are detrimental to preservation.

3.2. CONCLUSION

Forensic taphonomic history includes the actual death event, the interval of bone exposure through modification of soft tissue, the potential interval of bone modification, and the point of discovery and collection (Black & Ferguson 2011:280; Haglund & Sorg 1997:19).

Numerous and unpredictable environmental factors can and do influence the extent of preservation. Furthermore, every individual has a unique set of factors, which contributes to the preservation of the remains.

Modern forensic taphonomy utilises taphonomic models, approaches and analysis in forensic contexts to estimate the time since death, reconstruct the circumstances before and after deposition and discriminate the products of human behaviour from those created by the earth's biological, physical, chemical and geological subsystems (Haglund & Sorg 1997:3). The time between death and discovery – the postmortem interval – is one of the key questions to be answered in forensic taphonomy. In the archaeological setting this perimortem interval gives the answer *vis-à-vis* chronology.

4. CHRONOLOGY[3]

The first question arising from the discovery of material, after determining that it is of human origin, is whether it is of modern medicolegal context or not. Modern medicolegal context, or more commonly referred to as the forensic context, is depended on the time since the demise of the human remains. The answer to the question, namely how long have the remains been there, gives the postmortem interval, which is chronology in the archaeological field.

Chronology is defined as the '**study of order in time**: the study of the order in which things occur, or the science of determining this' (Encarta Dictionaries 2009). Scientific chronology seeks to place all happenings in the order in which they occurred and at correctly proportioned intervals on a fixed scale.

4.1. INTRODUCTION

A novelist, Nelson DeMille (2003: *sv* archaeologist), aptly compared a scene of a homicide with an archaeological excavation site:

> What you see at the scene of a homicide is frozen in time, it is no longer a moving, living dynamic. You can create several stories about this still life, but these are only theories. A detective, like an archaeologist, can assemble hard facts and solid scientific evidence, and still draw the wrong conclusions … it is your job to know the truth.

The archaeologist furthermore has to keep in mind what Moses Maimonides, also known as Rabbi Moses ben Maimon (1135 - 1204), a Spanish-born Jewish rabbi, philosopher and physician said:

> A great disparity subsists between the knowledge an artificer has of the thing he has made and the knowledge someone else has of the artefact in question (Microsoft Encarta 2009: *sv* knowledge).

The disparity between the knowledge a living human being possesses in contrast to the possible data obtainable from examining a body, skeleton or parts of a body is even greater. However, although scientific knowledge is only partial, it gives humans the ability *to make phenomena perceivable* (Encyclopædia Britannica 2012: *sv* history of science). The prodigious progress in the field of natural science in the 20th century, continuing into the 21st century, enables archaeologists to garner data

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[3] This chapter was published (revised) by the author as an article in the *Journal for Semitics* 26/1 (2017) 194-215.

previously not possible – to *support a scientific hypothesis* by making it *perceivable* – with hard facts and solid scientific evidence.

The technological progress *vis-à-vis* the determination of the chronological age of a biological sample in an archaeological setting enables the researcher to reach much more accurate answers, thus providing a chronological date for the 'still life'. These answers are perceived on hard scientific data in contrast to the 'educated guesses' (theories) that the 'father' of the modern era of the scientific study of archaeology in the Ancient Near East, William M Flinders Petrie (1853-1942), posited from 1890. He applied the concept of stratigraphy, based on the principle of sequence dating pottery, in his excavations at the Palestinian site of Tell el-Hesi, based on the ground-breaking work of Heinrich Schliemann at Troy (Currid 1999:28; Poole 2012: *sv* Petrie, Sir Flinders). Today this method of dating is still practiced as *relative chronology*.

4.2. RELATIVE CHRONOLOGY

The major instrument in relative chronology in the Ancient Near East is pottery, where relationships on a single archaeological site are sequenced, based on stratigraphy (Currid 1999:29). The relativity arises from linking similar objects at two separate sites regarding chronologically (Finkelstein 2013:6; Finkl 2009: *sv* dating methods; Krogh 2012: *sv* dating).

The intrinsic properties of pottery render the unbroken vessel vulnerable, but potsherds are durable and are found virtually in all the strata at a dig. After more than a hundred years of analysing the common pottery of ancient Palestine, archaeologists are now confident that they can date most forms, even small fragments, within about a century. Dever (2003:118) wrote about archaeologists' obsession with pottery:

> As one scholar, Robert Ehrich, has observed: 'Pottery is our most sensitive medium for perceiving shared aesthetic traditions, in the sense that they define ethnic groups, for recognizing culture contact and culture change, and for following migration and trade patterns.'

Despite the confidence in dates derived from relative chronology, it is still based on an individual's interpretation of artefacts and results in lively debates in the archaeological field. The questioning of Kenyon's (1973) chronological sequence regarding the Late Bronze Age is an example, because ‘in spite of her keen eye for stratigraphical detail and her implicit caveat against placing too much emphasis on sites that were poorly excavated during the infancy of the discipline, Kenyon's system has not been widely accepted … Weinstein arrived at the relative chronology that is used in this article’ (Leonard 1989:7). Despite the fact, relative chronology regarding the Ancient Near East is at such a stage that a respected scholar, Finkelstein (2013:6), ventures the following statement:

> Our knowledge of the chronology … of the Iron Age strata and monuments in the Levant has been truly revolutionized. In terms of relative chronology, intensification of the study of pottery assemblages from secure stratigraphic contexts at sites such as Megiddo and Tel Rehov in the north and Lachish in the south opened the way to establish a secure division of the Iron Age into six ceramic typology phases: early and late Iron I … early and late Iron IIA … Iron IIB and Iron IIC.

Unfortunately, matters are complicated because there is no uniformity in the naming of various archaeological periods, not in the Ancient Near East and definitely not worldwide (Yadin 1963:27). A remarkable breakthrough in scientific knowledge, carbon dating, helped to augment this deficiency in the archaeological field. In the Ancient Near East of the past 9 000 years, although the periodical perplexity continue, it is possible to ascribe a more accurate numerical chronological value, particularly to artefacts of organic origin.

Willard F Libby developed the carbon-14 dating technique in 1947 and received the 1960 Nobel Prize in chemistry for this work (Microsoft Encarta 2009: *sv* Willard Frank Libby). Similar to other scientific fields, techniques were and are continuously refined and developed to enhance the accuracy when dating biological samples in, *inter alia*, the archaeological field. Today, minuscule material, such as a single grain of pollen or a piece of charcoal, may sometimes provide hard scientific data surpassing that gained from theories based on macroscopic finds (Greeff 2005:23-24). Unfortunately, skeletal remains are neglected as a biological source to determine chronology due to traditional scepticism to the reliability thereof (Higham *et al* 2006:179). Auspiciously, due to the progress in modern science and technology, together with the refining of techniques and processes, bone is an excellent medium to determine chronology.

4.3. ABSOLUTE CHRONOLOGY

Continuous development in radiometric dating methods since the 1940’s, subsequent to the discovery of radioactivity, revolutionised chronology in archaeology, particularly biblical archaeology. The principal atom used to enable accurate dating in a resolution of thirty years is Carbon-14 (Finkelstein 2013:6; Finkl 2009: *sv* dating methods; Krogh 2012: *sv* dating).

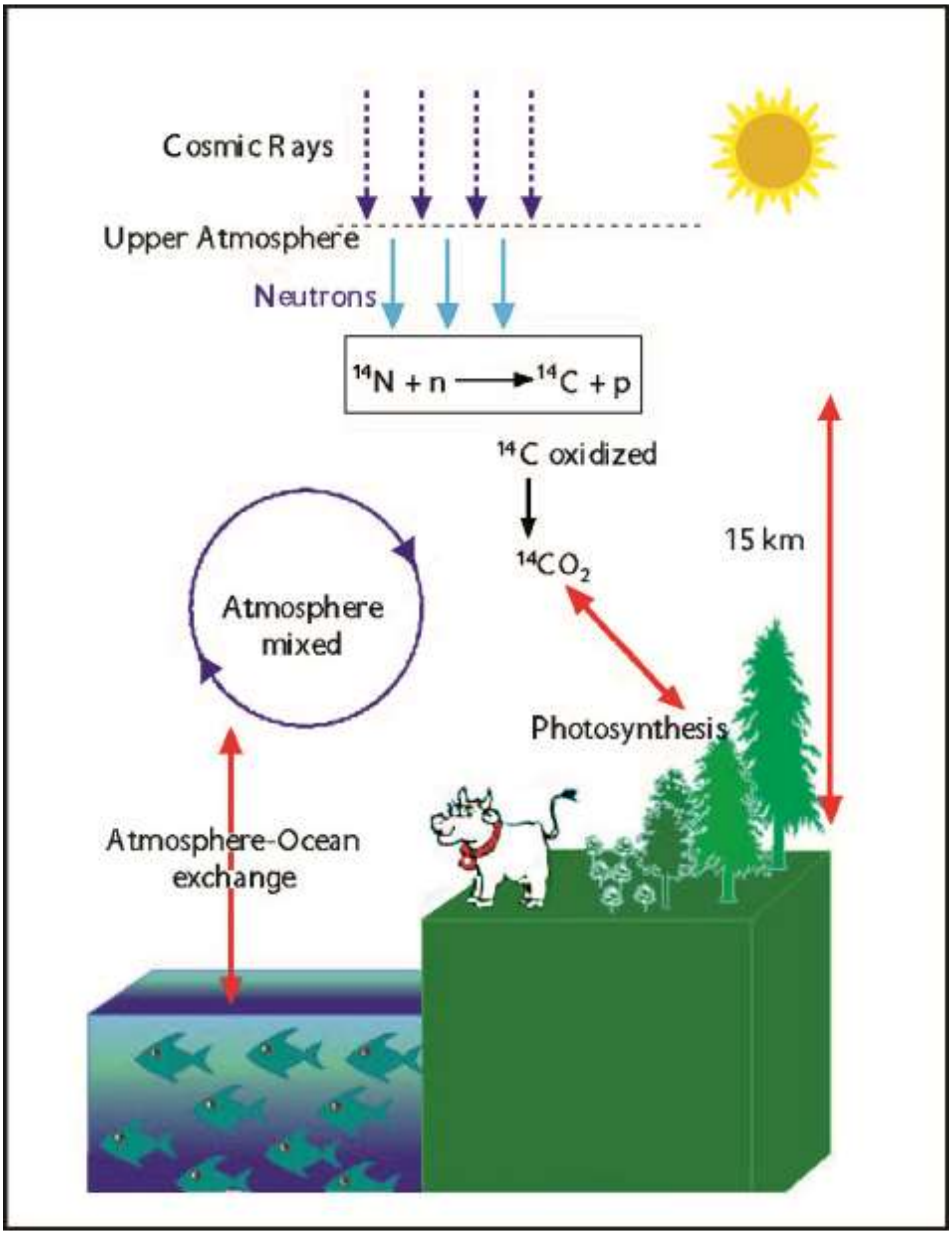

Figure 4.1: Production and distribution of cosmogenic carbon-14. Produced mainly in the upper atmosphere due to interaction of thermal neutrons with nitrogen, carbon-14 is relatively quickly oxidised and mixed in the atmosphere. Through photosynthesis, it enters the biosphere and through gas exchange, the oceans (Hajdas 2008:3).

Carbon is the fundamental building block of material in all living organisms (Fig 4.1). Carbon forms more compounds than all the other elements combined and is present as the principle material in all substances known as organic compounds (Encyclopædia Britannica 2012: *sv* carbon; Lutz 2009: *sv* carbon). The presence of carbon *in all organic compounds* renders it the 'perfect' element to use in determining 'answers' from organic material.

4.3.1. Carbon-14 dating

The principle on which radiocarbon dating is based, utilises the properties of carbon regarding the incorporation of all its isotopes[4] indiscriminately into organic material. The 'normal' carbon atom, carbon-12, as well as the different isotopes are all incorporated in organic material, notwithstanding that the different isotopes have their unique characteristics and radioactivity. These differences are perceivable through modern science. The most abundant *stable* isotope of carbon is carbon-12, which makes up 98.89% of natural carbon, with the carbon-13 isotope only 1.11% (Fig 4.2). Carbon-14 forms one part per trillion of the carbon in the atmosphere. Regarding the dating of biological matter, only the carbon-14 isotope of the 12 radioactive carbon isotopes, with the longest half-life of 5 730 ± 40 years, is of value.

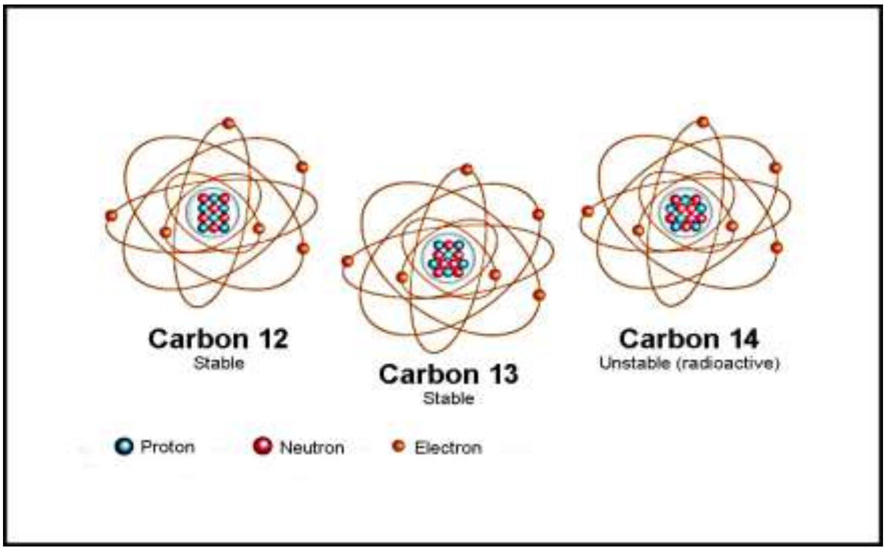

Figure 4.2: Isotopes of carbon depicting the difference in the nuclei (Microsoft Encarta 2009: *sv* carbon).

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[4] **Isotope: 'form of element with same atomic number:** each of two or more forms of a chemical element with the same atomic number but different numbers of neutrons' (Microsoft Encarta 2009: *sv* isotope).

Cosmic radiation of nitrogen (N) in the atmosphere produces carbon-14 (Fig 4.1 & Fig 4.2). The reaction is as follows, with a neutron symbolized as $^{1}_{0}n$, the nitrogen atom as $^{14}_{7}\mathrm{N}$, and a hydrogen nucleus, or proton, as $^{1}_{1}\mathrm{H}$ (Encyclopædia Britannica 2012: *sv* carbon):

$$^{14}_{7}\mathrm{N} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{14}_{6}\mathrm{C} + {}^{1}_{1}\mathrm{H}$$

The result is a carbon atom with six protons and eight, instead of six neutrons. This radioactive carbon-14 is unstable and its nucleus can decay, meaning that the carbon-14 will ‘lose’ a proton and revert back to a stable nitrogen atom (Fig 4.3).

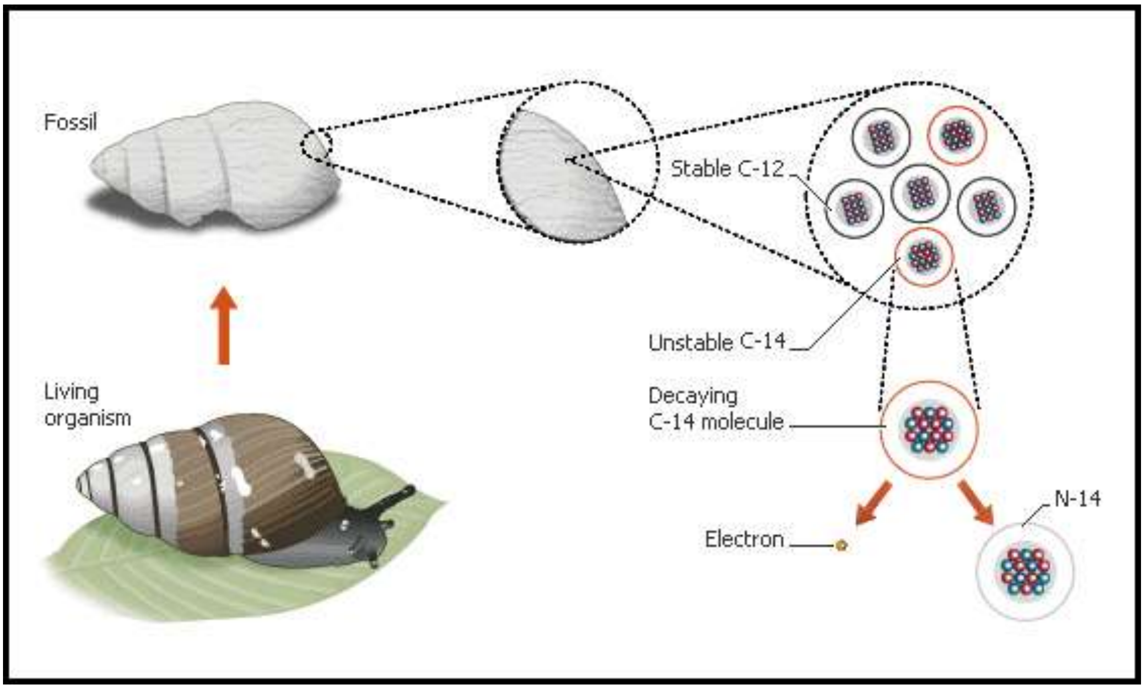

Figure 4.3: Radiocarbon dating through carbon-14 decay (Fraser 2009: *sv* neutron).

The carbon-14 atoms are converted to carbon dioxide by reaction with atmospheric oxygen. The carbon dioxide in the atmosphere thus is a uniformly distributed mixture containing stable carbon-12 and radioactive, unstable carbon-14 atoms (Fraser 2009: *sv* neutron). As seen in Figures 4.1 and 4.3, all living organisms use atmospheric carbon dioxide indiscriminately to its radioactivity, through processes of photosynthesis and respiration (Smith 2009: *sv* carbon cycle (ecology)). The result is that all living organisms maintain the exact ratio of carbon-12 to carbon-14 that exists in the atmosphere. Carbon-14 forms one part per trillion of the carbon in the atmosphere, thus the same ratio persists in all organic material – while the organism is alive (Basics of radiocarbon dating: http://www.informath.org/Basic14C.pdf). The maintenance of the equilibrium between organic material and the atmosphere stops the moment the organism dies and the concentration of carbon-14 starts to diminish (Libby 1960:595-596).

The decay of the unstable carbon-14 is by way of a radioactive reaction. The carbon-14 converts back to nitrogen *at a known rate of conversion*. It is expressed as the half-life of the carbon-14 atom: the time radioactive carbon-14 takes to lose half its radioactivity through decay. The half-life of carbon-14 is 5 730 ± 40 years (Fig 4.4). The carbon-12/carbon-14 ratio in a living organism is always in equilibrium with the atmospheric carbon-12/carbon-14 ratio, therefore it is possible to know the amount of carbon-14 with which an organic sample started. The total of the carbon-14 atoms left in the sample can be measured, hence it is possible to calculate how long it took the sample to ‘lose’ the ‘converted’ carbon-14 atoms (Encyclopædia Britannica 2012: *sv* carbon-14 dating; Finkl 2009: *sv* dating methods; Hajdas 2008:3).

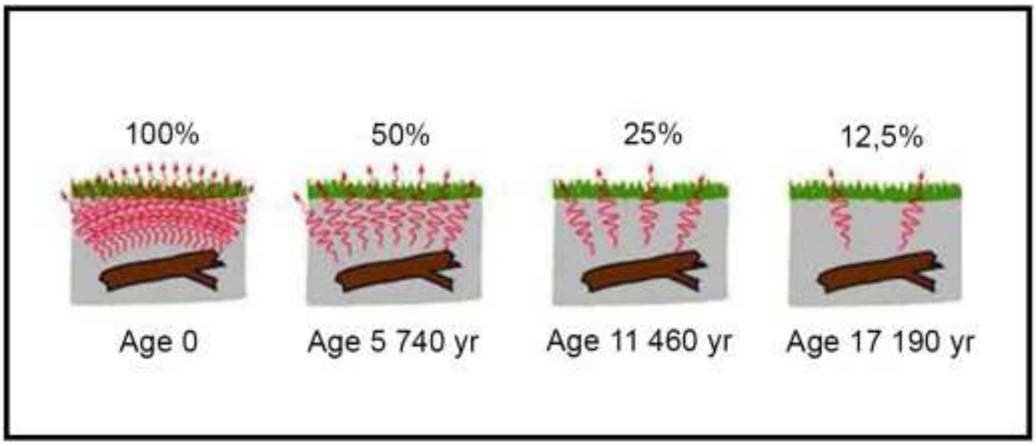

Figure 4.4: Radioactive decay of carbon-14 with a 5 730 ± 40 years half-life (Cited 27 October 2015, online: http://hyperphysics.phy-astr.gsu.edu/hbase/nuclear/cardat.html).

This was the theory posited by Libby (1964?:17), that due to the radioactivity of carbon-14 and its known rate of decay it would be possible to determine the chronological age of a specific organic sample. Libby and his partner, Arnold, practiced the black carbon method, which needed about 10 grams of carbon, because they literally counted the radioactive reactions produced from carbon-14 decay in the sample. They counted the individual radioactive incidents using a screen wall Geiger counter, which took up to three months to carefully measure a sample (Libby 1964?:7). To settle a dispute regarding the correlation between the Babylonian calendar in the time of King Hammurabi and the current calendar, due to the problem of identification of a particular eclipse from about four thousand years back, Libby tested an organic sample from a known ancient date. The sample of wood that he tested came from a beam from the roof of a house in Nippur and the beam bore a clear and legible Hammurabian calendar date (Libby 1960:608-609). Among the first samples Libby tested, with significant interest to the biblical archaeology field, was the linen wrapping of one of the Dead Sea Scrolls (Fig 4.5), the Book of Isaiah (Libby 1960:603).

Figure 4.5: Box of linen in the Qumran stores, Rockefeller Museum, Jerusalem, with the bitumen impregnated into the fabric (Taylor 2012:xiv).

Newer refined techniques use progressively less carbon to attain the required results. Currently, with the development of several forms of mass spectrometers and other equipment, very small samples can be analysed without the three month need to count the individual radioactive reactions of decaying carbon-14 (Richter 2009: *sv* carbon dating & archaeology). There are different techniques to analyse the sample, but the principle is to convert molecules into ions and then to separate the ions according to their mass-to-charge ratio. Mass spectrometers determine the chemical composition of a sample by identifying atoms and isotopes, thus are able to measure the specific ratio of carbon-12, carbon-13 and carbon-14 directly. Subsequently, the age of a sample can now be calculated. A tandem mass spectrometer, consisting of more than one mass spectrometer, is more than a thousand times more sensitive than any single unit, making them useful for analysing extremely small quantities of biological compounds (Brown 2012: *sv* mass spectrometry; Microsoft Encarta 2009: *sv* mass spectrometer). As little as one milligram of carbon is sufficient to measure the carbon isotope ratio, consequently as small a find as a single grain of pollen can be used to help determine the chronology of an excavation (Krogh 2012: *sv* dating).

The hard connective tissue that comprises almost all skeletal systems in an adult vertebrate is bone. The word skeleton is derived from the Greek word meaning 'dried up', because bone appears to be non-living (Microsoft Encarta: *sv* bone (anatomy)). However, bone is composed of cells embedded in an abundant, hard intercellular material, with the same physiological processes necessary for the normal turnover of cells in living organisms. These physiological processes facilitate the equilibrium between the carbon isotopes in the bone and the atmosphere to the current ratio in the atmosphere. The two principal components of bone are collagen and calcium phosphate, the organic and inorganic parts. Collagen fibres, which gives bone its tensile strength and ability to yield, are generally resistant to putrefaction, the phase during the taphonomic process when the loss of cellular tissue occurs (Garland 1987:121; İşcan & Steyn 2014:318). The protein in collagen consisting of amino acids, which is the substance/tissue suitable to be carbon dated. The degree of the preservation of the bone protein plays a cardinal role if radiocarbon dating is to be performed on ancient bone samples (Stafford *et al* 1987:30).

4.3.2. Radiocarbon dating problems

Radiocarbon dating is more of an exact science than relative chronology, where personal interpretation may result in ambiguous dates. Unfortunately, radiocarbon dating is not without limitations. The main problems regarding radiocarbon dating are (Krogh 2012: *s v* dating):

- Current (post 1950) carbon-14 levels cannot be used as the baseline level.
- Carbon-14 ratio fluctuation in the atmosphere.
- Carbon-14 has a relative short half-life.
- Infiltrations in porous bone.

The impact on the accuracy of radiocarbon dating due to these problems is not insurmountable and results are still achieved with a ± 40 year sensitivity.

4.3.2.1. Post-1950 carbon-14 levels

Although radiocarbon dating was a useful by-product of the research and work done regarding the development of the atom bomb, atomic explosions negatively impacted on radiocarbon dating. From the 1950's various nations did numerous experimental nuclear explosions. During these radioactive explosions, atmospheric nitrogen was, similar to cosmic radiation, converted to carbon-14. The unfortunate result is that the post-1950 carbon-14 levels are twice as high as the average of the previous 5 000 years (Krogh 2012: *sv* dating). Therefore, due to the equilibrium between living organisms and the atmospheric carbon-12/carbon-14 ratio, the 'baseline' carbon-14 level of current organic samples cannot be used as the baseline for ancient excavated organisms. Corresponding samples regarding ancient times must thus be 'current' samples – prior to 1950. Scientists must calibrate their calculations accordingly.

Uncalibrated or raw results *before present*, are being set at the year *1950* on the Gregorian calendar (Richter 2009: *sv* carbon dating & archaeology). After calibration, the results are then given as more absolute *calibrated before present*, in correlation with the Gregorian BCE/CE dates. Raw dates are written without capital letters as bc/ad or bce/ce, while capital letters are used (Cal BP/BP, BCE or CE) to indicate a calibrated date (Hajdas 2008:16).

4.3.2.2. Fluctuation in carbon dioxide levels

Carbon and carbon dioxide form part of the physiology of all living organisms (Fig 4.1 & Fig 4.3). Furthermore, volcanos were (and still are) a major contributor to atmospheric carbon (Hayes 2012: *sv* geologic carbon cycle). Events, such as volcanic eruptions or massive fires had an effect on the atmospheric carbon. It was however only volcanos, which were a rich source of carbon-14 depleted carbon dioxide, which had a significant effect on the carbon-12/carbon-14 ratio.[5] The result is that the carbon dioxide levels, as well as the atmospheric carbon-12/carbon-14 ratio were never constant throughout the ages and that the atmospheric radiocarbon level prior to 1000 BCE deviates measurably from the contemporary (1950) level.

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[5] Modern carbon dioxide emissions from carbon-14 depleted fossil fuel, which also alter the atmospheric carbon-12/carbon-14 ratio, are not relevant to the current discussion regarding the past times of the Ancient Near East.

The fluctuation is such that in the year 6 200 BCE it was about 8% above the 1950 level. If the present-day level is used as baseline regarding ancient samples with a true age of 8 200 years, it would be dated by radiocarbon as 7 500 years old (Krogh 2012: *sv* dating).

Carbon-14 is not homogeneously distributed among today's plants and animals. Additionally, the levels were not stable throughout the ages. The deviations all involve non-atmospheric contributions of carbon-14-depleted carbon dioxide to organic synthesis. Specifically, volcanic carbon dioxide is known to depress the atmospheric carbon-14 level (Krogh 2012: *sv* dating). Although the amount of carbon-14 stays the same, subsequent to more carbon dioxide in the atmosphere, the carbon-12/carbon-14 ratio changes and the percentage in living matter is proportionally smaller after volcanic eruptions (Decker & Decker 2012: *sv* volcano).

The equation to determine chronology utilises the rate of decay of carbon-14. The rate of decay is the only constant in the equation. The three variables in the calculation are:

- The amount of carbon-14 in the living organism.
- The amount of carbon-14 in the dead organism on the test date.
- The time between death and the processing of the sample.

Therefore, if any two of the three variables are known, the third can be calculated. In archaeology the second variable, the amount of carbon-14 in the sample, is accurately measured utilising mass spectrometry, which in reality leaves only two variables, namely the starting total of carbon-14 and elapsed time. During the historical era certain past events were accurately documented regarding time and place. Organic samples associated with such events can be utilised to determine the starting total of carbon-14, when the sample was a living organism. The known elapsed time makes it possible to calculate the carbon-14 level for a certain region at a specific time. With enough dated samples from a region the atmospheric carbon-12/carbon-14 ratio can be chronologically calibrated.

Biblical archaeology is in the fortunate position that it falls mostly in the historical era, where chronology can be established regularly and accurately without radiocarbon dating. Dated organic samples from these sites are utilised to establish calibrated atmospheric carbon-14 data. Finkelstein (2013:8) mention Megiddo as an exceptional example:

> A statistical model for a single site – Megiddo: circa 100 radiocarbon determinations from about 60 samples for 10 layers at Megiddo, which cover circa 600 years between circa 1400 and 800 B.C.E. ... Megiddo is especially reliable for such a model because the time span in question features four major destruction layers that produced *many organic samples from reliable contexts*. This, too, is unprecedented: no other site has ever produced such a number of results for such a dense stratigraphic sequence (author's italics).

Another field utilised to calibrate radiocarbon dating is dendrochronology. The annual ring produced by a tree during the growing season incorporates atmospheric carbon *only in that season*. A tree, living for hundreds or even thousands of years, is therefore a living chronograph of the seasonal fluctuation of the carbon-12/ carbon-14 ratio in the atmosphere. By counting a crosscut of the tree trunk the year in which a ring was grown can be determined exactly. The atmospheric carbon-14 ratio can be calibrated by measuring the carbon-14 concentrations in old tree rings of a known age. The 4 000 plus years old bristlecone pines of California have proven to be particularly suitable for such chronologies (Encyclopædia Britannica 2012: *sv* dendrochronology). Olive trees in the Mediterranean, thought to be between 3000 and 5000 years old, can give carbon-14 calibration for the last 2 000 to 3 000 years (Alalou 2017: *sv* Oldest olive trees). Again, the biblical archaeological timeline benefits from this calibrating method.

In spite of the chronological calibrating of the atmospheric carbon-14 ratio, there are still 'wiggles' or plateaus in the calibration curve (Yizhaq *et al* 2005:193). These fluctuations arise from variations in atmospheric carbon-14 content caused by the changes in the production rate and changes in the carbon cycle, for example, a major volcanic eruption (Hajdas 2008:16). The decay of carbon-14 is constant, thus theoretically an age/concentration-graph should be smooth curved. The *Hallstatt plateau* (Fig 4.6), 2500-2400 BP (700-400 BCE), is one of these 'wiggles', which prevented Finkelstein (2013:7) from giving accurate dates regarding samples that originate from Iron Age IIB and Iron Age IIC contexts. Notwithstanding, these 'wiggles', calibrated radiocarbon dating in the Near East is probably one of the most effective calibrated regions regarding time and space, with accurate results.

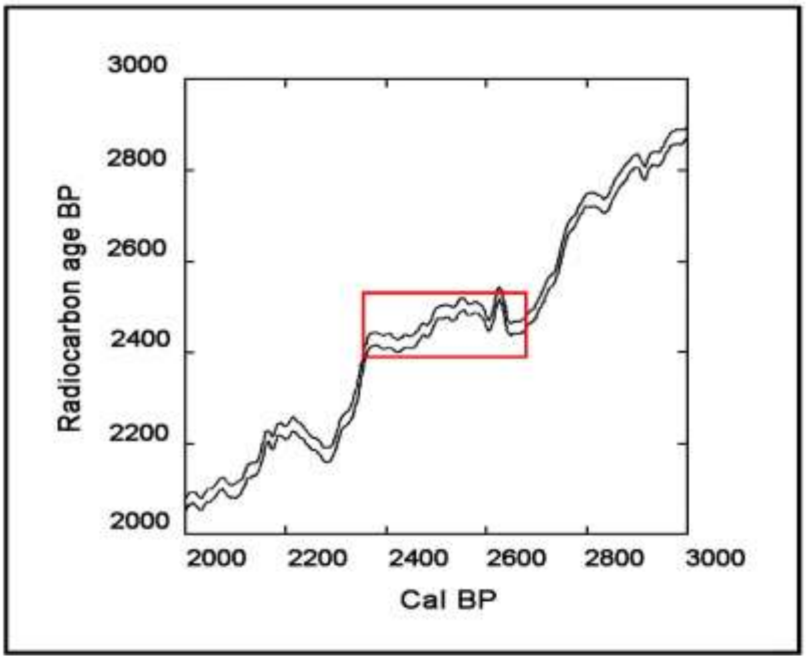

Figure 4.6: Radiocarbon age plateau (wiggle) at 2400-2500 BP (700-400 BCE) known as a 'Hallstatt plateau' marked on the radiocarbon calibration curve (Hajdas 2008:16).

4.3.2.3. Relative short half-life of carbon-14

The half-life of any radioactive substance is the time elapsed to lose half of the radioactive substance to decay. The result is that after only seven halve-lives there are less than 1% of the original amount of the radioactive substance left in the material. With more halve-lives elapsing, the accuracy of results decrease accordingly. The use of carbon-14, with a relatively short half-life of 5 730 ± 40 years, is problematic when the age of the specimen reach more than 50 000 years, which is more than eight half-lives. Although the method is sometimes extended to 70 000 years, errors as great as 2 000 to 5 000 years may occur (Finkl 2009: *sv* carbon-14 dating).

Studies in the Ancient Near East cover the whole past of *Homo sapiens*, with biblical archaeology especially focused on the time since history was documented. For example, written Egyptian documents date to *circa* 3150 BCE, when the first pharaohs developed the hieroglyphic script in Upper Egypt (Encyclopædia Britannica 2012: *sv* Egyptology). Biblical archaeology falls in the time-slot where radiocarbon dating is the most sensitive and additionally calibrations regarding carbon-14 fluctuation from dated sources are available to increase accuracy.

4.3.2.4. Infiltrations in porous bone

Bone is a porous medium, thus susceptible to infiltration by foreign material, both organic and inorganic. Any infiltration of foreign material during the taphonomic process, prior to testing, may alter the accuracy of the results obtain from bone. *In terra* stained bones, used in some studies, indicate postmortem accumulation of iron. Preliminary electron probe microanalytical studies have suggested a postmortem infiltration of iron-containing compounds within the stained region. Garland (1985:123) caution that 'such infiltrations ought to be borne in mind by the palaeopathologist in the investigation of palaeodiets and in the interpretation of radiocarbon dates obtained from the inorganic portion of bone.'

The empty vascular and cellular spaces are an ideal environment for algae, fungi, saprophytes and plant rootlets to infiltrate and multiply. These organic infiltrations, with their own 'current' carbon-14 levels, infiltrating bones possibly years after the time of death, are implicated as possible sources of contamination in radiocarbon dating utilizing the organic portion of bone. The results may consequently produce dates younger than the true bone age (Garland 1985:122-123). New techniques address these concerns.

4.4. UTILISING ANCIENT BONES

The key to radiocarbon dating is to isolate the organic component of bone: collagen. In other words, inorganic as well as all organic material contained in the bone due to and during taphonomic processes must be eliminated prior to determining the radiocarbon related age. Certain organic compounds are insoluble in specific acidic solutions. Pollen, for example, is insoluble in caustic chemicals, such as hydrofluoric acid (Greeff 2005:23). The same principle is utilised when carbon-14 is analysed in bone. A bone sample is subjected to series of processes, *inter alia* 'washings', in which the insoluble quality of the collagen part of bone in specific solutions, is utilised (Fig 4.7).

Collagen is composed of proteins. Proteins are a combination of amino acids, which are carbon based molecules. The quality of a radiocarbon date starts with a sound scientific archaeological context from which the sample is recovered, the demonstrated purity of the material to be analysed and the known accuracy and precision of the analytical method (Yizhaq *et al* 2005:193). The progress in the analytical methods and procedures renders the results from radiocarbon dating bone very accurate.

The accurate analysis in radiocarbon dating for all organic material, including bone, is mainly done with an accelerator mass spectrometer. To reach such high accuracy in dating bony remains, the bone must be pre-treated to exclude contaminants and to isolate the organic material pertaining to the bone sample – cleaning procedures to isolate the collagen samples (Yizhaq *et al* 2005:198).

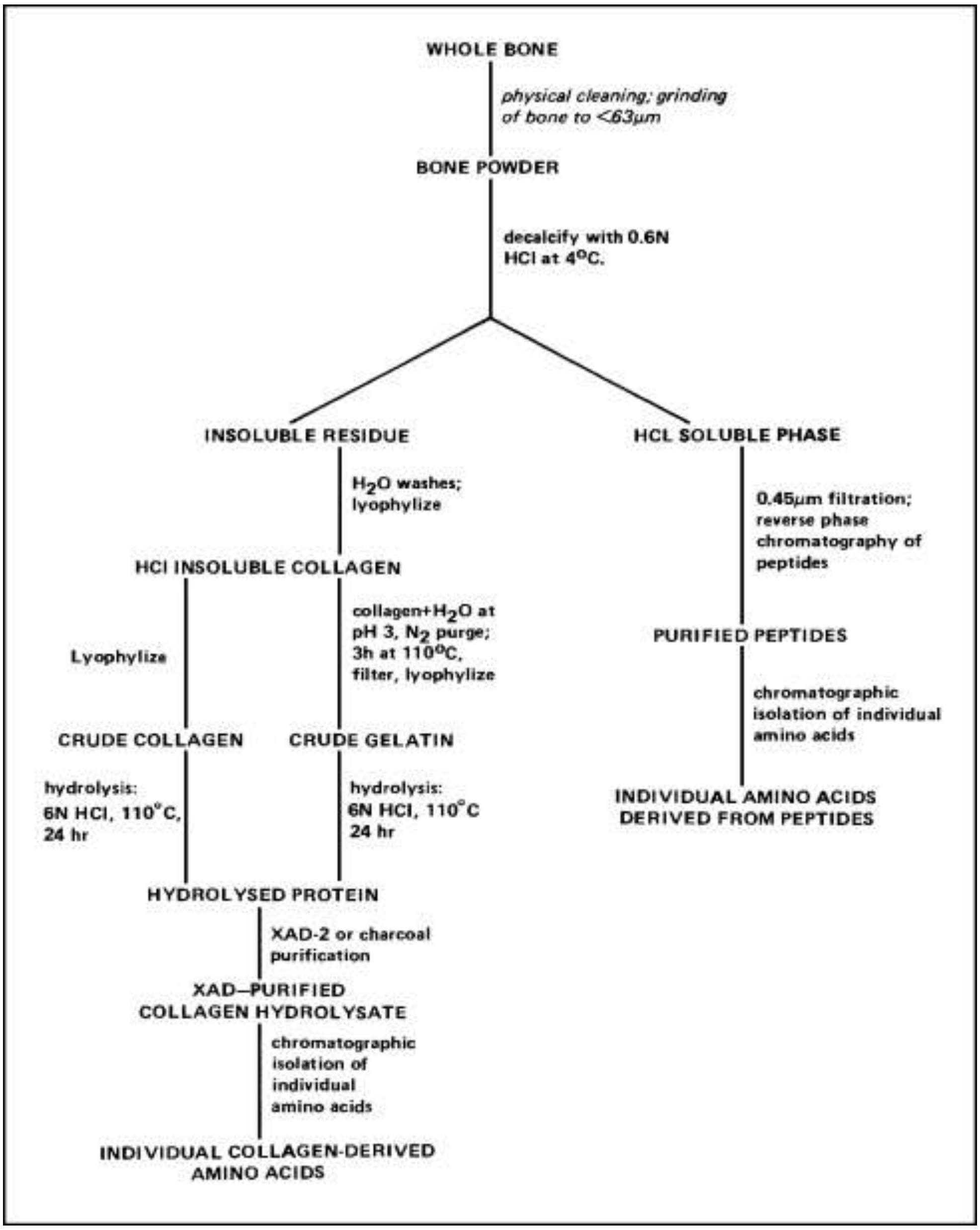

Figure 4.7: Flow diagram showing pre-treatment methods used for cleaning collagen when radiocarbon dating bones (Stafford *et al* 1987:27).

The process is such that the soluble organic and inorganic portions of the bone are removed (Fig 4.7). This leaves the insoluble triple-helical collagen. The helical collagen is then denatured, that is the helix is untwisted. The result is a gelatin, consisting of organic matter originating only from the bone sample (Higham *et al* 2006:179). The gelatin is consequently prepared to be analysed in an accelerator mass spectrometer. The gelatin is combusted to CO_2, which is then reduced to graphite. The graphite is finally analysed for its carbon-14 content in an accelerator mass spectrometer (Yizhaq *et al* 2005:197).

The quality of the collagen determines whether radiocarbon dating will be possible and hence the degree of accuracy of the results. In order to define the state of preservation of collagen, several methods, such as infrared splitting factors, weight percent (wt%), carbon/nitrogen ratios and amino acid composition are available to verify the feasibility of accurate testing (Yizhaq *et al* 2005:196).

In the Ancient Near East, if the bone sample is adequate, the collagen preservation seems to be very good. Yizhaq *et al* (2005:197-198) analysed 30 bones from the early Pre-Pottery Neolithic B layer at the site of Motza, about five kilometre west of Jerusalem. Although the quantity of collagen present in these bones was low, the quality of the extracted collagen in these *circa* 9 000 years old bones was good. In fact, the extracted collagen samples were comparable to modern collagen with respect to their infrared spectra, namely, carbon/nitrogen ratios and amino acid compositions. In the Motza study, the bone collagen and charcoal dates were similar (Yizhaq *et al* 2005:202).

Dating bone samples, following scientific principles and methods renders radiocarbon dating an accurate and valuable tool in the analytical process of human remains in the archaeological setting.

4.4.1. Radiocarbon dating in biblical archaeology

The potential margin of error in radiocarbon dating increases proportionally to the increase in age of a specimen, augmented in areas where the means to calibrate ancient carbon-14 levels are not available. However, biblical archaeology, in contrast to some of the other archaeological fields, is in the fortunate position where the main problem areas regarding radiocarbon dating do not affect the dating process in such a degree as other regions. The primary reasons are:

- The dates applicable to biblical archaeology are less than two half-lives of carbon-14.
- The biblical archaeological era falls in a well-documented time in history in an area where such documentation was exceptional for the time.
- Trees, up to 4 000 years old, are a further source in regard to the calibration of carbon-14 levels through dendrochronology.

The scientists in the field of biblical archaeology are able to use documents and inscriptions, organic archaeological samples from reliable contexts and dendrochronology to calibrate the carbon-14 levels regarding the last 5 000 years for the Ancient Near East. Furthermore, with dates falling in a time less than two half-lives of carbon-14, the carbon dating results produce excellent accuracy. The result is the ability to date samples from the Ancient Near East with an accuracy of ± 40 years.

4.5. CHRONOLOGY IN BIBLICAL ARCHAEOLOGY

Finkelstein (2013:7), one of the modern archaeologists who, especially in Israel, contributed to calibrate carbon-14 levels for the region, is of the opinion that:

> The radiocarbon results from Israel are the most intensive for such a short period of time and small piece of land ever presented in the archaeology of the ancient Near East.

Finkelstein (2013:7) published a statistical model utilising radiocarbon tests from 38 strata at 18 sites in Israel to produce 229 results after 143 samples were collected. The result is that radiocarbon dating and pottery/ceramic phases were merged to help the biblical archaeologist on yet unexplored (as well as old sites) to propose previously impossible dates to artefacts/strata.

With radiocarbon dating previous subjective interpretations and assumptions can be refuted with hard scientific evidence. An example is the six-chambered gates in casemate walls at Hazor (Fig 4.8), Megiddo and Gezer. In 1 Kings 9:15 the fortifications of these cities are attributed to Solomon’s engineers and accordingly Yadin called the gates ‘Solomonic Gates’ (Scheepers & Scheffler 2000:65).

Figure 4.8: The foundation walls of the six-chambered gate of Hazor (Scheepers & Scheffler 2000:67).

The continuous development in biblical archaeology, with the augmentation from natural science, enabled biblical archaeologists to change Yadin's initial reckoning that Solomon was the builder of these monumental buildings. Finkelstein's (2013:9) postulate of the chronology of the Omride dynasty, based on scientific data, will be hard to refute:

> On the side of archaeology, it has become clear, among other reasons thanks to the *radiocarbon studies* mentioned above, that the monuments that were traditionally perceived as representing the great united monarchy of the tenth century B.C.E. were in fact built during the rule of the Omride dynasty in Israel in the ninth century B.C.E. [author's italics].

4.6. CONCLUSION

Modern science developed exponentially in the 20th century and continues to do so in the 21th century. These developments enable modern archaeologists to do tests where hard scientific data can elucidate the past. This, however, does not take out the scientifically based 'art' of sound archaeological doctrine ascertained by the 'founding fathers' of biblical archaeology, such as Petrie's stratigraphic approach. Relative chronology utilising pottery is still based on Petrie's guidelines and individual knowledge, skill and interpretation still play a significant role. However, the development of radiocarbon dating, utilising the carbon-14 atom, revolutionised chronology. Continuous development in the radiocarbon dating field has made it possible to use miniscule amounts of organic material to do tests. Furthermore, previously discarded material, such as bone, is testable with reliable results.

The combination of the ‘art’ of relative chronology, together with the hard science of calibrated radiocarbon dating enables the modern biblical archaeologists to make ancient events, previously lost in the past, perceivable, thus augmenting our knowledge.

The developer of radiocarbon dating, Willard F Libby (1960:607, 609), made the following astute comment in his Nobel Prize lecture on 12 December 1960:

> The determination of the chronology of ancient civilizations may be said to be the main archeological problem and task of radiocarbon dating … the investigation of the history of man through the use of chemistry.

5. TRAUMATIC INJURIES

The investigation of history includes one of the less admirable attributes of *Homo sapiens* – war, with its consequential physical damages to individuals, which is detectable in human remains.

Trauma is the disruption of the normal anatomy of the tissue(s) of a body due to the application of an external force sufficient to cause damage, irritation or inflammation of the soft and hard tissues and can be accidental or nonaccidental in origin (Davidson, Davies & Randolph-Quinney 2011:183). This disruption of the normal anatomy elicits a physiological reaction from the body, which may or may not ultimately be compatible with life, thus precipitating the death of the individual.

The biomechanics regarding the reaction of the human body to an external force (load), is borrowed from other scientific fields, originating from the law of elasticity discovered by the English scientist, Robert Hooke in 1660 and the 18th-century English physician and physicist, Thomas Young (Encyclopædia Britannica 2012: *sv*: Hooke's law; Encyclopædia Britannica 2012: *sv* Young's modulus). In Figure 5.1, the reaction of any material to an external force or load is illustrated utilising the well-known Young's modulus or stress-strain curve for any material (İşcan & Steyn 2014:318-319).

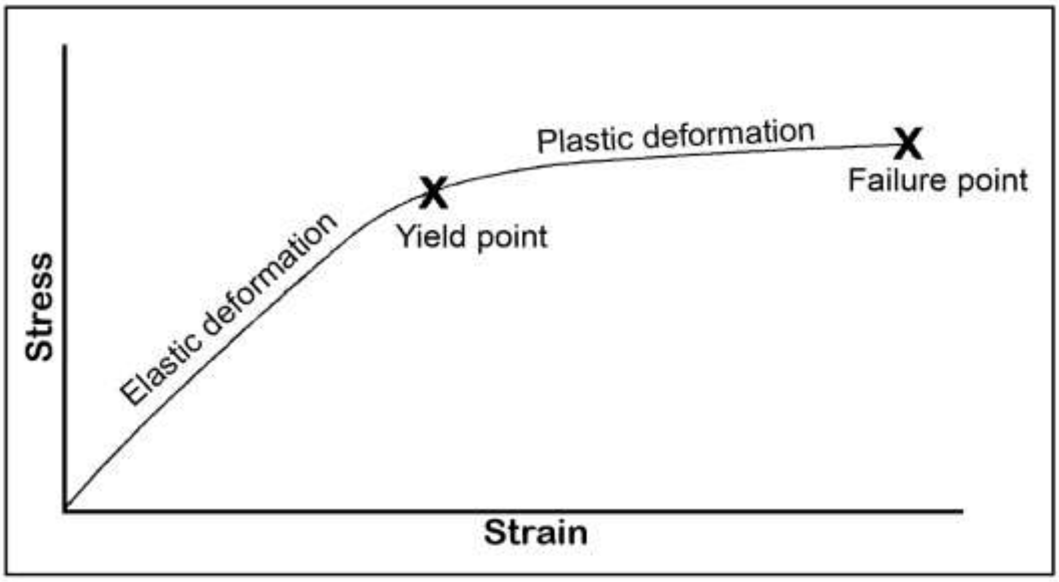

Figure 5.1: General stress-strain curve. As stress increases, the relationship between stress and strain changes. Once the yield point (X) is passed, the material (human tissue) can no longer go back to its original shape and will undergo deformation. Eventually it will fail (İşcan & Steyn 2014:319).

Trauma is the physical injury or wound to the human body caused by the application of energy or a load to the body, which surpasses the yield point and eventually the failure point on the stress-strain curve (Fig 5.1). The type of trauma sustained is dependent on factors that include the quantity of energy applied, directionality, velocity and focus of impact. Skeletal trauma is highly variable and each case presents its own set of unique characteristics and challenges to the interpretation and reconstruction of the causative events (Davidson *et al* 2011:184; İşcan & Steyn 2014:319). The physical force responsible for trauma in the Iron Age can be divided into two main groups (Payne-James *et al* 2011:77; Shwär *et al* 1984:310):[6]

- blunt force and
- sharp force.

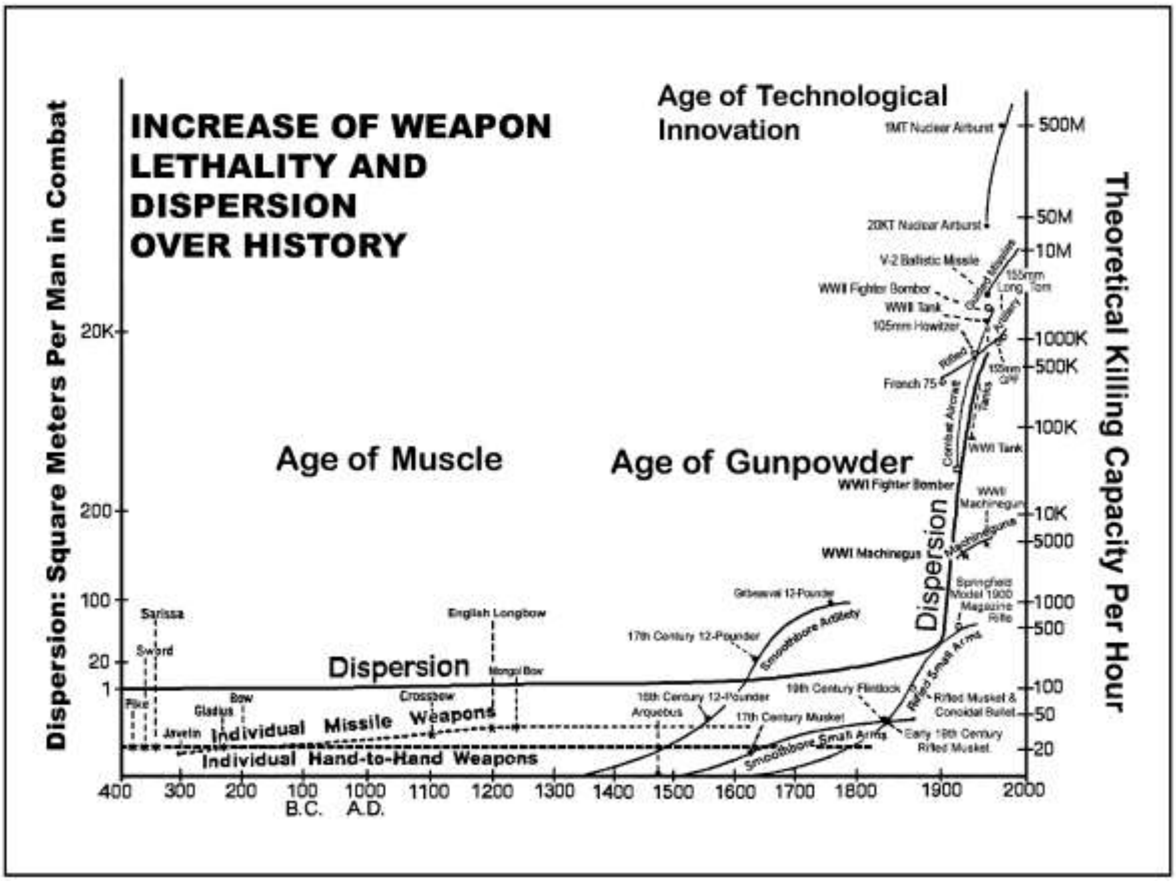

Figure 5.2: Weapon lethality index (Human 2006:222).

During war, weapons are the means with which the energy/force that causes trauma, are transferred. Through the ages, with technological advancement, *inter alia* in

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[6] The third major modern class, ballistic trauma, is not part of this dissertation, because projectiles with high enough speed to cause such injuries are associated with the much later invention of gunpowder.

weaponry and warfare, mankind strived to make it easier for the soldier to kill his enemy with less risk to himself. The lethality of a weapon is measured as the matrix of total deaths caused within the shortest time span possible and *Homo sapiens* has striven throughout its existence to better this ability. Dupuy divides the evolution of weapon lethality into three great periods (Human 2006:222):

- The Age of Muscle (~ c 1305 CE);
- The Age of Gunpowder (c 1305 CE - 20th century);
- The Age of Technological Innovation (20th century ~).

The lethality of weapons during the Age of Muscle, that is the first four millennia of world history, did not change radically in the way gunpowder and especially technology made it possible to kill masses of humans quickly as seen in Figure 5.2 (Human 2006:222). The Iron Age in the Ancient Near East forms part of the Age of Muscle, where blunt and sharp force were the *modus operandi* with which wounds were inflicted on the enemy.

Unlike the armamentarium of modern soldiers, where high velocity projectiles and explosions cause the majority of trauma, the ancient warrior's armamentarium had only blunt edged and sharp edged weapons, whichever effectiveness was dependent on the proficiency of the soldier. Subsequently, casualties were predominantly from blunt force and sharp force injuries. According to recent calculations, a person's skeleton amounts to about 60% of a body's target area in a frontal view. However, Aranda-Jiménez *et al* (2009:1048) refer to Walker, whose estimation is that the chance of hitting bones with a random weapon shot is only 50%. These specific bone hitting injuries may usually be detectable in skeletal remains.

5.1. BLUNT FORCE TRAUMA

Newton described the physics of bodies that are moving as well as those in rest. An object at rest tends to remain at rest and an object in motion tends to continue in motion in a straight line unless acted upon by an outside force. Newton's third law states that when two bodies interact, they apply forces to one another that are equal in magnitude and opposite in direction. The third law is also known as the law of *action* and *reaction* (Microsoft Encarta 2009: *sv* inertia; Westfall 2012: *sv* Newton, Sir Isaac). Besides inertia,[7] movement of the human body and the magnitude of the force, the characteristics of the tissue determine the likelihood that a lesion will be inflicted or not, as well as the lethality of the injury (Shwär *et al* 1984:32-33). Blunt force trauma may have a number of outcomes, namely (Payne-James *et al* 2011:78):

- no injury;
- tenderness;
- pain;
- erythema (reddening);
- oedema (swelling);
- contusion (bruising);
- abrasions (grazes);
- lacerations (jagged cuts);
- fractures (broken bones).

Of interest to the archaeologist are the injuries that will be detectible in the remains of a human body after excavation. Soft tissue injuries may be perceptible in mummified remains, however the majority of data will be gained from skeletal remains, where fractures can be evaluated to determine which type of force was the cause of the injury and evaluate it *vis-à-vis* cause of death – as is done in modern forensics (Davidson *et al* 2011:184; Haglund & Sorg 1997:1).

5.1.1. Blunt force trauma – physical and biomechanical factors

There are physical factors of an instrument or object in play regarding its *verwondingsvermoeë* (ability to wound) in general, which are specifically exploited in war where the aim is to deliberately inflict lethal injuries (Shwär *et al* 1984:33). These factors are also applicable to sharp force injuries, as well as high velocity injuries in a modern scenario.

5.1.1.1. Kinetic energy

The impact of a moving object upon a human body is dependent on the *kinetic energy* (E_K) thereof. The total amount of kinetic energy in joule that can possibly be

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[7] Inertia, the property of matter that causes it to resist any change of its motion in either direction or speed (Microsoft Encarta 2009: *sv* inertia).

transferred from the moving object (weapon) to the body can be calculated with the formula:

$$E_k = \frac{1}{2} mv^2$$

In the formula ‘m’ is the mass of the object in kilogram and ‘v’ is the velocity in metre per second. From this equation it is apparent that the result of doubling the mass will be less than doubling the velocity of the object. If the moving object is stopped by the body, all the energy will be transferred, which will not be the case if it is a glancing blow. The more kinetic energy transferred to the body the more damage will be done to the tissues (Shwär *et al* 1984:33). Although current science was not part of the ancient ‘perceivable knowledge’, trial and error produced the most effective weapons with the material and knowledge at hand.

5.1.1.2. Duration of impact

The duration of contact during which time kinetic energy is transferred from the moving object to the body, depends on the movement or not of the target-person. If both the object and the body are moving in the same direction the impact of the energy conveyed will be less than if the body is stationary. The most energy per timeframe will be transferred into the body if it is moving in the opposite (head-on) direction than the object. A glancing blow will also reduce the amount of energy transferred. An example from modern-day sport is the stopping/catching of a hard ball (eg cricket or baseball ball). If the hand is stationary when the ball is stopped, the hand will be painful, red and burning. If the ball is caught with the hand moving in the same direction as the ball during the catch, it is not painful and without redness (Shwär *et al* 1984:33).

5.1.1.3. Surface of impact

With a sharp object, all the energy is conveyed via the point or the cutting edge (eg arrow or sword), in contrast with a relatively blunt object (eg slingstone). When the energy is transferred over a bigger area, the result is a lesser injury. A direct hit, where energy is transfer over a smaller area, will be more traumatic than a glancing blow over a larger area (Shwär *et al* 1984:33).

5.1.1.4. The effects of the impact on the object

The intrinsic characteristics of the object will determine what happens to it during impact, as well as the amount of energy transferred into the target. Plasticity, deformability and breakability dictate what will happen during impact. If the projectile/object deforms or shatters, kinetic energy is used up in the process of deforming/breaking, therefore all the kinetic energy is not transferred to the target. This reduction in the energy conveyed, consequently causes less trauma. Snowballs, breaking on impact do not hurt as much as a potential lethal blow with a stone of similar proportions, which does not break (Shwär *et al* 1984:33).

5.1.1.5. Different reactions from different types of tissue

The human body is tougher than one thinks and may take remarkable punishment before a person succumbs. The type of human tissue exposed to the external blunt force, plays a major role in the wound suffered (or not), as well as the potential lethality of the subsequent injury. The skin is tough and elastic and may not present any sign of injury while there is extensive damage to the underlying tissues. The skin covering different anatomical structures is also more susceptible to wounding than others, such as frequently injured skin covering the head versus abdominal skin that seldom shows blunt force injuries. Due to the elasticity of the skin, the kinetic energy is transferred to the underlying tissues, where the lethal injuries may occur. Encapsulated organs, such as the liver and the spleen, are prone to rupture from direct blunt force trauma and such a rupture may be fatal. Unfortunately, injuries in soft tissues are not detectable in skeletal remains. The human skeleton, with limited elasticity, is less resistant to blunt force. Deformations may result due to the inability of the tissue to dissipate the energy (Davidson *et al* 2011:189). Blunt force trauma to hard-tissue of the skeleton may vary from a simple undisplaced fracture (hairline crack) to an open compound fracture (open wound with fragmented bone). These bony fragments may further injure adjacent tissues (Shwär *et al* 1984:34).

The most ‘sensitive’ anatomical structure susceptible to blunt force, is the skull (cranium) (Fig 5.3). Several cranial bones develop during infancy and childhood, which during growth fuse together to form the adult cranium, containing some of the most fragile bones of the skeleton. This make it one of the most complicated hard-tissue structures of the body, which in the adult shows variations in normal shape and size, enabling the skilled anthropologist to determine the ancestry and sex of a deceased (Black & Ferguson 2011:67-69, 128-132; Gill 1984:329-346; Keita 1988:387; Redfern 2009:407; Wienker 1984:236-239).

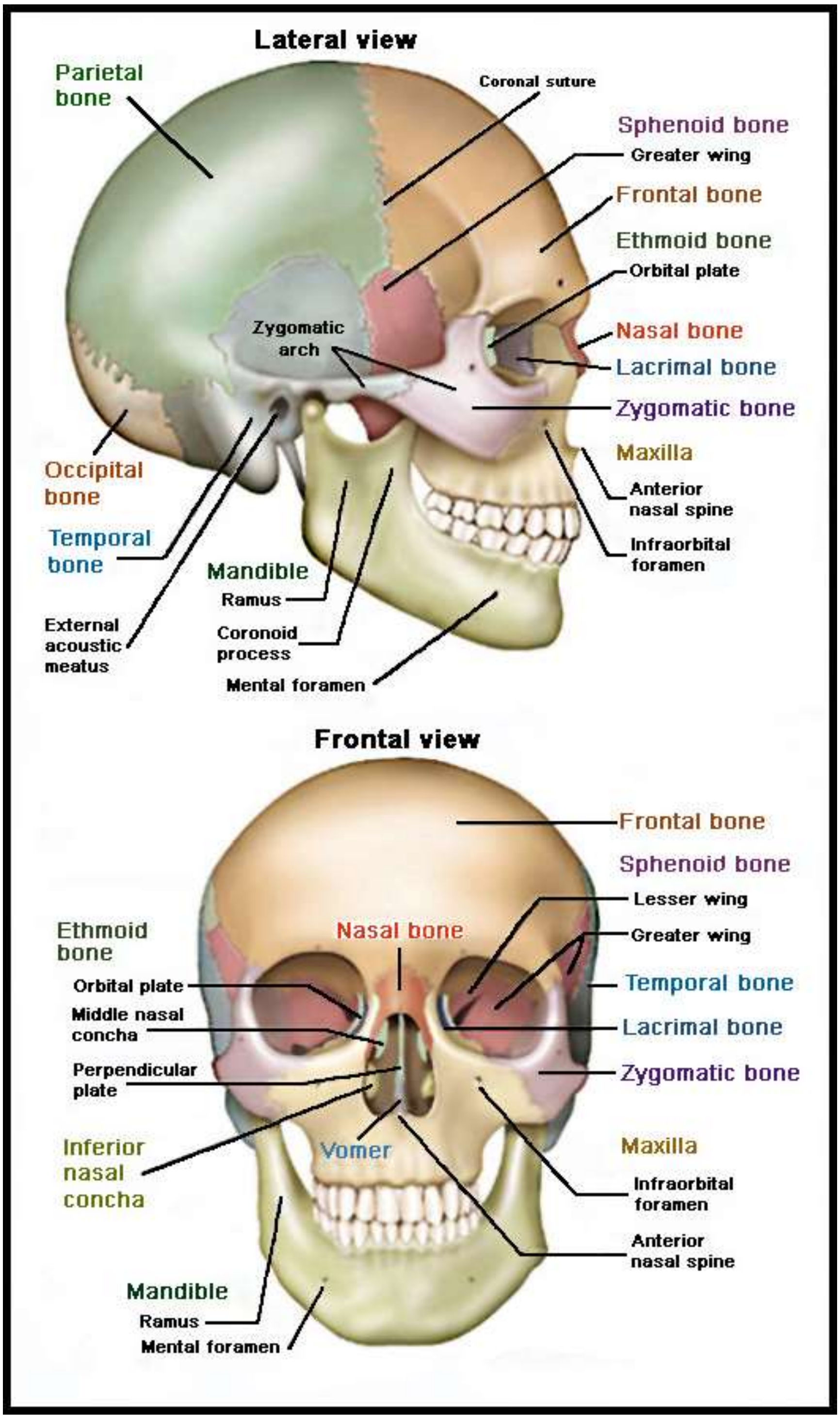

Figure 5.3: The human skull (Warren 2012: *sv* skeletal system, human).

The cranium consists of three layers: an inner and outer hard layer, 2-6 mm thick, with the outer layer normally twice as thick as the inner layer. The middle layer of the cranium is a layer of spongy cancellous[8] bone tissue found between the harder inner and outer bony layers of the cranium. The cranium contains four buttresses (mid-frontal, mid-occipital, posterior temporal and anterior temporal)[9] made from thicker bone, which influence fracture patterns. For example, a blow to the centre of a parietal bone will produce radiating fractures in the area between the mid-frontal and anterior temporal buttresses.

As discussed above, the physical factors (eg kinetic energy, impact duration and area) in combination with the biomechanical factors, determine the severity of the injury from blunt force. The cranium may or may not fracture, only the outer layer may fracture or all three layers may fracture with damage to the brain with potential life-threatening injury, due to the transference of the kinetic energy from the blunt (or sharp) force (Payne-James *et al* 2011:98-100; Redfern 2009:404).

If the energy or load transferred overcomes the resilience of the cranial tissues, such as the scalp, cranial bones and their blood vessels, and breaches the failure point (Fig 5.1), a haemorrhage[10] may develop with fatal consequences. Death may be due to direct damage to the brain, secondary brain damage due to increased intra-cranial pressure following the haemorrhage or subsequent infection (Payne-James *et al* 2011:101-103; Shwär *et al* 1984:73).

5.2. SHARP FORCE TRAUMA

Sharp force injuries result when the force applied to the body is concentrated on a very small area – the tip or cutting edge of a weapon. In general, sharp force injuries have cleanly divided, distinct wound edges, which may span irregular surfaces and penetrate different types of tissue with the same contact (Payne-James *et al* 2011:86; Shwär *et al* 1984:58). The 'convenience' of sharp weapons is that less force is necessary to inflict a fatal wound, compared to blunt force weapons. There

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[8] **Cancellous**: not solid: describes bone that has a mesh of hollows on the inside, as opposed to being compact or dense (Encarta Dictionaries 2009).

[9] The following medical terminology indicate the following anatomical positions regarding the skull (Fig 5.3):

- Mid-frontal: the middle of the front part of the skull.
- Mid-occipital: the middle of the back of the skull.
- Posterior temporal: the hindmost part of the side (temporal bone) of the skull.
- Anterior temporal: the foremost part of the side (temporal bone) of the skull.

[10] **Haemorrhage**: excessive bleeding: the loss of blood from a ruptured blood vessel, either internally or externally (Encarta Dictionaries 2009).

are a number of factors, according to Payne-James *et al* (2011:87) that determine how much force is required to deliver a lethal blow:

- The sharpness of the tip/point of the weapon. This is often the most important factor and the sharper the tip or point, the easier it is to penetrate the skin, thus needing less energy;
- The sharpness of the 'cutting edge' of the (bladed) weapon;
- The nature of the force applied. Stabbing incidents are usually dynamic, involving complex relative movements between the attacker and defender;
- Whether clothing has been penetrated: some items of clothing, such as thick leather jackets, may offer significant resistance to penetration. In the Iron Age armour played a significant role to reduce the lethality of blows during battle;
- Whether bone has been encountered. Skin offers very little resistance to penetration by sharp weapons, but injury to bone tends to suggest that a greater force has been used to inflict the wound. Significant penetration of bone may also damage the weapon with occasionally part(s) of the weapon embedded in the bone (to the delight of archaeologists).

The sharpness of the instrument is one of the most significant factors if the example of a modern surgeon is taken into account. In modern-day surgery, 'lethal' wounds are caused during operations *without the need of force*, just because the scalpel has such a razor sharp cutting edge. The load is applied to such a small area that a relatively small amount of energy is sufficient to reach the failure point of the tissue.

There are different types of sharp force injuries: stabs, chops/hacks and cuts (Payne-James *et al* 2011:88; Shwär *et al* 1984:58-60). A stab wound occurs when the external wound on the skin is smaller than the tract of the penetrating wound. Although the 'small' external wound may appear negligible, internal damage to underlying organs can be fatal. An injury from a deep penetrating arrow is an example of such a *stab* or *penetrating* sharp force injury.

A cut is generally a longer breach of the skin with shallower penetration of the underlying tissue. As a rule of thumb these injuries are not as lethal as the deeper penetrating wounds. If more and/or larger blood vessels are injured, the prognosis is worse.

Chops or hacks are usually applied with more force, thus convey more energy with more damage to the body. Although the external skin wound may be as long as superficial cuts, penetrating wounds are deeper with potential fatal injuries to internal organs. In war, severe injuries, such as amputation of limbs, may be the result of a chop or hack. Swords and axes in Iron Age Ancient Near East could typically inflict such injuries. Furthermore, deliberate peri- and postmortem dismemberment took place on a regular basis during war in the Iron Age (Fig 8.4; Fig 9.3; Fig 9.4).

Death from sharp force injuries may follow as a result of various reasons. The factors as discussed, will determine the lethality and/or prognosis of a wound, with the main consideration being whether major blood vessels or vital organs were hit. Infection was the secondary killer, regardless of blunt or sharp force or the severity of the injury. Tetanus (lockjaw), for example, which is lately an extremely rare complication due to modern-day immunisation, was a deadly secondary complication from as small a wound as a pinprick (Shwär *et al* 1984:58).

5.3. EXTERNAL PROTECTIVE MATERIAL

External measures have an effect on the *verwondingsvermoeë* or lethality of blunt and sharp force instruments, thus trauma may be limited, reduced or even prevented (Shwär *et al* 1984:34). These measures, in the form of 'protective clothing of metal or leather worn in battle by soldiers in former times', are known as armour (Encarta Dictionaries 2009: *sv* armour). Armour is the soldier's way of countering the physical and biomechanical factors that cause injuries when blunt and sharp force are encountered during battle. The ancient soldiers may not have understood the science behind their measures, but again, common sense and trial and error led them to counter the contemporary weapons relative effectively. The armour facilitated the following:

- Prolonged the time the kinetic energy was transferred;
- Enlarged the area where kinetic energy transference took place;
- Covered vital anatomical structures, such as the cranium and thorax.

The armour, through which the energy must be transferred or the object must penetrate to reach the body to be able to cause damage, dispersed the energy over a larger area over a longer time and therefore reduced the lethality of the blow, thrust or cut (Shwär *et al* 1984:34). An example of the use of this principle in modern-day life is the wicketkeeper in cricket or the catcher in baseball, both wearing special protective gear including a helmet, gloves and shin guards/pads.

5.4. CONCLUSION

Lethal injuries are as old as the conflict between members of the species *Homo sapiens.* To achieve these injuries, an amount of energy, sufficient to exceed the failure point with consequent disruption of the tissues of the human body, needed to be transferred to a specific area of the opponent's body. Blunt force and sharp force were the methods used in the Ancient Near East in the Iron Age to transfer this energy. The aim of artisans was to make the weapons used in the application of force easier, deadlier and to be one step ahead of the protection/armour of the opponent. The analysis of the injuries during these violent encounters can be an additional source of knowledge regarding the people involved, as well as the weapons used during these extreme displays of human behaviour. As a rule in archaeology, the bioarchaeologist will be presented with skeletonised human remains. In the process of examining and analysing the remains, forensic principles must be applied to these bones to establish whether the body was exposed to interpersonal violence (İşcan & Steyn 2014:3-4; Krogman & İşcan 1986:8).

There are several macroscopic criteria to be taken into consideration when evaluating injuries on skeletons, with emphasis on crania, to determine whether it was the result of blunt or sharp force. Although Table 5.1 concerns projectiles, the same criteria are applicable to any blunt or sharp-edged weapon of the Iron Age, because it is the energy transfer that causes disruption or injury to tissues, irrespective of the method of transfer.

During the evaluation of human remains *vis-à-vis* injuries sustained during violent events, the following criteria may be used to enable the researcher to elucidate the past, especially if patterns emerge, namely:

- Sex;
- Age;

- Ante-, peri- or postmortem injuries;[11]
- Blunt or sharp force trauma (Tab 5.1);
- Material embedded in the skeleton;
- Anatomical distribution of the injuries;
- Identification of multiple injuries;
- Signs of infection;
- Signs of surgical intervention.

Table 5.1: Macroscopic criteria used to identify blunt and sharp projectile injuries.

Blunt projectiles	**Sharp projectiles**
Depressed fracture	Penetration or perforation
Penetration or perforation	V/semi-V/U-shaped cross section perforation
Bone displacement	Bevelling at injury site[12]
Internal bevelling	Point insertion or notched defect
Radiating and concentric fractures	Radiating fractures
Lozenge-shaped apertures[13] (pointed objects)	Lozenge-shaped apertures
Delamination at the entrance wound[14]	Delamination at the entrance wound

(Redfern 2009:406)

The patterns emerging from skeletal analysis may show how dubious 'traditional' assumptions might be or support 'traditional' views, as respectively posited by Aranda-Jiménez, Montón-Subías and Jiménez-Brobeil (2009) after their research of the Argaric people in Iberia and Redfern (2009) at Dorset in England.

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[11] **Antemortem**: before death with signs of healing.
Perimortem: during dying, the probable cause of death.
Postmortem: after death.

[12] **Bevelling**: the fracture of the skull is as such that the pieces are at an angle to each other and the normal curvature of the skull is disturbed.

[13] **Aperture**: a small *narrow* opening through the skull.

[14] **Delamination**: Separation of the bony layers of the skull.

6. IRON AGE WEAPONRY

The yardstick for effectiveness of weaponry throughout the ages, was the ability of the weapon in the warrior's hand to overcome his enemy while surviving the battle. To evaluate the effectiveness of weapons during battle, Dupuy posited the *lethality index* of weapons (Fig 5.2). The lethality index of a weapon can be defined as 'the matrix of total deaths caused within the shortest time span' (Human 2006:221-222). Weapons developed from hand-to-hand and individual missile weapons to nuclear weapons, changing the ability of one man to engage one enemy at a time to the ability of one person to kill millions with a weapon of mass destruction.

6.1. LETHALITY INDEX

The lethality index played a major role in the average area a soldier could dominate with contemporary weapons, as seen in Dupuy's dispersion pattern table (Tab 6.1).

Table 6.1: Battlefield dispersion patterns.

Historical Army Dispersion Patterns* (Army or Corps of 100 000 Troops)						
	Antiquity	**Napoleonic Wars**	**American Civil War**	**World War I**	**World War II**	**October War**
Area occupied by deployed force, 100 000 strong (km^2)	1.0	20.12	25.75	248	2 750	4 000
Front (km)	6.67	8.05	8.58	14	48	57
Depth (km)	0.15	2.50	3.0	17	57	70
Men per km^2	100 000	4 970	3 883	404	36	25
Square metres per man	10.00	200	257.5	2 475	27 500	40 000

*Dupuy's dispersion table quoted by Human (2006:225).

The weapons of the Iron Age Ancient Near East fall into the Age of Muscle, which reflect little technological change in military application. War and weaponry development aimed at the ability to move troops to engage and injure and/or kill the enemy without serious injury to oneself (Yadin 1963:3). General technological innovations throughout this time period were continuous, but it did not change the lethality index of weapons as, for example, technology did in the 20th century (Human 2006:223).

There is a direct nexus between the injuries inflicted during the Age of Muscle, in which the Iron Age figured, and the weapons utilised. Predominantly blunt force and sharp force were the cause of traumatic injuries and subsequent death during war. These injuries are reflected in Iron Age human remains excavated throughout the world.

6.2. ASSYRIAN RULE DURING THE IRON AGE

The Assyrian rule, notwithstanding its relatively short duration from *circa* 732-604 BCE, left possibly one of the richest and most important imprints in the archaeological record, with the most distinguished remains being several images and inscriptions written in Assyrian cuneiform script. These pictorial images, such as the Lachish Reliefs, and written documents, enable archaeologists to study the weapons, not only those of the Assyrians, but also the weapons of their opponents (Negev 1996: *sv* weapons and warfare; Stern 2001:14; Yadin 1963:320).

To conquer Palestine and other regions, the Assyrian army seems to have been first to apply *blitzkrieg* – a well organised army, ‘which enabled it to cover large distances in a relatively short time with its *sophisticated equipment* [author’s italics] and to position large units against a few rivals simultaneously, even under difficult conditions’ (Stern 2001:4). Assyrian military documents and numerous reliefs depicting the Assyrians at war, enable biblical archaeologists to decipher this part of the history of the Ancient Near East. The siege of Lachish left biblical archaeologists with the singularly unique situation where a historical event described in the Bible (2 Ki 18:13-19, 36; Is 36:1-38) is collaborated in the material culture at the city of Lachish, as well as with physical evidence at an excavation site *outside* Palestine, the Assyrian capital, Nineveh. In Nineveh, Sennacherib's reliefs celebrate and depict elaborately his conquest of Lachish in 701 BCE (King & Stager 2001:248; Scheepers & Scheffler 2000:250; Yadin 1963:428-437). Yadin (1963:320) stated his opinion regarding these reliefs as follows:

> To this day, these reliefs are the most important source of our knowledge of the methods used by the Assyrian army to subdue fortified cities.

Various types of personal weapons, siege machines and weapons to counter them, as well as a siege ramp, are depicted and were uncovered during excavations at Lachish. Material remains, such as at Lachish, witness the local response to the advent of full blown imperialism of first Assyria, then Babylon and thereafter Persia (Human 2006:268-269).

6.3. WEAPON CLASSIFICATION

Each soldier had his ‘personal’ weapons, depending on the unit in which he was serving and whether he was a defender or an attacker (Negev 1996: *sv* weapons and warfare). Deist (2000:221) categorised weapons as projectiles, shock weapons (thrust, hack and strike) and mobile weapons. King and Stager (2001:224) divided personal weapons as offensive or defensive and then subsequently classified weapons according to range. However, apart from hand-thrown rocks and firebrands by defenders, the personal weapons used by both defenders and attackers were for all intents and purposes the same type of weapons. Yadin (1963:6) sees range, as a basic factor in the use and development of weapons, as a convenient criterion in weapons classification. Forensic analysis cannot categorically discern whether an Iron Age injury, either blunt or sharp force induced, was caused by a short-, medium- or long-range weapon. The practical range-classification, combined with whether the weapon will cause blunt or sharp force trauma, is presented in Table 6.2.

Table 6.2: Personal weapon classification according to range and blunt or sharp force.

Trauma	Short-range	Medium-range	Long-range
Blunt force	Club	Stones thrown by hand	Sling and stone
	Mace	*Firebrands thrown by hand	
Sharp force	Axe	Spear	Bow and arrow
	Dagger	Javelin	
	Sword	Lance	
	Spear	* Apart from blunt force trauma, injuries from firebrands will also be due to thermal energy (burns)	
	Lance		

Slingers, archers and spearmen were some of the infantry units deployed as depicted on the Lachish reliefs. More than one weapon were used, such as the Assyrian javelin-throwers at Lachish, with round shields in their left hands, spears in their right hands and a sword/dagger in their girdles on the left thigh (Fig 6.1). The sling and the bow were the long-range personal weapons in an Iron Age army (Fig 7.5), transferring energy via blunt and sharp force over a distance (King & Stager 2001:227). The spear was the medium as well as short range weapon. In the final close combat situation the long straight sword was utilised (Yadin 1963:294). These medium and short range shock weapons were more likely than missile weapons to be specialized for war (Keeley 1996:50).

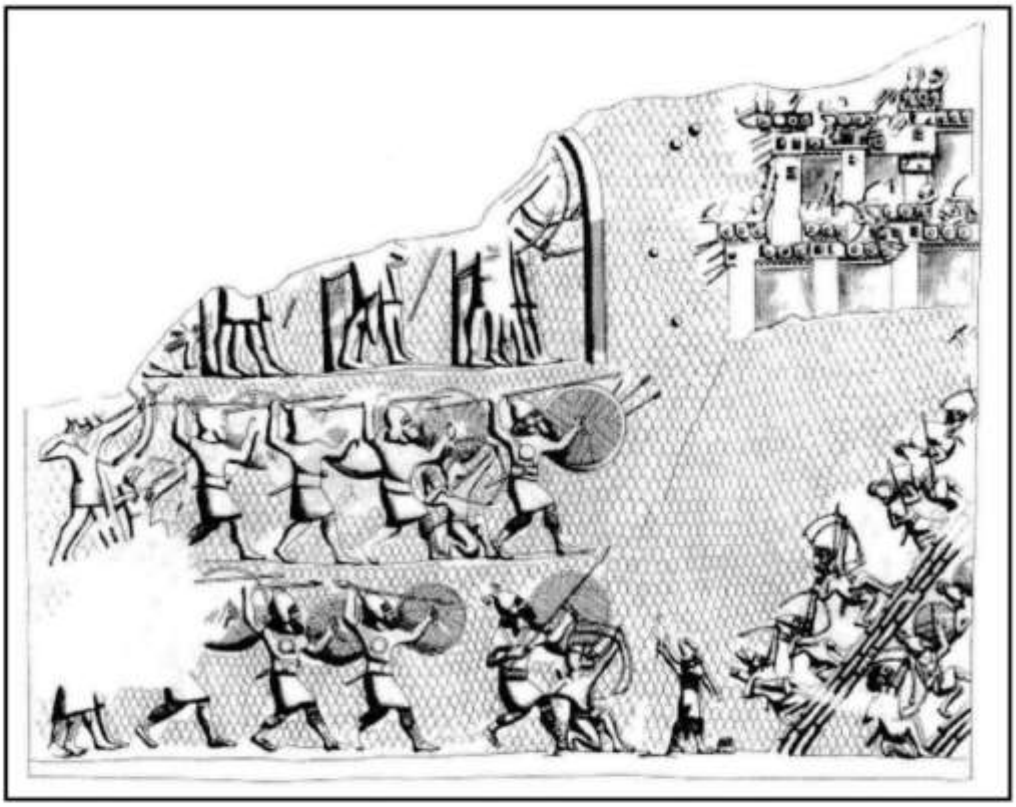

Figure 6.1: Lachish Relief, second scene: attacking infantry (Scheepers & Scheffler 2000:257).

6.4. CONCLUSION

The ability to distinguish between blunt and sharp force injuries is more exact than estimating the probable range of the weapon responsible for the injury. Nevertheless, wound pattern(s) may provide an educated guess. Redfern (2009:401) is of the opinion that Iron Age weaponry, from a bioarchaeological perspective, should be divided into sharp and blunt types. This is probably the best approach in bioarchaeology for all ages – an analogue to modern forensics (Maples 1986:218-228). The result is that researchers of ancient interpersonal violence could ‘speak the same language’, such as is the case in modern medicine.

7. WEAPONS INFLICTING BLUNT FORCE TRAUMA

Almost any of the handheld short- and medium-range Iron Age weapons (edged weapons included) could cause blunt force trauma, for example, a hit from a (broken) spear instead of a thrust. Even a shield, essentially part of the armour, could have caused blunt force trauma if the enemy was hit with enough force. Anything in the heat of battle was probably possible. The weapons *designed* to deliver blunt force trauma will be discussed in this section.

7.1. CLUB AND MACE

The club, made entirely out of wood, was the first purpose-made handheld weapon. Longer and heavier than a human arm/fist, it delivered more energy to the target with more damage to the enemy. With a rock or stick in the hand a person can hit harder than with a fist, thus the next step in weapon evolution was the mace, a combination of the two (Human 2006:237-238). The mace was a simple rock, shaped for the hand and intended to smash bone and flesh, to which a handle had been added to increase the velocity and force of the blow (Guilmartin 2012: *sv* military technology). Generally it had a wooden handle fitted with the operative part, known as the mace head, on the end. The two parts were joined by means of a socket, the wooden handle being inserted into a hole drilled in the mace head. The two most common forms of mace heads were those shaped like a pear or apple and those that were discoid or saucer-shaped, the latter group being found mainly in Egypt. The head was usually made of stone, but was later replaced by metal, especially ceremonial maces for royalty in Egypt (Negev 1996: *sv* weapons and warfare). The mace was an effective weapon, so long as the enemy was not armoured and his head, in particular, was without a helmet. Armour compelled that another weapon had to be invented, which could be swung with force and which had the power to penetrate – namely the axe (Yadin 1963:41, 120).

Negev (1996: *sv* weapons and warfare) and Human (2006:238) are of the opinion that in the Iron Age in the Ancient Near East, the axe replaced the club and the mace in warfare and limit the use of the mace to warfare during the Bronze Age. It disappeared towards the middle of the second millennium BCE. This perception may change if Iron Age skeletal remains are examined *vis-à-vis* the type of trauma and weapons responsible for the trauma.

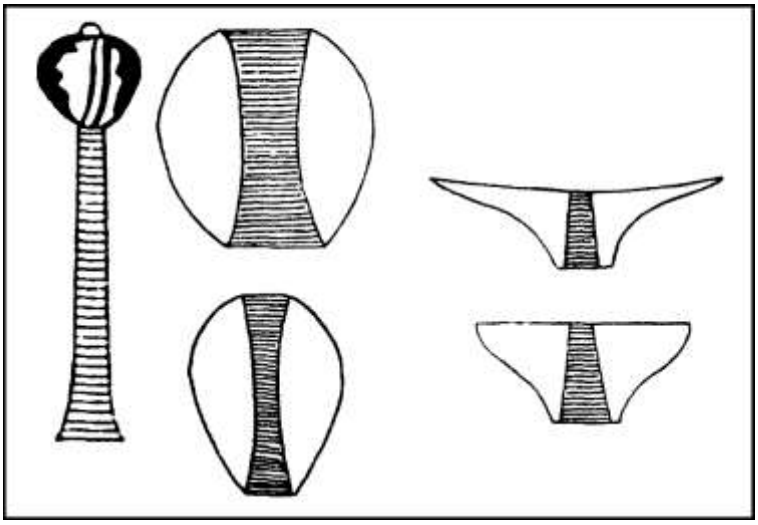

Figure 7.1: Types of mace-heads: apple-shaped, pear-shaped, and saucer-shaped. The handled mace is one depicted on Egyptian monuments (Yadin 1963:11).

7.1.1. Injuries from the club/mace

If the kinetic energy, transferred from one combatant to another during battle via the club/mace, overcomes the resilience of the body, an injury ensued. The factors, as discussed above, are applicable to the degree of trauma from a blunt weapon. The most important factor is where the adversary is hit. The most vulnerable part of the body to blunt force trauma is the head. A single blow to the head, even through armour, may result in disorientation, unconsciousness, fracture of the cranium, intracranial bleeding and subsequent death. Body blows may result in soft-tissue injuries as well as fractures, however it had to be an extremely violent hit to be fatal.

Aranda-Jiménez *et al* (2009:1038) appraised the perception in archaeological circles that in Bronze Age Europe ‘the emergence and institutionalisation of violence and warfare are inherent to processes of increasing social complexity … Specialised *weaponry* such as halberds and *swords* have been correlated with *evidence* of the existence of warriors and – more or less implicitly – *warfare* [author’s italics].’ However, when these researchers examined 155 skeletons in such a ‘warrior’ society, where sharp edged weapons were in evidence in burial sites, the results did not concur with the perception that these ceremonial, or similar weapons, were used in battle. They evaluated signs of physical violence, its anatomical pattern, as well as its occurrence according to age and gender (Aranda-Jiménez *et al* 2009:1045). In spite of irrefutable evidence of sharp edged weapons in burial sites, the palaeoanthropological findings of Aranda-Jiménez *et al* (2009:1047) were consequently:

> (I)t seems clear that, at present, the only signs of possible intentional lesions are derived from cranial trauma. However, we must emphasise the fact that *no evidence of blade injuries has been found in the analysed sample*, or even mentioned in other palaeoanthropological reports … Whatever role swords and halberds (even axes and daggers/knives) may have played in actual combat engagements, *their imprints on bones are non-existent* [author's italics].

The aforesaid research was done *vis-à-vis* the Argaric societies in Iberia, corresponding to the Bronze Age in south-eastern Spain (*c* 2250-1450 BCE). Although it falls outside the Iron Age and is not in the Ancient Near East, it is nevertheless applicable to this dissertation. Due to new contradicting data from skeletal examination, where only evidence of blunt force trauma is found, 'traditional' believes from archaeological evidence need to be re-assessed. Bioarchaeological evidence contradicts archaeological evidence, in that sharp edged weapons, although present in excavations, were not used by the Argaric people in warfare to the extent that archaeological evaluations deemed.

The mace is currently not seen as part of the Iron Age weaponry of the Ancient Near East during battle. It may be possible that examination of skeletal remains will prompt biblical archaeologists to reconsider this perception.

7.1.2. Club and mace in the bible

The Hebrew word, *shebhet*, is the word for club, rod or mace. This rod or mace was used by a sovereign as a symbol of royal authority. The word is used figuratively in the Bible and not literary in connection with war, as are, for example, the sling, bow and sword (Orr 1999: *sv* sceptre).

7.1.3. The club/mace in reliefs

The club and/or mace are not as common in Assyrian reliefs as, for example, the bow and arrow. It seems as if it was used to deliver the *coup de grâce* to an already subdued enemy or prisoners. In Figure 7.2, the Elamite king, Teuman, is struck with a mace by an Assyrian soldier. In this depiction the trauma to the skull would have been excessive blunt force trauma.

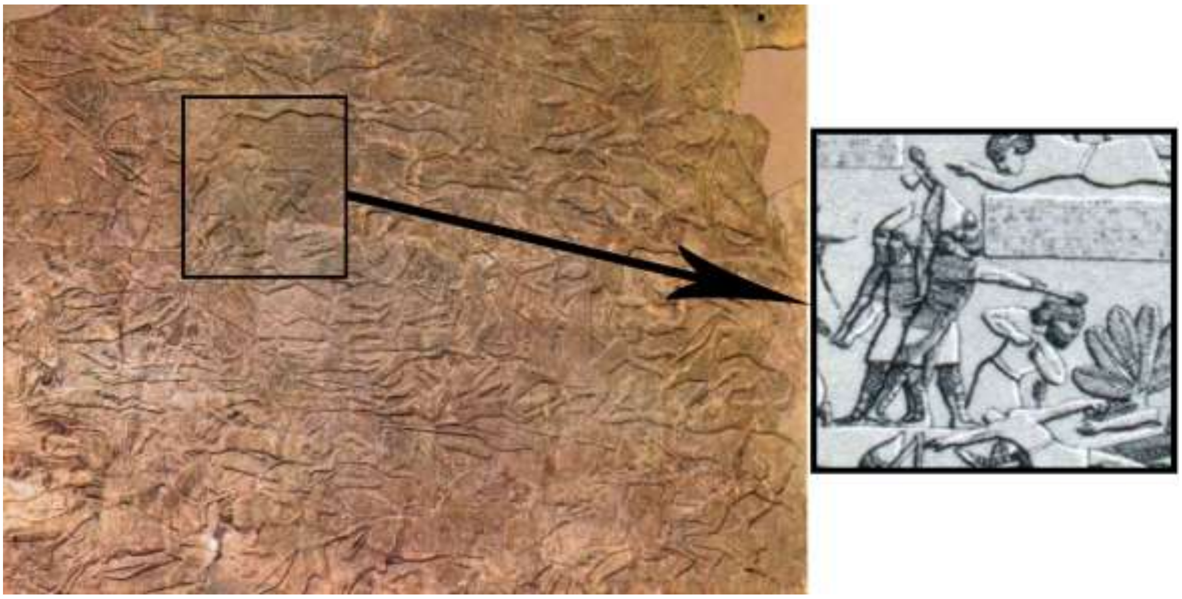

Figure 7.2: An Ashurbanipal relief from Sennacherib’s southwest palace at Kuyunjik (Nineveh, c 668-630 BCE) on display in the British Museum, with illustrative drawing (Yadin 1963:443, 445).

7.2. SLING AND SLINGSTONE

The sling, devised by ancient shepherds to scare predatory animals from attacking their flocks, gradually made its appearance on the battlefield as a weapon of war, because it enabled a missile to be thrown a considerable distance (Yadin 1963:9). The sling was a formidable weapon, which could slay giants (1 Sm 17; Gladwell 2013:18-20). The sling was made from perishable material (leather or cloth), thus archaeologists rely on written accounts and reliefs from battles to deduce what the sling looked like in the Iron Age (King & Stager 2001:228). It consisted of a small strap or socket of leather to which two cords of approximately 60 centimetres were attached.

The warrior, or slinger, held the ends of the cords in one hand with possibly one of the cords tied with a loop around the wrist or finger, placed the missile snugly in the strap and whirled the socket and missile rapidly above his head (Fig 2.1). By letting go of the unattached cord at the right moment, the slinger could let the missile fly out of the socket at a high velocity with considerable accuracy (Encyclopædia Britannica 2012: *sv* sling; Stander & Louw 1990: *sv slingervel*). If the Lachish reliefs portraying the Assyrian slingers (Fig 7.5 & Fig 7.6) are used, together with the ‘anatomical man’ of 1.70 metres to extrapolate the dimensions of an Assyrian sling, the length of 60 centimetres for the cords of the sling is proportionally correct.

Figure 7.3: Slingstones from Lachish (Scheepers 2011:36).

The slingstones, on the other hand, were made from very durable material. Hundreds of these round tennis/baseball/cricket ball size limestone or flint slingstones, six to seven centimetres in diameter, were found at Lachish (Fig 7.3). Most of them were found in the area of the siege ramp the Assyrians built, from which they broke into the town (King & Stager 2001:228; Stern 2001:6). This corroborates Yadin's (1963:9, 297) opinion that a sling's capacity to fire up a slope, indeed, gave it some importance in assaults on fortified cities. Stern's (2001:6) opinion, that *lime* was used to produce projectiles, is probably a case where the wrong terminology is used and it should have been *limestone*. Hills of chalk and chalky limestone are part of the geography around Lachish (Scheepers & Scheffler 2000:215). However, it seems that the Assyrians did not utilise the limestone in the region to produce some of the slingstones, but transported flint slingstones from another region (Scheepers 2015). The data from the Lachish excavations suggests that more flint slingstones were recovered than limestone projectiles (Ussishkin 2004). It was time-consuming and labour intensive to make the round slingstones, whether it was made of flint or limestone.

Flint and limestone are both non-metallic minerals with more or less similar specific gravity of 2.6, meaning that projectiles of the same dimensions weigh more or less the same.[15] In comparison to a modern-day baseball or cricket ball, weighing about 170 grams, a Lachish-slingstone was relatively heavy for its size at approximately 250 grams (Melville 2009: *sv* cricket). However, flint has a hardness of 7 and limestone only 3.5 to 4 on the Mohs hardness scale[16] (Encarta: *sv* dolomite, limestone; Encyclopædia Britannica 2012: *sv* chert and flint, limestone, specific gravity). Both types would have been lethal when a person took a direct hit to the head, while causing different degrees of injury with a hit from the blunt force to the body. The difference between flint and limestone projectiles, due to their different physical properties, became apparent when a hard object, such as a wall, was hit. The softer limestone projectile would be pulverised without forming sharp secondary projectiles. The harder flint, on the other hand, with uniform fine grain, conchoidal[17] fracture and brittleness, shattered on impact. This flint projectile shattered into a multitude of razor-sharp shards, which could inflict serious sharp force trauma onto people in the vicinity. Any type of slingstone (flint, limestone, *spoelklip*,[18] hardened clay or lead projectile in later ages) would have been lethal throughout its whole trajectory.

Projectiles of 250 grams could be hurled at up to 240 km/h (King & Stager 2001:229), which produced 556 joules kinetic energy. Compared to the modern military weapons used by the North Atlantic Treaty Organization (NATO), being the 5.56 mm (NATO) assault rifle, which produces 1803 joules kinetic energy and the 9 mm pistol, which produces 468 joules kinetic energy, the sling was a weapon to be reckoned with (Cheney 2003:34).

Redfern (2009:401-402) states about the range of slingers the following:

> Harrison (2006) also suggests that in antiquity, if a person had been trained from childhood, they could have made accurate hits at a distance of more than 700 m. Brown

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[15] **Specific gravity** (G): ‘is defined as the ratio between the weight of a substance and the weight of an equal volume of water at 4 °C (39 °F). Thus a mineral with a specific gravity of 2 weighs twice as much as the same volume of water’ (Encyclopædia Britannica 2012: *sv* specific gravity).

[16] **Mohs hardness** is a ‘rough measure of the resistance of a smooth surface to scratching or abrasion, expressed in terms of a scale devised (1812) by the German mineralogist Friedrich Mohs. The Mohs hardness of a mineral is determined by observing whether its surface is scratched by a substance of known or defined hardness’ (Encyclopædia Britannica 2012: *sv* Mohs hardness).

[17] **Conchoidal:** with smooth ridges and depressions: having or being a surface shaped like a bivalve shell with smooth ridges and depressions (Encarta Dictionaries 2009: *sv* conchoidal). This describes the morphology of the shards produced when flint is hit or it shatters.

[18] The English words possible translated from *spoelklip*, namely pebble, shingle or gravelstone suggest a smaller stone than the smooth round stones used in a sling.

> Vega and Craig's (in press) review of modern, historical and archaeological sling throws found that the maximum reported range was 500 m.

The *Guinness world records* gives that the furthest distance a *projectile* (dart-shaped) can be hurled using only human power, is with a sling – 477 metres (Glenday 2014:113). According to Gladwell (2013:28), the modern world record for slinging a *stone* was set in 1981 by Larry Bray: 437 metres. The best possible modern equipment and technology were utilised to set these records with only optimum distance, without any accuracy, in mind. It is safe to posit that Harrison overestimates the abilities of slingers, while Brown Vega and Craig are probably also over optimistic with the *maximum* range of 500 metres.

7.2.1. Injuries from slingstones

Medium velocity projectile weapons, at a velocity in the region of 60 metres per second (216 km/h), will cause blunt force trauma to the skeleton (Redfern 2009:404). A projectile in excess of 200 kilometres per hour will cause much more skeletal damage than a projectile with a velocity of 140 kilometres per hour (39 m/s), which already can be dangerous. Modern-day batsmen in cricket regularly face balls of 140-150 kilometres per hour and despite their protective gear (contemporary 'synonym' for armour) there are still serious injuries, even with fatalities. Slingstones, twice as heavy as cricket balls, fall into the category of medium velocity projectiles and cause blunt force trauma. A blunt force injury may result in a superficial laceration (ragged breach in the skin from a blunt instrument), bruising to soft tissue, rupture of internal organs (eg liver or spleen), as well as fractures to underlying bones. The factors in play regarding the lethality of blunt force are also applicable to slingshot injuries. A hit to the body is likely to be less lethal due to the resilience of the human body.

However, a hit to the head is another matter. Redfern (2009:404) describes the injuries to the head from a slingshot as follows:

> Forensic and archaeological research has shown that projectiles, owing to their highly lethal nature, can cause extensive damage to the cranium and, if launched with sufficient power, will shatter the entire structure. These weapons will penetrate the bone surface and result in complete discontinuity, bone displacement, bevelling, and radiating and concentric fractures.

Apart from the lethality from a direct injury to the brain, if left untreated, intra-cranial bleeding due to a cranial-fracture is almost always fatal, because the blood leaking out of the blood vessels cannot escape the fixed volume of the cranium. Pressure builds up inside the cranium and restricts/decreases blood flow to the brain and the brain mortifies[19] with fatal consequences.

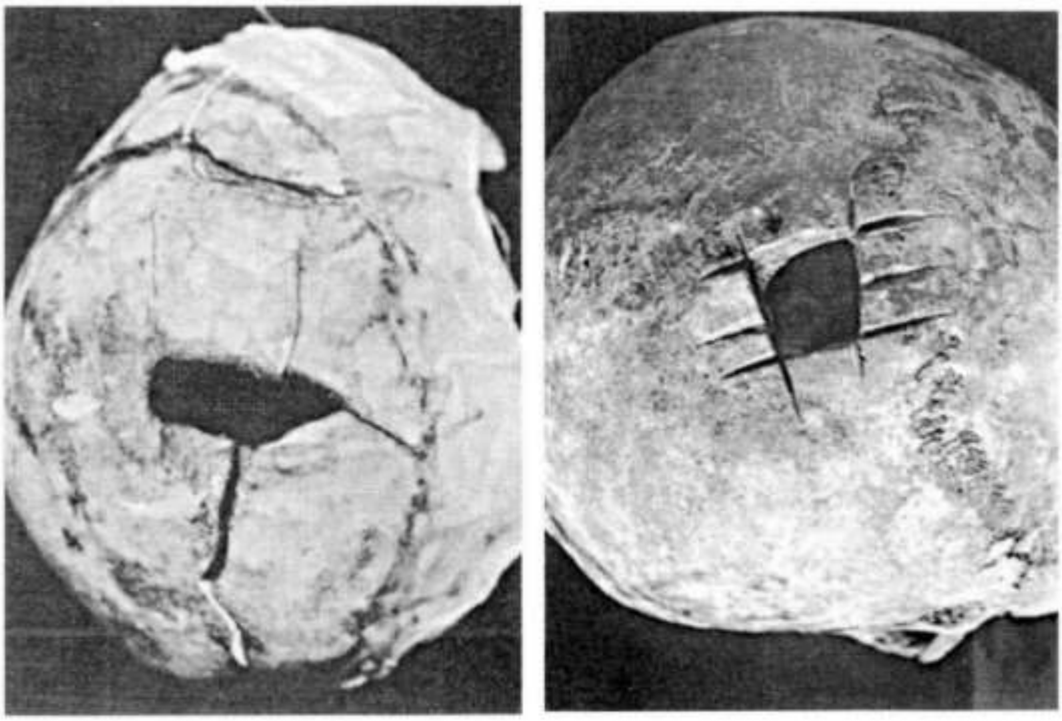

Figure 7.4: Two of the three skulls from the mass grave near Lachish on which head-operations were performed while the persons were still alive. The skull on the left was of a young adult male who survived long enough after the operation for the bone to heal (Scheepers & Scheffler 2000:249).

At Lachish, three crania were found on which trephination was seemingly performed to relieve the increasing intra-cranial pressure (Fig 7.4). Trephination is surgery where a piece of the cranium is removed to allow the blood causing the high intra-cranial pressure, to be drained. The data available does not enable the author to comment emphatically on the injuries to the skulls in Figure 7.4. Consequently, it is not possible to comment on the type of fractures or the type of weapon which caused the injuries. However, sharp force trauma would have left a communicating wound tract through which the intracranial blood could have drained, enabling the

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[19] **Mortify:** '*intransitive verb* Medicine **decay:** to decay and die (*refers to living tissue*)' (Encarta Dictionaries 2009: *sv* mortify).

assumption that the injuries were the result from blunt force, possibly inflicted by slingstones.

7.2.2. Sling and slingstones and the Bible

The Hebrew word, *’eben*, occurs 260 times in the Hebrew Tenakh (Bible) and is translated as stone with various meanings, *inter alia* slingstone (Vine, Unger & White 1996: *sv* stone). The general understanding of the size of the stone used in a sling, especially in the Afrikaans-speaking community, is that of a ‘*klippie’*, which translates to pebble. In 1 Samuel 17:40, the *Afrikaanse Ou Vertaling* uses the words *gladde klippe*, which is not the diminutive, *klippie*, used in the *Afrikaanse Nuwe Vertaling*. When laymen are questioned as to their understanding of the size of David’s slingstones, the general idea is that of a *klippie*, not bigger than a golf ball and the person is astonished when informed that it is more or less the size of a cricket ball, but twice as heavy. This misperception is reflected in Van Zyl (1993: 1 Sm 17:40) and Stander and Louw’s (1990: *sv slingervel*) use of the word *klippie* when they explain the use of a sling and slingstones. These *gladde klippe* or *spoelklippe*, translated as *smooth stones* in most of the English Bibles, are smooth round stones from a riverbed, six to seven centimetres in diameter and perfect as projectiles in a sling.

The Bible, in Judges 20:16, 1 Samuel 17, 2 Kings 3:25 and 2 Chronicles 26:13, portrays armies deploying slingers. The best known Bible ‘sling-story’ is David felling Goliath with his sling (1 Sm 17). With the sling David outranged the weapons of Goliath (Yadin 1963:252, 265). Before David took on Goliath, he told King Saul how he defended his father’s flock against bears and lions in 1 Samuel 17:33-35. Suffice to say he made use of his sling to smite the ‘sheep-thief’. A *klippie* (golf ball size) would not have had enough energy to inflict a lethal or at least a debilitating blow to the bear or lion, but a stone of cricket ball size, with twice the weight, would have been sufficient.

It is possible that Goliath had acromegaly, an overproduction of pituitary growth hormone (somatotropin) after maturity, resulting in abnormal growth (Encyclopædia Britannica 2012: *sv* acromegaly; Gladwell 2013:25-27). The person suffering from acromegaly, due to excessive overgrowth of the bone, may have thin and porous bones, which is not as strong as healthy bones. This would not have mattered if David's aim was true, as any normal person would succumb to a direct hit with a slingstone to the head. Goliath's cranium would present classical signs of blunt force trauma.

In 1 Samuel 17:50-51 David 'slew' the Philistine with a sling and stone and then 'slew' him (again) with Goliath's own sword, hence it is not clear whether Goliath was *lifeless* or not when David cut of his head. In modern medicine, 'many examples exist of individuals with apparently potentially immediately fatal wounds who have performed purposeful movements/actions for some time after the "fatal" injury' (Payne-James *et al* 20011:91). A person could show signs of life after a lethal wound from a 9 mm pistol to the head (author's own experience). A sling and stone and a 9 mm pistol generate approximately the same amount of kinetic energy. Comparably, a slingstone to the head, with subsequent intra-cranial bleeding, may render the victim with a severe headache or even unconscious (as possibly in the case of Goliath), only to expire later, hence it would have been possible that Goliath displayed some signs of life, prompting David to use Goliath's sword to 'slew' him and cut off his head. In 1 Samuel 17 David cut off the head of the Philistine to take it as 'trophy' with him. The scenario *supra*, gives an additional reason for David cutting off Goliath's head, posited from modern science applied together with archaeological findings from the Iron Age.

7.2.3. The sling in reliefs

The Assyrian reliefs depict the sling in battle during the Iron Age in the Ancient Near East. The best depictions are on the reliefs of Sennacherib and Ashurbanipal (Yadin 1963:296-297). The siege and attack scene of Lachish covers many reliefs. According to Yadin (1963:428) the Lachish reliefs (Fig 7.5 & Fig 7.6) constitute one of the most important 'war documents' on battle in Judah and depict the order of battle – for offence as well as defence.

From the reliefs it is possible to discern the dimensions of the sling used by the Assyrian army as well as the battle order of the slingers. The slingers are deployed, together with the archers, as part of the long range weapons, albeit the wounds inflicted from the projectiles will be different. All infantry units are armed, in addition to their 'primary' weapon, with the long straight sword for hand-to-hand combat (Yadin 1963:294).

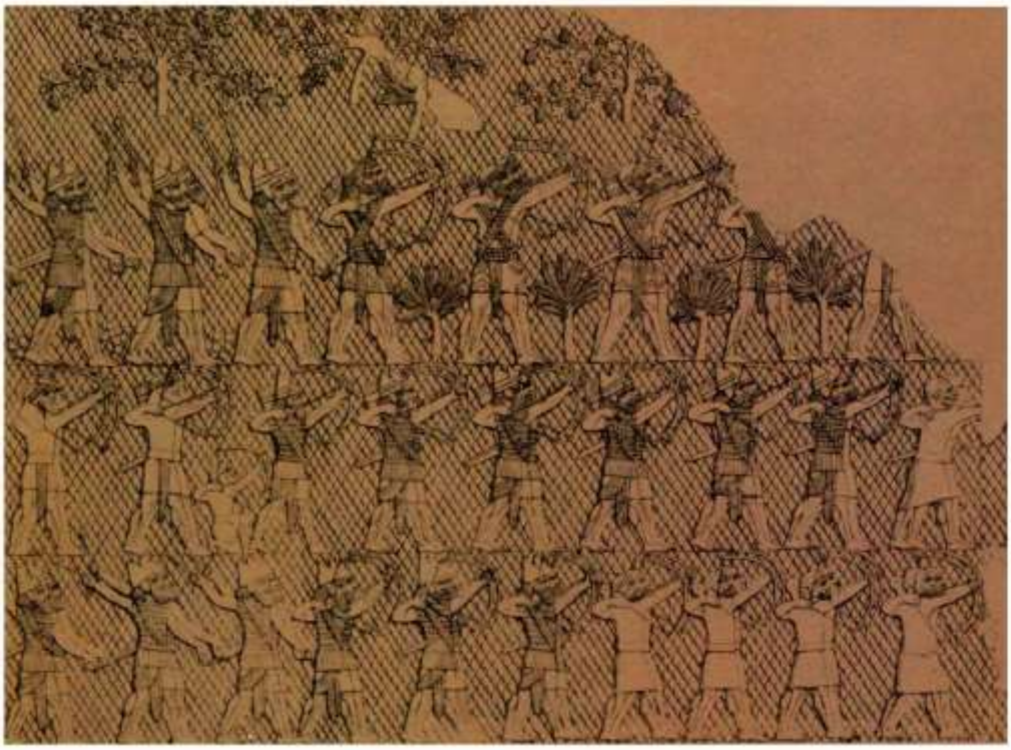

Figure 7.5: Drawings of reliefs in the palace of Sennacherib (southwest) at Kuyunjik (Nineveh) (704-681 BCE). Advancing infantry with archers and slingers at Lachish (Yadin 1963:430).

Figure 7.6: Lachish Reliefs – first scene: Advancing infantry with archers and slingers (British Museum nr 124905. Cited 16 February 2018, online: http://www.britishmuseum.org/research/collection_online/search.aspx?searchText=124905&images=true).

7.3. CONCLUSION

It is inevitable in war that there will be blunt force trauma. Due to the unpredictability of the nature of battle, wounds that appear to be caused by blunt force are not necessary caused by supposedly blunt force weapons. Analysis of the wound and wound pattern(s) will enable the examiner to posit a possible cause for a wound. For example, the pattern of a fracture due to a fall will not look the same as one received from a slingstone. An examination of the human remains from Lachish may as well elucidate the importance of, *inter alia*, slingers during battle as depicted on the Lachish reliefs, when wound patterns resulting from blunt force and sharp force are analysed.

8. WEAPONS INFLICTING SHARP FORCE TRAUMA

Weapons evolved from blunt instruments to instruments with a sharp edge to enable the warrior to inflict a fatal injury to his enemy with the use of less force. However, due to the ‘perpetual struggle’ between weapon development and personal protection, progressive development of armour neutralised the reduction in force necessary to cause trauma. Armour had to be penetrated or breached before an injury could be delivered. Furthermore, the lethality index of the weapon was still dependent on the power and skill of the individual (Fig 5.2). The lethality index during the Age of Muscle stays the same, indicating that the development of neither weaponry nor armour resulted in a permanent advantage.

Iron production began in Anatolia about 2000 BCE and the Iron Age was well established by 1000 BCE. From 1200 BCE onwards, iron instead of bronze,[20] was preferred as metal of choice to produce weapons. ‘Pure’, unprocessed or wrought iron was not ideal to produce a durable sharp edge. This was overcome by tempering the iron, in which process the carbon contents of the iron was increased. In the tempering process the iron was heated to 850º-900º Celsius and then quenched in water. The material became very hard but brittle. The brittleness was overcome by reheating the iron to 350º-500º Celsius and hammering it into the required shape, which produced steel, superior to iron.

This type of heat treatment was known to the Egyptians by 900 BCE, as can be judged by the microstructure of remaining artefacts and formed the basis of a steel industry for producing a material that was ideally suited to the fabrication of more durable *sharp edged* weapons (Allen 2009: *sv* Iron and steel manufacture; Human 2006:246-247; Nutting 2012: *sv* steel).

The axe, dagger/sword, spear/lance/javelin and bow will be discussed as the weapons responsible for sharp force trauma in the Iron Age in the Ancient Near East.

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[20] Bronze is a metal compound/alloy containing copper and 5-23% tin (Encyclopædia Britannica 2012: *sv* bronze).

8.1. THE AXE

The axe as a weapon emerged together with the progress in armour, even for the common soldier. The blunt mace was not lethal enough and was modified with a sharp edge to increase its effectiveness in battle. The transfer of the kinetic energy during a swing of the axe is concentrated on the weapon's edge, enabling the soldier to penetrate and inflict sharp force trauma beyond the enemy's armour (Yadin 1963:11-12, 41). The design of the axe varied considerably during the Bronze Age and both socket-type and tang-type axes continued into the Iron Age. Human (2006:240-242), Negev (1996: *sv* axe) and Yadin (1963:261, 314) are of the opinion that due to the development in armour, the axe did not play as prominent a role as a weapon in the Iron Age as it did in the Bronze Age. It was not used as a weapon, but as a tool to cut down trees as needed during a campaign, as well as to breach fortification.

8.1.1. Injuries from the axe

The Iron Age axe was narrow-headed to inflict injury after penetrating armour (Human 2006:240-241). It was broader and heavier than a dagger/sword with a different shape than a spear/lance/javelin and as such its wounds can be discerned. The kinetic energy from a swing from an axe will be more than that of the thrust from a sword. The broader cutting edge with a thicker blade will leave evidence of sharp force trauma, as well as evidence of blunt force.

The author was not able to secure an in-depth study regarding injuries on skeletal remains from the Iron Age in the Ancient Near East. Therefore the author cannot comment on the possibility that such a study will alter the view about the axe as an obsolete weapon in the Iron Age, parallel to the study of Aranda-Jiménez, Montón-Subías and Jiménez-Brobeil (2009), which gave a new perspective regarding warfare and the weapons used during the Bronze Age in southern Spain.

8.1.2. The axe and the Bible

The shape of the axe varied, so that the seven different Hebrew words which the King James Version renders 'axe' could be translated as *axe*, *pick-axe* or *adze* (with cutting edge at right angle to the handle), *billhook*, *chisel* and *pick* – all of them cutting tools, mostly for wood but sometimes for stone (in Palestine especially limestone). The axe is never mentioned in the Bible *vis-à-vis* battle, although it was used during war to cut down boughs from trees to set fire to a stronghold (Jdg 9:47-49), to cut trees for siege works (Jr 46:22) and to hack down the wooden decorations of the temple (Ps 74:4-7) (Pfeiffer 1975: *sv* axe).

8.1.3. The axe in reliefs

Yadin (1963:261, 314), *inter alia*, is of the opinion that the axe in Iron Age Ancient Near East was used as a tool and not as a weapon. It seems as if this deduction comes from the depictions, where the axe seems to be presented as a tool (Fig 8.1). Bronze Age depictions include the axe as a weapon, but the use as a weapon is largely absent from the reliefs of the Iron Age. The biblical account is on par with pictorial version for this era. That is not to say it was not used during the melee that is combat, therefore in the analysis of skeletal trauma, the axe cannot be totally ignored as a potential cause of trauma.

Figure 8.1: Photograph of an orthostat in Ashurnasirpal II's palace (northwest), Nimrud (883-859 BCE) with an axe and arrows in a quiver (Yadin 1963:386).

8.2. THE DAGGER/SWORD

The dagger was not a bulky primary attack weapon, but a last resort weapon, which could inflict sharp force injuries. When the blade of the dagger became longer than the hilt, it became a short sword. Sword shapes varied throughout the region, for example, leaf-shaped blades, sickle-swords, short and stocky blades or longer heavier blades of both bronze and tempered iron (Human 2006:246). A sharper cutting edge or point made the weapon more lethal, with the subsequent reactionary development in armour. The lethality index of the weapon was still dependent on the power and the skill of the combatant. As depicted in Figure 8.2, kings hunted to practise their skills with the instruments of war, *inter alia* with swords (Pfeiffer 1975: *sv* hunting; Pretorius 2016:771-772).

Figure 8.2: Assyrian lion hunt with a two-edged sword, usual for the time. Notice the arrow embedded in the lion's head and the archer with arrows in his hand but none in the quiver (Van der Crabben: *sv* Assyrian lion hunt).

8.2.1. Injuries from the dagger/sword

The shape of the weapon in conjunction with the physical factors determine the nature of the injuries inflicted. A sharp edge will damage soft tissue without the necessity to use much power. Incised wounds (cuts), by their nature, are only life-threatening if they penetrate deeply enough to damage a blood vessel of significant size (Payne-James *et al* 2011:86). Penetrating (thrust) wounds are more dangerous, because these wounds are more likely to damage the larger blood vessels, which are generally located deeper in the body. When bone is encountered, which function as the body's own armour to protect vital organs, considerably more force is needed. It is possible for bioarchaeologists/palaeoanthropologists to determine the type of wound and estimate the force applied to inflict the injury. A nick of a bone (a small V-shaped cut or indentation) is indicative of a cut, while penetration of a bone with fractures will be interpreted as a thrust. However, the identification of the specific weapon responsible for the sharp force trauma, in the absence of embedded weapons, is not definitive. A small lozenge-shaped aperture (diamond-shaped narrow opening), for example, in the skull could have been caused by a dagger rather than a sword, arrow or spearhead (Redfern 2009:406).

8.2.2. The dagger/sword and the Bible

The Hebrew word, *ḥereb*, translates as sword or dagger. It is referred to more than four hundred times in the Bible and makes it the most frequent mentioned weapon in the Bible (King & Stager 2001:224; Pfeiffer 1975: *sv* sword). The dagger/sword was unambiguously mentioned in the Bible as an instrument of war. The story of Ehud, the left-handed Benjaminite who slew Eglon, king of Moab, illustrates the use of the dagger (Jdg 3:12-30). If the skeletal remains of Eglon is ever discovered, there is a 50% chance (*vide supra*) that there will be a nick of his lumbar spine or pelvis, an indication of a penetrating wound to the abdomen. Similarly, if Goliath’s remains of his head and body could be put together, there should be indications of sharp force injuries to his cervical (neck) vertebrae, consequent to the fact that David severed his head from his body and took it as a trophy (1 Sm 17:51). His head would show signs of blunt force trauma from the hit he took from David’s slingshot.

Similar to the story of Ehud, 2 Samuel 2:16 describe how ‘…they [the combatants] caught every one his fellow by the head, and thrust his sword in his fellow’s side; so they fell down together’. This is a description of individual battle comparably depicted in contemporary scenes (Fig 8.3).

8.2.3. The dagger/sword in reliefs

The sword was the weapon in the final close quarters combat, therefore every soldier, whether in the long-range (sling and bow) units or in the medium- to short-range (spear) units, had a sword. The sword was used during battle as well as after the battle to dispatch wounded enemies, kill prisoners or to take trophies (Pretorius 2016:769, 785). These scenarios, as aptly described in the Bible, are depicted throughout the reliefs (Fig 7.5, Fig 8.3 & Fig 8.4).

Figure 8.3: Orthostat from the palace of Kapara at Tell Halaf (10th century BCE). Swordsmen engaging in battle (Yadin 1963:362).

Figure 8.4: Extreme left of band four of the Gates of Shalmaneser III (858-824 BCE). Assyrian troops use their swords to cut off the heads, feet and hands of their vanquished enemies (Yadin 1963:399).

8.3. THE SPEAR, LANCE AND JAVELIN

The spear predates history, reaching back into the Palaeolithic period, where it began as a long shaft with a sharpened end, the point being hardened in a fire. In the Iron Age the tip was fashioned from metal and iron gradually replaced bronze as metal of choice (Human 2006:249). Pole-arms had a wooden shaft of varying lengths and weight with a metal point or head, usually with a double edge (Pfeiffer 1975: *sv* spear). The spear, with its significant advantage of reach in battle, remained the basic weapon of the heavy-armed infantry, while the lighter javelin or lance was used by the cavalry and charioteers. Heavier spears are more likely to injure an enemy, but casts from lighter spears (javelins) could reach longer distances.

To hurl a javelin of about 600 grams more than 50 metres requires a velocity of more than 22 metres per second (Redfern 2009:401). The kinetic energy of such a projectile is 145 joules, much less than the 556 joules of a slingstone. The sharp edges of the head/point of the spear/lance/javelin enable the weapon, although with lower kinetic energy, to be lethal. In addition, a thrust from a spear is much more forceful. As with all the Iron Age weapons during the Age of Muscle (Fig 5.2), the lethality of pole-weapons is proportional to the power and skill of the warrior.

The average Iron Age soldier could not meet the modern-day athlete’s performance – the men’s world record with a modern-day javelin with a weight of a minimum of 800 grams is 98.48 metres (Hollobaugh 2009: *sv* track and field). The Iron Age range of a spear/javelin is less than 50 metres. This is a significant shorter range than that of the sling and the bow. The spear was primarily used as a very effective close combat weapon with a longer reach than the sword. The Assyrian spearmen, for example, fitted out in a heavy coat of mail that hampered their freedom, had additionally a shield in one hand. They were not in a comfortable position to throw a spear effectively, but were deployed as shock troops with their spear in hand in close quarters combat (Yadin 1963:294).

The lighter spear or javelin was equipped to the charioteers (Yadin 1963:298). In Figure 8.1 a javelin can be seen upright behind the warrior drawing a bow. The cavalry’s shock weapon was the heavier spear or lance. In wooden areas these units were utilised, but not during the assault on fortified cities (Yadin 1963:297).

8.3.1. Injuries from the spear, lance or javelin

Pole-weapons inflict sharp force trauma. Stab wounds are suffered when the external wound on the skin is smaller than the tract of the penetrating wound, with penetration of different types of tissue with the same contact (Payne-James *et al* 2011:86). All penetrating sharp force injuries present similar characteristics, thus it is difficult to determine the exact type of sharp edged weapon responsible for the injury without an embedded weapon or part of the weapon (Redfern 2009:406). However, the size of the wound may enable a scientist to venture an ‘educated guess’ as to the cause of the wound. A bigger wound could reduce the probable options to a spear or a sword, while a smaller aperture could narrow the possibilities down to a dagger or arrow.

Figure 8.5: This reconstruction of the siege of Lachish, prepared under the supervision of RD Barnett by E Sorrel, is based on the Sennacherib reliefs, the physical terrain of Lachish, and the plans of the fortifications at the time of the Sennacherib attack as revealed by the Starkey excavations. The two walls of the city and the double gate connecting them are well shown (Yadin 1963:436-7).

8.3.2. The spear, lance and javelin and the Bible

The spear/lance/javelin was unequivocally part of the instruments of war as presented in the Bible. Two Hebrew words, *ḥánît* and *rōmaḥ*, definitely refer to pole-weapons and are translated as spear, javelin or lance. The Hebrew word, *kîḏôn*, has traditionally been rendered ‘javelin’ (eg 1 Sm 17:6), but the translation has been disputed and the evidence of the Qumran War Scroll supports the meaning of ‘sword’. Although in certain circumstances the spear was a symbol of royal authority (1 Sm 26:7), there are numerous occasions in the Bible where the spear is part of warfare and used as a weapon during battle (Douglas 1982: *sv* spear and javelin).

8.3.3. The spear, lance and javelin in reliefs

Pole weapons were part of every war, battle or conflict in the Ancient Near East, as depicted in numerous reliefs (Fig 6.1, Fig 7.2, Fig 8.1, Fig 8.10, Fig 9.3 & Fig 9.6). Figure 8.5 is an artistic reconstruction of the siege of Lachish, based on contemporary reliefs and archaeological data, which gives an overall view of the violent action, *inter alia* using pole weapons, during the Iron Age of the Ancient Near East.

8.4. BOW AND ARROW

The bow and arrow is one of the most ancient weapons used in hunting and warfare (Fig 6.1, Fig 7.2, Fig 7.5, Fig 7.6, Fig 8.1 & Fig 8.2). It is a system for launching a straight sharpened projectile at a distant target. To use a bow and arrow, the archer places an arrow against the bowstring and pulls the bowstring back, bending the bow and storing the muscle energy of the archer in the drawn bow. By letting go of the drawn bowstring, the archer suddenly releases the energy stored in the bent bow, rapidly propelling the arrow forward. The arrow ‘received’ the potential energy stored in the drawn bow in the form of kinetic energy, which will be subsequently transferred to the target. During flight some of the kinetic energy is ‘lost’ due to the resistance of air that needs to be overcome. The result is a reduction in the velocity of the arrow over distance, with less energy to transfer when the target is reached (Microsoft Encarta 2009: *sv* bow and arrow). The metal arrowhead enables the soldier to hone it to a sharp point with sharp cutting edges. The sharper the point and edges the better the penetration ability of the arrow, with consequently higher lethality.

8.4.1. The bow

Due to the bow’s construction of perishable material, there are, apart from examples of bows found in Egypt, no bows excavated in more than 150 years of archaeological work in the Iron Age Ancient Near East (Zutterman 2003:121-122). Knowledge comes from pictorial images and documental descriptions (Negev 1996: *sv* war and warfare). The composite bow with a recurved shape, was the most effective of the bows used during the Iron Age (Fig 8.6). Assyrian archers were equipped with such a highly advanced type of composite bow, which played a decisive part in battle – both against cities and in open terrain (Yadin 1963:295).

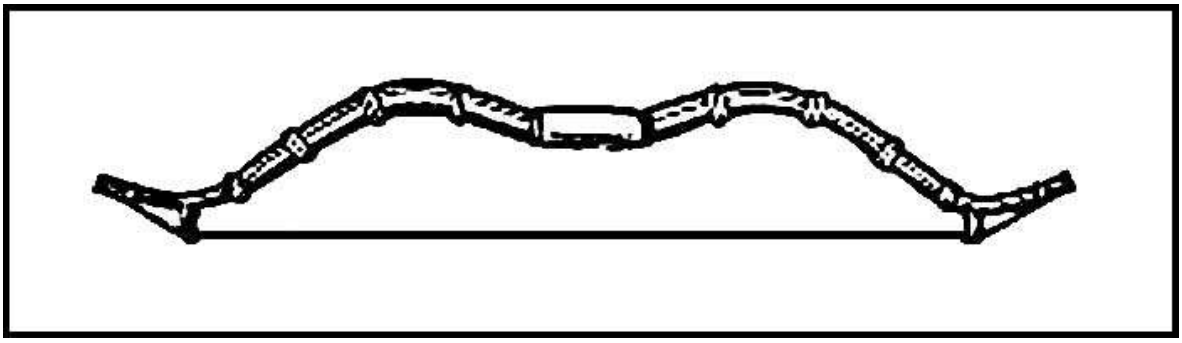

Figure 8.6: The strung composite bow with a recurved shape (Encyclopædia Britannica 2012: *sv* bow and arrow: historic bows).

The composite bow was made of several strips of wood (laminated) for resiliency, along with sections of animal horn, tendons, sinews and glue. This combination of materials provided the bow with the flexibility and strength needed for effective combat (Ronald 1995: *sv* bow). The more powerful composite bows, being very highly stressed, reversed their curvature when unstrung. The height of perfection of the composite bow was reached when it was given a double-convex form (Yadin 1963:7). It acquired the name *recurved* since the outer arms of the bow curved away from the archer when the bow was strung, which imparted a mechanical advantage at the end of the draw. More energy is given to the arrow because the tension is continuous, which results in a catapult-like effect (Zutterman 2003:120). When strung, it extended from the head to the waist of the archer. This powerful bow had a range exceeding two hundred (200-275) metres (Encyclopædia Britannica 2012: *sv* military technology; King & Stager 2001:227; Redfern 2009:401). These bows were too expensive for many nations and this led to the superiority of the imperialistic Assyrian army (Gowers 1987: *sv* foot-soldier; Yadin 1963:295).

The bowstring was made of organic material, but it is not clear which type of organic material was utilised – flax cord (Deist 2000:216-217), sheep gut (Gowers 1987: *sv* foot-soldier) or ox gut (Pfeiffer 1975: *sv* bow and arrow). The composite recurved bow was kept unstrung and the string was only attached before the archers were deployed for battle, as depicted in Figure 8.7 (Yadin 1963:64).

Figure 8.7: Two Assyrian archers string the powerful composite bow, while others test bows and prepare the quivers (Yadin 1963:453).

8.4.2. The arrow

The archer was equipped with a quiver, which is a deep, narrow basket constructed especially to carry arrows (Fig 7.5, Fig 7.6, Fig 8.2, & Fig 8.7) (Ronald 1995: *sv* bow). The quivers were carried with a shoulder-strap or fitted to the side of a chariot (Fig 8.1) (Yadin 1963:296, 298). The arrow is a long, straight projectile with a pointed tip. The shaft was made of reed or wood with feathered tails to stabilize the arrow in flight. Shafts were made of perishable material, thus archaeologists do not have the privilege to have Iron Age arrow shafts to study. The shafts would have been as smooth as possible to ensure stability during flight for maximum range. The tip of the arrow, the arrowhead, was made of a different material than that of the shaft, with a sharp point and two or three ‘wings’ with cutting edges to inflict as lethal a wound as possible (Yadin 1963:8). Arrow design was probably the first area of military technology in which production considerations assumed overriding importance. As a semi-expendable munition that was used in quantity, arrows could not be evaluated solely by their technological effectiveness, because production costs had to be considered as well. As a consequence, the materials used for arrowheads tended to be a step behind those used for other offensive technologies (Encyclopædia Britannica 2012: *sv* military technology).

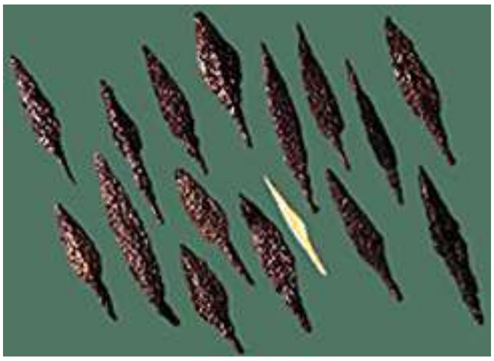

Figure 8.8: Iron arrowheads excavated at Lachish, with one made of bone (Ussishkin 2004).

Arrowheads were made by flattening a round or square iron-bar by hammering it. This process was made easier by first heating the metal in a forge or in the coals of a very hot fire. Once the metal has been flattened, it must then be shaped and the edges sharpened. The hammering, which in effect tempered the arrowhead, made it possible that the edge retained its sharpness better. It is then classified as a broadhead. The broadhead is now mounted into the shaft by drilling or burning a channel into which the tang[21] of the broadhead is inserted. It can be glued in place. The shaft is now bound on with sinew or cord from a suitable material. It is the degree of sharpness which determines the resulting wound, thus the rate of bleeding and therefore the effectiveness of the broadhead (Cheney & Cheney 2004:88-89; Payne-James *et al* 2011:87). Iron Age arrowheads, such as the Assyrian arrowheads found at Lachish (Fig 8.8), were about seven centimetres long and approximately two to three centimetres across (King & Stager 2001:227).

The Assyrian arrowheads were relative small and leaf- or rhomboid-shaped with two cutting edges (King & Stager 2001:227; Negev 1996: *sv* weapons and warfare). Most of the arrowheads found at Lachish were made of iron (Fig 8.8), which is on par with the general tendency regarding the production of arrowheads according to production cost. Scheepers and Scheffler (2000:246) are of the opinion that there were no bronze arrowheads at Lachish, which differ from King and Stager (2001:226) who are of the opinion that there were a few bronze heads. Ussishkin's photo (2004) from Lachish clearly shows a bone arrowhead between the iron

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[21] **Tang:** '*sharp end going into handle*: the sharp part at one end of a chisel, knife blade, or other similar tool that secures it to the handle or shaft' (Microsoft Encarta 2009: *sv* tang).

broadheads from Lachish, but none of bronze (Fig 8.8). Both armies at Lachish utilised recurved bows shooting iron tipped arrows, because, if otherwise, there should have been other than the predominant iron arrowheads found at the siege ramp's end, where the attackers and defenders focussed their main efforts.

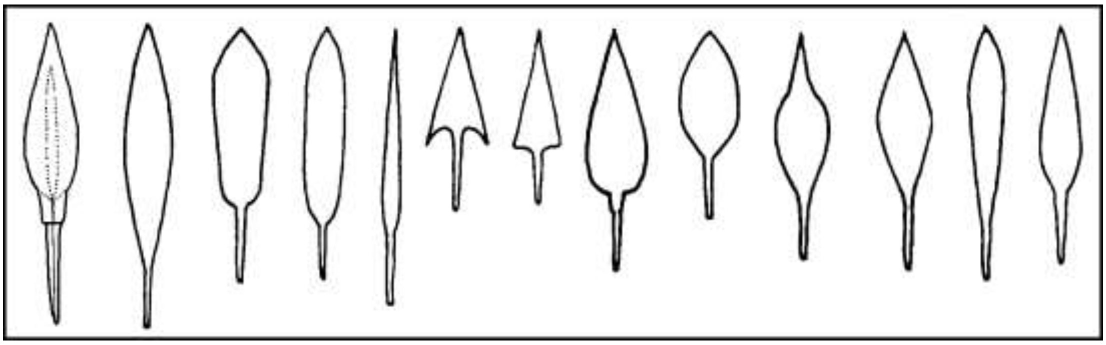

Figure 8.9: Forms of arrowheads (Yadin 1963:8).

The availability of resources must have played a role in the manufacturing of the iron instead of bronze arrowheads, because bronze is more fusible (more readily melted) and hence easier to cast. It is also harder than pure iron and far more resistant to corrosion. The substitution of iron for bronze in weapons from about 1000 BCE, as the Assyrians did with arrowheads, was the result of iron's abundance compared to copper and tin rather than any inherent advantages of iron (Encyclopædia Britannica 2012: *sv* bronze). Later in the Late Iron Age II Period, the Babylonians, for example, did not take production cost and availability of resources into account when they made their triangular arrowheads, which were more advanced in design, utilising bronze (Stern 2001:310).

8.4.3. Bow and arrow injuries

Ballistics[22] of the arrow determines the energy at the end of the trajectory, which is available to be transferred into the target. Kinetic energy is less at the end than at the beginning of the trajectory, because it is spent to overcome air resistance. An arrow flying through the air eventually slows down to such an extent that it falls to the ground without sufficient energy to cause trauma to an enemy (Pearcey & Thaxton 1996: *sv* Galileo's Theory of Relativity). The archer's intent was to hit a target before this happened to ensure deep enough penetration to damage a vital

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[22] **Ballistics:** science dealing with the motion of bodies projected through space (Microsoft Encarta 2009: *sv* ballistics).

organ to kill the enemy. Several factors influence penetration, namely momentum, shaft drag factor and the sharpness and type of arrowhead (De Beer 2007).

Furthermore, clothes (especially armour) and whether bone was struck or not, may have influenced the depth of penetration (Payne-James *et al* 2011:87). Due to the lack of available data, a general posit of wounds inflicted by arrows will be discussed, bearing in mind the deadliness of a bow and arrow. From a distance of 25 metres, in modern-day hunting, 115 joules kinetic energy from an 85 pound draw-strength bow, a single 42 grams arrow with a razor-sharp two winged broadhead, is enough to kill a Cape buffalo (*Syncerus caffer*) weighing 800 kilograms (De Beer 2007).

An iron arrowhead, with two or three cutting edges, will damage the various tissues of the intended target through which it penetrates. The result is a sharp penetrating wound, deeper than it is long on the skin surface (Payne-James *et al* 2011:86). The amount of bleeding of a wound varies according to the nature of the wound because of the physiology of blood vessels and blood clotting. The body's reaction differs according to the mechanics that causes the wound – a cut from a sharp edge *vis-à-vis* blunt force trauma. Blunt force *stretches* the blood vessels and only if they are stretched *beyond* their breaking point, will they rupture. A blood vessel, when stretched, reflexively retracts with a reduction in the diameter of the vessel, as well as initiating the blood clotting cascade. The result is a relative minor haemorrhage in proportion to the wound (such as a laceration from a blow from a slingstone).

Contrary to blunt force, where a large wound may result in minor haemorrhage that is not life-threatening, a relative small cut from a very sharp object can result in a major haemorrhage. A blood vessel cut with a sharp object does not stretch and does not initiate blood clotting as quickly as when stretched. No reflex constriction of the now open ends of the blood vessel takes place and the wound bleeds freely. It is thus safe to say that a sharp edge weapon wielded with the same force as a similar blunt force weapon in the Iron Age, which falls in the Age of Muscle, will always have a higher lethality index.

The intention of the ancient archers was to inflict a sharp penetrating wound as deep as possible, to inflict a fatal wound to their enemy. The cut from, for example, an

Assyrian broadhead, inflicted a two to three centimetres wide cut for the whole length of the arrow's penetration track. With a minimum of three centimetres penetration, internal organs such as the lungs or liver could have been damaged. The cut from the sharp-edged arrowhead would then cause relative uncontrolled internal bleeding with potential fatal results. The deeper the arrow penetrates, the longer the cut from which the victim can bleed. Blood vessels, as a rule of thumb, spread like the branches of a tree from the central part of the body (heart) to the outside. The bigger vessels are deeper in the body, where a deep penetrating broadhead would cause a massive haemorrhage, which would quickly ensure death.

A relative shallow hit to the thorax, only penetrating the thorax cavity without injuring the lungs, may result in a pneumothorax. This is an accumulation of air outside of the lungs, but still inside the chest cavity, which can be fatal. Deeper penetration may cause a haemo-pneumothorax, a combination of haemorrhage inside the thoracic cavity, with air and blood between the lungs and the ribcage. This is a much more dangerous injury with a higher mortality rate.

A hit to the abdomen would have been equally life-threatening. If the liver or spleen were hit, a fatal haemorrhage would have been likely. Any penetration of the digestive tract would have led to a fatal infection, even if the victim survived the initial bleeding. Unfortunately, the chance of detecting an abdominal hit when examining skeletal evidence is smaller than a hit to the head or thorax.

Soft-tissue injuries may not be detectable when skeletal remains are examined. However, as the skeleton of a person present about 60% of the frontal target area of a human body, there is a 50% change that a random shot will damage some part of the skeleton (Aranda-Jiménez *et al* 2009:1048). It is highly possible that an arrowhead penetrating the thorax will nick one or two ribs, enabling a bioarchaeologist to posit a cause of the wound(s) on the skeleton. Arrows were relatively fragile and broke easily, leaving the arrowhead in the victim's body. Depending on the arrow's penetration, the arrowhead may be lodged in soft-tissue or embedded in the skeleton. Care must be taken during excavations to determine when a piece of a weapon, such as an arrowhead, is found in proximity to a body, whether it caused an injury to the skeleton. If the arrowhead is stuck in the skeleton, it enables the archaeologist to formulate a broader picture of the past. Although concerned with a period and area outside the Iron Age Ancient Near East, Redfern (2009:417), for example, posits regarding Iron Age Dorset that:

> (T)he evidence for a Roman projectile point embedded in the 12th thoracic vertebra of a male from Maiden Castle, and the presence of Roman ballista bolts at Hod Hill, it is possible that many of these cranial injuries were produced by Roman rather than native weaponry.

8.4.4. The bow and arrow and the Bible

The bow and arrow is part of the armaments and is a common occurrence in the Bible. In Judges 16:8, Samson was bound with 'seven fresh bowstrings, not yet dried', which were possibly made from flax cord (Deist 2000:216-217), sheep gut (Gowers 1987: *sv* foot-soldier) or ox gut (Pfeiffer 1975: *sv* bow and arrow). The mentioning that it was 'not yet dried' makes it more probable that it was either from sheep or ox gut, because flax cord would not have been wet, even if it were 'fresh bowstrings'.

In 1 Kings 22:34, the story of Ahab's death is related. He was shot by an archer and the arrow 'went in between the joints of his harness' or armour. The Hebrew word *shiryan*, is translated as a 'harness' in 1 Kings 22:34 and 2 Chronicles 18:33, or rendered 'breastplate' in Isaiah 59:17. It is also possible that a coat of mail was his armour (Easton 1897: *sv* harness). The armour was not effective – thus the arrow wounded Ahab. He continued to ride in his chariot until he succumbed to his wound later in the day.

A possible elucidation why Ahab, before he perished, had the ability to take part in the battle for the rest of the day, may have been as follows: The arrow which hit him, had enough kinetic energy to overcome the armour and penetrated Ahab's body sufficiently to inflict a small, yet fatal wound. The armour was worn over the 'vital' parts of the body – the thorax and upper abdomen. It seems Ahab suffered a wound to either a lung, the spleen or the liver. The armour would have absorbed some of the energy of the arrow, with a relative shallow penetrating wound. Any wounds to these organs would have caused bleeding, internal as well as external, without ensuing immediate death. Most likely the lower lung was hit with a consequent pneumothorax or even a slow-forming haemo-pneumothorax. Payne-James *et al* (2001:91) wrote:

> It must be remembered that survival for a time after injury and long-term survival are not one and the same thing. The initial response of the body to haemorrhage is 'compensatible shock', shutting down peripheral circulation; if blood loss continues. The homeostatic mechanisms may be overwhelmed and the individual enters the phase of 'uncompensated shock', which leads inexorably to death.

Ahab kept standing until the blood loss, combined with his inability to breathe normally, were too much for the body to compensate. He would then suddenly collapse, just as described in the Bible.

8.4.5. The bow and arrow in reliefs

The Bible and the Iron Age depictions are in sync regarding the commonality of the bow and arrow as an instrument of war. In the case of the bow and arrow, it is true that a picture is worth a thousand words. The types of bow, the application during battle by the attackers and defenders, the formation of the archers and even maintenance of the bow are depicted in numerous scenes.

The Assyrian depictions, such as the Lachish reliefs, portray the army's formations with the archers in front of the slingers (Fig 7.5 & Fig 7.6). King and Stager (2001:229), as well as Human (2006:78) are of the opinion that the sling lacked the range of the bow and arrow. Redfern (2009:401-402) disagrees. The question arises whether these depictions are accurate if the ballistics/physical factors involved with projectiles are analysed.

The farthest distance recorded in the *Guinness world records* for a projectile to be hurled using only human power, is with a sling – 477 metres (Glenday 2014:113). The record distance to *hit a target* consistently with a bow (modern compound bow with an intricate pulley and cable system and not a composite bow, as used in the Iron Age), is 200 metres (Glenday 2012:268). However, modern flight shooters,[23] whose records advance with technological improvements of bows and arrows, have shot beyond 1.6 kilometres (Encyclopædia Britannica 2012: *sv* flight shooting). This is much further than the 'range exceeding two hundred metres' according to King and Stager (2001:227) or Zutterman's (2003:131) 230 to 260 metres. Yadin (1963:7)

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[23] **Flight shooting** in archery: a form of competition in which shooting for maximum distance is the object, with little or no regard for accuracy (Encyclopædia Britannica 2012: *sv* flight shooting).

is of the opinion that the composite bow was effective up to a range of 270 to 360 metres.

There are specific physics involved in determining the distance a projectile may travel during flight, namely *sectional density* and *ballistic coefficient*. A projectile with a higher sectional density retains its velocity better. A heavy projectile, like a slingstone of flint or limestone (high sectional density), will retain its velocity better than a fledged arrow made of lightweight wood or reed (low sectional density).

Ballistic coefficient is the effect of the design of the projectile: a longer designed cylindrical projectile, with a smaller-diameter (high ballistic coefficient), with the same weight as a larger round spherical object (low ballistic coefficient), loses velocity slower than the spherical projectile (Cheney & Cheney 2004:25-26). In the comparison between slingstones and arrows, the weight of the stones is a more important factor regarding the end speed of the projectiles than the more aerodynamic design of the arrows. Slingstones, due to their weight, retain enough velocity to still be lethal at the end of their trajectories, while the much lighter arrows lose velocity due to air resistance, decelerating to speeds where they fall out of the air. According to Redfern (2009:401), Harrison posited that the fletching on an arrow adds air resistance that could result in its efficiency being reduced by 75% at ranges over 50 metres. In modern-day bow hunting the average shot at game is less than 40 metres, despite the use of better equipment. Thick-skinned animals, such as Cape buffalo, are usually shot no further than 25 metres (De Beer 2007). This is to ensure the lethality of the wound inflicted by the arrow, before its speed, due to air resistance, is reduced to non-lethal velocities.

The materials, as well as their proportions used in constructing the bows and arrows depicted in Assyrian reliefs, are not known, because much of modern knowledge comes from ancient pictorials (Yadin 1963:8). Consequently, an exact comparison with modern-day equipment is not possible. Without sufficient data, it is difficult to calculate the exact ‘lethal distance’ the Assyrian slingers and archers could have achieved. The Lachish Reliefs (Fig 7.5 & Fig 7.6), for example, depict the slingers further away from the city than the archers. It seems that King and Stager (2001:229) are not correct in their opinion that the relief is inaccurate depicting the slingers behind the archers. Similarly, Human's (2006:78) opinion that archers were lethal over a longer distance than slingers, is questionable. They are probably correct in their opinion that the archers could attain greater distances with their arrows, but the slingers would have been *lethal* over a greater distance, therefore the Lachish Reliefs are probably correct in depicting the formation of the Assyrian army's units. Stern (2001:4) is of the opinion that in the Assyrian army 'the place of each weapon was fixed according to its range', supporting the view that the Lachish Reliefs are correct.

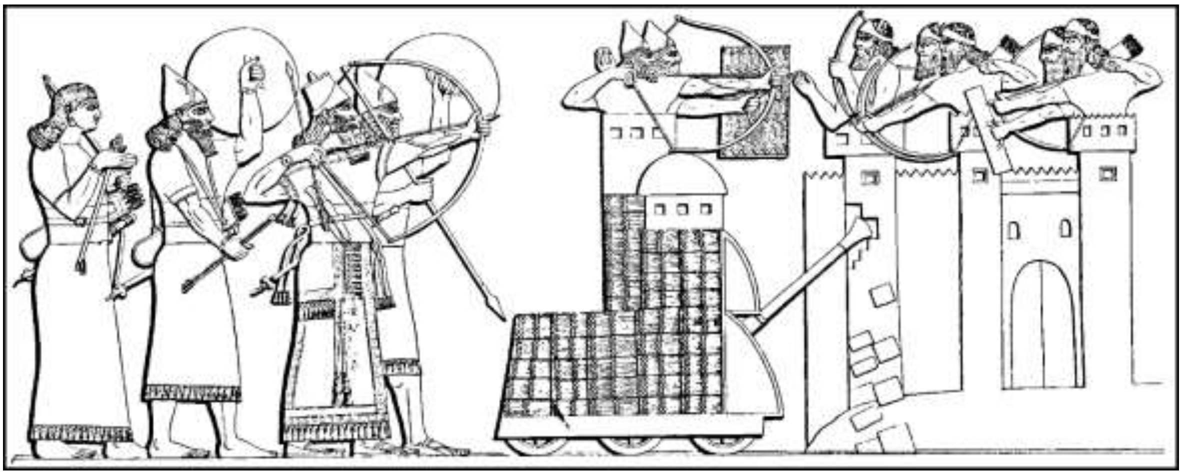

Figure 8.10: Ashurnasirpal assaults a city. A drawing of an orthostat from Ashurnasirpal II's palace (northwest), Nimrud (883-859 BCE) in the British Museum (Yadin 1963:388).

There seems to be no question about the importance of the bow and arrow as a long-range weapon during offensive and defensive war, following the prominence of the bow and arrow in the numerous reliefs dating from the Iron Age in the Ancient Near East (Fig 8.10).

8.5. CONCLUSION

Homo sapiens is perpetually divided into 'us' and 'them' and never is it more acute as during war (Harari 2015:171, 195). Instruments of war were (and are) constantly improved to make it easier for 'us' to annihilate 'them' with the least risk to 'us'. Iron provided the ability to develop sharp edge weapons superior to bronze weapons that could inflict fatal injuries in spite of the improvement of armour. Furthermore, a sharp edge weapon wield with the same force as a similar blunt force weapon, *inter alia* in the Iron Age, which falls in the Age of Muscle, will always have a higher lethality index.

Knowledge of the weapons in use during a war ameliorate the ability to determine the cause of trauma and eventually the cause of death during the examination of human remains. The trauma patterns detected in human remains can therefore elucidate the use of these weapons in correlation with the contemporary depictions of war.

9. BIOARCHAEOLOGY *VIS-À-VIS* IRON AGE DEPICTIONS: THE LACHISH RELIEFS

During the Iron Age, the Assyrians, Babylonians and Persians conquered Palestine and widespread destruction of settlements and deportation of the inhabitants took place. This is reflected in the excavations of Palestine, with evidence of major battles and destruction of settlements. New fortresses were built to guard the important roads, especially the *Via Maris* (Fig 2.2), guaranteeing imperial influence during the occupation of the imperial power (Keita 1988:376; Stern 2001:21).

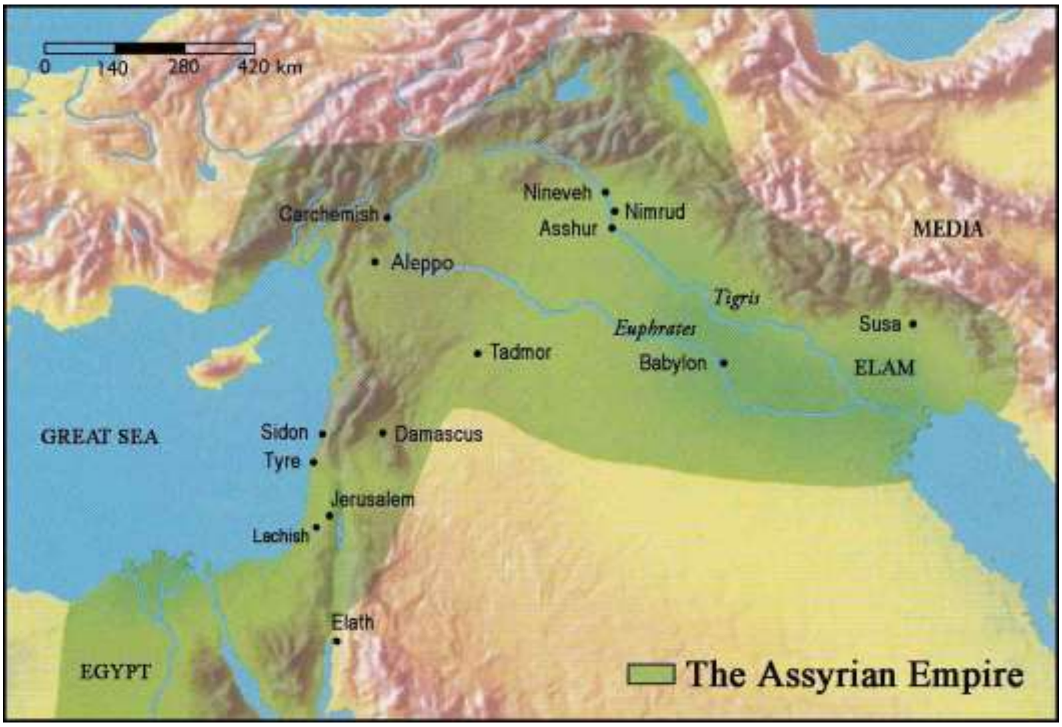

Figure 9.1: The Assyrian Empire with control over the major crossroads, *inter alia* Palestine (Perego 1998:47).

The imperialism of the Assyrians in the Ancient Near East (Fig 9.1), brought a new way of warfare into Israel: a well organised army with new methods of breaching fortifications. At Lachish the Assyrians disregarded the city-gates and focused their main attack on a part of the wall, as indicated by the amount of slingstones and arrowheads recovered from the area of the siege-ramp, where the wall was breached (Ussishkin 2004). The defenders even tried to counter the siege ramp with one of their own on the inside of the wall, opposite the Assyrian ramp. This was a new phenomenon in Israel. The Israelites were not able to repel the Assyrians with their new siege technology and military strategy, where well organised units, the slingers and archers, supported the direct attack of the ‘shock troops’ on the wall (Fig 9.6).

The siege of Lachish is unique in the account of the fact that it is described in the Bible (2 Ki 18:13-19, 36; Is 36:1-38), historically accounted from another source with beautiful detailed Assyrian depictions and a confirmed site with rich archaeological excavations. Unfortunately, there is an absence of academic study regarding the analysis of human remains at Lachish (Tell ed-Duweir).

Figure 9.2: Disarticulated skulls of men, women and children found in the burial cave at Lachish (Scheepers & Scheffler 2000:248).

The siege of Lachish left a rich treasure-trove – not only regarding the material culture regarding war and warfare, but also a possibility of a related mass burial (Fig 9.2). This secondary burial of men, women and children contained skeletons and skulls of 1 500 individuals (Scheepers & Scheffler 2000:248). From the data available to the author, it seems as if there are more skulls than disarticulated skeletons and everything was in a ‘jumbled mass’ (Keita 1988:376). The one published article (Keita 1988) *vis-à-vis* the bioarchaeological evaluation of these remains in the mass burial at Lachish, focused only on the crania in the British Museum. No other data regarding mass graves could be obtained for sites in Palestine. This is an underutilised field in biblical archaeology, which needs exploration, because with the application of the current available armamentarium of the bioarchaeologist, the possible additional knowledge to gain is immense. A postulate of the possible examinations and analysis to undertake regarding the correlation between human remains and the depictions of primarily the Lachish reliefs, will be presented.

The appropriate steps in analysing human remains to determine the biological profile include the ascertainment of the following:

- Age
- Sex
- Ancestry
- Stature
- Individualising traits
- Cause of death
    - Antemortem trauma/disease
    - Perimortem trauma/disease
    - Postmortem trauma

In this chapter the focus will be on the ancestry and the cause of death, in particular casualties of violence.

9.1. THE LACHISH VICTIMS

Keita (1988) used the morphometric patterns of 61 crania from the Lachish series in the British Museum of Natural History, to determine the geographical origins of the skulls. He concluded, using canonical discriminant functions and metric variables, that there is an Egypto-Nubian presence in the Lachish series. In the Bible, during the imperial wars of Sennacherib (2 Ki) there is a suggestion of an alliance of the Judean Kingdom with Egypt during the time of the Twenty-fifth Dynasty, when Nubia ruled Egypt. In 2 Kings 19:8-9, the warning to Sennacherib underscores this notion:

'Behold, Tirhakah the Ethiopian (Nubian) has come out to fight against thee.' Tirhakah was one of the pharaohs of the Twenty-fifth Dynasty (Keita 1988:385).

Keita (1988:387) is of the opinion regarding the geographical origin of some of the Lachish crania as 'representing an African Mediterranean climatic zone, with the southern Egyptian series from Abydos and Nakada predynastic series as denoting a zone between the Mediterranean and "tropical Africa."' Furthermore, there is a Romano-British presence, which denotes a northern temperate morphometric pattern, definitely dissimilar from the Egypto-Nubian presence.

9.1.1. Cranial presence in reliefs

In the Lachish reliefs the Assyrians, as the victors, are depicted where they decapitate some of the prisoners (Fig 9.4). The Lachish reliefs are not the only Assyrian depictions where enemies are beheaded (Fig 8.4). Captives were tortured in front of their comrades, as a graphic message to the target population, to assure the besieged people what will happen to them if they do not immediately yield (Stern 2001:6).

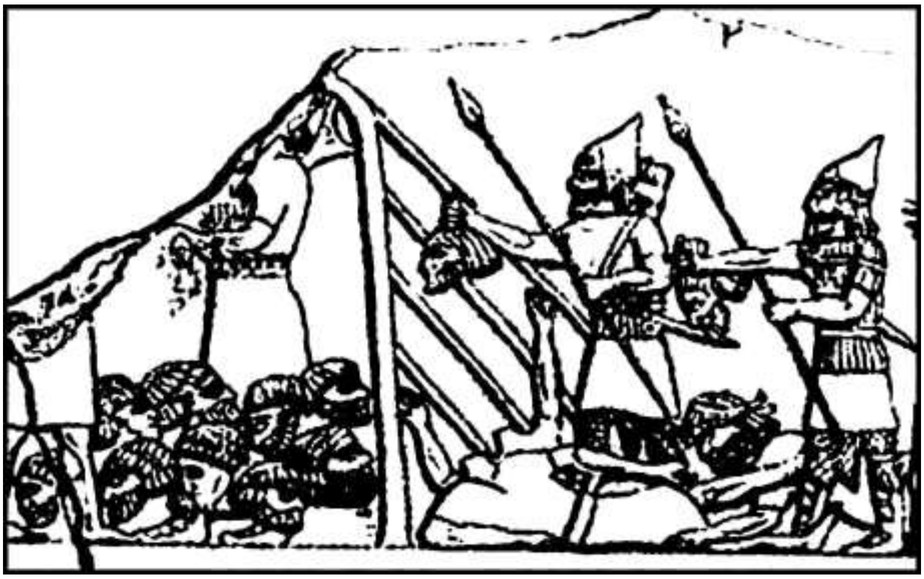

Figure 9.3: Drawing of Assyrian headhunters. Piled heads appear in a relief from the reign of Ashurbanipal (668-627 BCE). In this scene the heads are collected inside a tent, at left. Outside the tent, two Assyrian soldiers carrying additional heads wade through the decapitated bodies of their Elamite enemies (Belibtreu 1991: *sv* Assyrian headhunters).

Apart from the menace and cruelty towards 'them' to apply pressure on the defenders, it seems as if the Assyrians took the term 'head count' literally. Soldiers amputated various body parts of the enemy and brought them to the military scribes as physical proof of enemy casualties (Yadin 1963:260, 399). In one of Ashurbanipal's (668-627 BCE) reliefs the Assyrians are literally doing a head count of the slain Elamites (Fig 9.3). The depiction on the Gates of Shalmaneser III (858-824 BCE) show the use of severed hands and feet together with the head count (Fig 8.4).

The question thus arises: Is the mass grave at Lachish with disarticulated crania a result of Assyrian war scribes' actions?

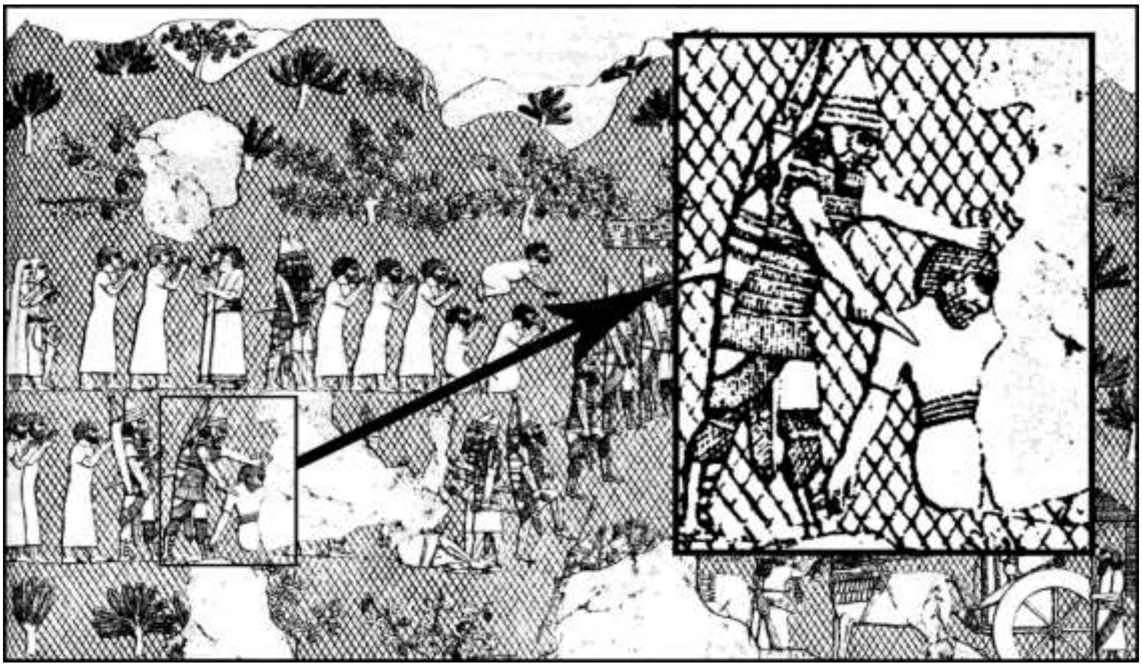

Figure 9.4: Lachish captives taken from the city and the brutal treatment meted out by their Assyrian captors, *inter alia* decapitation (Yadin 1963:431).

9.1.2. Taphonomy

Human interaction with a corpse is part of the taphonomy processes. The handling of a body postmortem, that is the funerary arrangements, or the lack thereof in addition to signs of defilement, may be indicative whether it is the body of a victor or a vanquished. The victor is in control after the battle, therefore is able to practice their own rituals regarding the handling of their fallen comrades' bodies. As seen in, for example, Figure 8.4, Figure 9.3 and Figure 9.4, defeated enemies of the Assyrians were not treated kindly. In war, mass execution of defeated prisoners of war, as well as non-combatants is common. The peri- and postmortem handling of these bodies may help the archaeologist/forensic analyst to reconstruct these circumstances in such a way that it was possible, for example, to discern (although from a modern era) between judicial and extrajudicial mass graves from the Spanish Civil War (Congram, Passalacqua & Rios 2014:82). The besieged city of Alkmaar successfully defended their city, thus, although the dead were buried in mass graves during a period of hostilities, they appear to have been buried with respect (Schats *et al* 2014:469).

The mass grave found at Lachish was a jumble of *circa* 1 500 bodies without the indication of funerary devotion or rituals. According to Scheepers and Scheffler (2000:248) 695 skulls were examined, with men, women and children represented. The lack of funerary devotion is indicative that the bodies are those of the defeated defenders and inhabitants of Lachish. This is in corroboration with Keita’s (1988) opinion that 2 Kings 19:8-9 is probably historically true and that the Egyptians, with *inter alia* Nubians in their ranks, were part of the defenders of Lachish against Sennacherib. It is possible that, as part of the Assyrian scribes’ ‘documentation’ of the Lachish campaign, the defeated dead were counted and discarded (Fig 9.3). The mass burial with bodies from different regions may have been the result. This supposition can theoretically be supported with further scientific analysis, namely strontium isotope analysis.

9.1.3. Isotope analysis

Stable isotope ratios measured in human tissues, provide a record of the foods consumed during life as well as the geographic location where drinking water or food was obtained (Bartelink *et al* 2014:124). Bone consists of an inorganic component (hydroxyapatite) and an organic component (collagen) that are laid down on a connective tissue bed. Hydroxyapatite (Ca10(PO4)6(OH)2) is composed of calcium, phosphate and hydroxide in a crystalized latticelike form that gives bone and teeth (dentine and enamel) rigidity, while collagen provides structural integrity and strength (Marshall 2014:300; Schultz 1997:188-196). In hydroxyapatite, the positive ion, calcium (Ca^{2+}), may be substituted by strontium present in the diet (Schats *et al* 2014:465). In the permanent teeth, once the mature tooth is formed (six months to eleven years), it does not substitute the deposited material. The elements in a tooth are thus a reflection on the period of a person’s childhood. However, bone remodel at 2-4% *per annum*, meaning that the 'oldest' bone in any person's body, notwithstanding age, is a decade.

Strontium is a naturally occurring element with various isotopes. The four naturally occurring isotopes in the order of their abundance are: strontium-88 (82.56%), strontium-86 (9.86%), strontium-87 (7.02%) and strontium-84 (0.56%) (Encyclopædia Britannica 2012: *sv* strontium). The isotope ratio of strontium differs regionally. Therefore it is possible, if bone and teeth are available, to determine the geological region where a person grew up, assuming that they consumed locally grown foods, as well as where the person was in the last decade before death (Schats *et al* 2014:465). Furthermore, a shift in ratio from first to last molar and bone may be indicative of a possible migration (Kamenov *et al* 2014:137). The strontium-87/strontium-86 of an area is contemporarily determined by analysing (thermal ionization mass spectrometry) the bio-available strontium range from local archaeological fauna (Schats *et al* 2014:466).

9.1.3.1. Strontium isotope analysis – Alkmaar

The strontium isotope analysis was utilised *vis-à-vis* the Alkmaar mass graves from the Eighty Years' War (1568-1648) between the Dutch and the Spanish. Although these graves are from the Age of Gunpowder (the siege of Alkmaar started on 21 August 1573) (Schats *et al* 2014:456), comparisons to the siege of Lachish are twofold in regard to this dissertation:

- Historical documents indicate that both cities utilised foreign soldiers during the defence of their respective cities (Keita 1988; Schats *et al* 2014).
- Secondly, the defenders were behind crenelated walls with battlements, as portrayed in contemporary art (Fig 9.5 & Fig 9.6), therefore wound patterns may be similar.

The demography of the Alkmaar mass graves suggests the possibility of two distinct groups of victims: civilians and soldiers. The question according to Schats *et al* (2014:464) arose whether the remains were from local civilians, local soldiers, refugees or foreign soldiers, namely Geuzen. To address this question, strontium isotope analysis was performed on eighteen individuals to determine their possible geographical area of origin (Schats *et al* 2014:464-468).

Prior to the strontium isotope analysis, biological profiles of the bodies were compiled, determining *inter alia* sex and age. This prompted Schats *et al* (2014) to view the two burial sites as one for soldiers and the other one for civilians. Samples from the remains of 18 individuals from both grave sites were submitted for strontium isotope analysis. Apart from two individuals from the civilian mass grave, all the isotope results indicate a local population that grew up in the vicinity of Alkmaar. The two ‘foreigners’ were an adult male (age 36-45) and a boy (age 8-12). Further analysis of the molars of these two individuals determined that they were from deferent regions more than 100 kilometres from Alkmaar. The male adult’s teeth produced a uniform strontium profile, indicating he grew up in one geographical region without traveling around. However, the strontium profile from the third molar from the boy differed from the first and second molars. The third molar’s profile was dissimilar to the first two, but also dissimilar to the profile from the Alkmaar regional profile. This phenomenon can be explained if the boy moved from one geographical region to another while the permanent third molars were formed. The conclusion reached was that he stayed in Alkmaar for a short time before his death, which therefore caused a mixture of different geographical strontium ratios in his third molar. The strontium isotope analysis enabled Schats *et al* (2014:468) to conclude:

> The individuals in the large mass grave appear to be local soldiers. In contrast, the remains of the males, females and children in the smaller mass grave appear to represent civilian victims that include both local and non-local individuals.

9.1.3.2. Strontium isotope analysis – Lachish

According to the Bible, in 2 Kings 19:8-9, Egypt supported Lachish against Assyria. Keita (1988) applied canonical discriminant functions and metric variables to determine that ‘the Iron Age biblical city of Lachish had a multinational population of diverse geographical origins’, with support for an Egypto-Nubian presence in the Judean setting. Furthermore, Assyrian reliefs depict each contingent of soldiers dressed distinctly with additional differences regarding beard and hair styles. The distinction in appearance probably identifies different ethnic divisions in the Assyrian army (Scheepers & Scheffler 2000:256). Depending on the composition of the Assyrian army regarding the total of non-Assyrian contingents of soldiers, there may have been at least four, but probably more, distinct groups from different geographical regions participating in the siege of Lachish.

The description of the mass grave at Lachish as ‘skeletons and skulls were piled here in disorder’, indicates that the grave probably contained the vanquished (Scheepers & Scheffler 2000:246). Therefore, notwithstanding the ‘cosmopolitan’ nature of the Assyrian army, their fallen may not be present in the mass grave.

Archaeological excavations, ancient depictions and documents present two opposing forces at Lachish. It seems as if these two forces were each composed of soldiers of at least two different regions. Keita (1988:388) supported an Egypto-Nubian presence in the Lachish crania. A strontium isotope analysis of the crania from Lachish is the ideal analysis to elucidate the composition of the Lachish crania regarding geographical region of origin.

9.1.4. Trauma pattern analysis

Documenting and explaining traumatic patterning in relation to violent death through analyses of the effects of applied loading or energy to bone, help to determine the cause of death and may help to elucidate the circumstances thereof (Davidson *et al* 2011:183-4). The application of modern forensic principles is applicable when examining any human remains, notwithstanding the age thereof. Suffice it therefore to compare different events with similar circumstances from different eras.

9.1.4.1. Head trauma - projectiles

Schats *et al* (2014) examined a site where a city (Alkmaar) was besieged and the defenders were behind crenelated walls with battlements, as was the case in the siege of Lachish (Fig 9.5 & Fig 9.6). The besieged behind the city walls faced projectiles from below, the same as the defenders at Lachish, albeit from different types/classes of weapons. As is often the case in osteology, at Alkmaar it was not possible to determine the cause of death regarding all the human remains and only four of the 31 individuals had cranial trauma. Patterns, in the result from analysing these remains, led to the following conclusion: ‘The trauma patterns are most consistent with Spanish gunfire from below the city wall’ (Schats *et al* 2014:469). The pattern is in accord with the depiction of the battle (Fig 9.5), where defenders are behind cover with their heads exposed to projectiles.

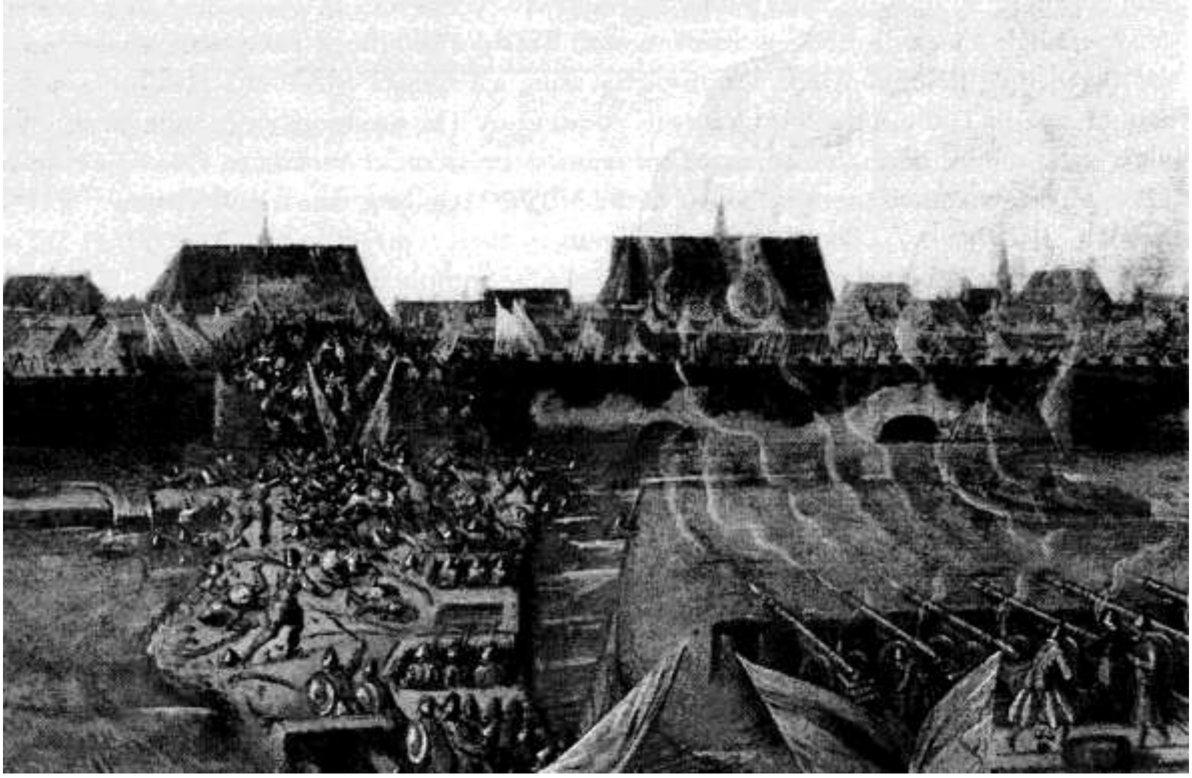

Figure 9.5: Oil on panel (Stedelijk Museum Alkmaar collection), *The Siege of Alkmaar by the Spanish, seen from the North*, by Pieter Adriaensz Cluyt, 1580 (Schats *et al* 2014:465).

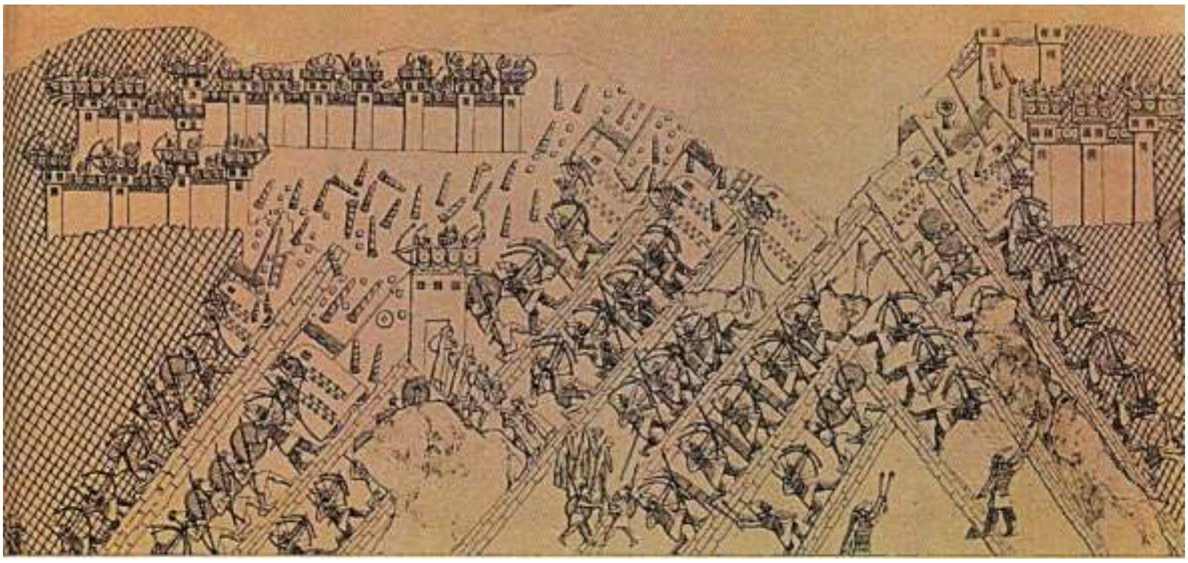

Figure 9.6: A drawing of a relief in the British Museum from the palace of Sennacherib (southwest) at Kuyunjik (Nineveh) (704-681 BCE), portraying the main assault of Lachish, with the city gate and its vicinity as the focal area of battle. The attack is led by scaling parties and battering-rams, supported by archers, slingers, spearmen and shield bearers. The defenders are behind fortifications (Yadin 1963:431).

An examination of the Lachish remains would probably produce results where head injuries from projectiles form part of discernible patterns. In Alkmaar the defence of the city was successful, while Lachish fell. That may result in different wound patterns, as well as the presence of more females with injuries, which may have occurred after the fall of the city.

Redfern's (2009) bioarchaeological analysis of Late Iron Age human remains from Dorset, has identified a range of sharp and blunt projectile injuries to both males and females. The injuries to both sexes were sustained from a variety of weapons, *inter alia*, 'spears, pointed and round sling-stones, larger pebbles, and perhaps arrows … Blunt and sharp injuries were identified in both sexes, with males having more perimortem injuries present' (Redfern 2009:417).

The age-related patterns showed that the majority of injuries were sustained by young adults (20-35 years), followed by middle-aged (35-50 years) and old adults (>50 years). Redfern (2009:413, 418) showed in the Dorset research that:

> The bioarchaeological study provides new, independent data for these martial acts, and lends support to Avery's … assertion that Iron Age warfare did involve large numbers of skilled people organized by warrior elites…. The range of injuries sustained indicates that a variety of weapons were employed, such as spears, pointed and round sling-stones, larger pebbles, and perhaps arrows…. These Durotrigian skeletons also show us that first century BC to first century AD communities were trained to participate in vicious, bloody acts of martial violence, with no quarter given to younger members of a tribe.

The wound pattern prompted Redfern (2009:418) to conclude that the defenders' wounds were sustained in a concentrated attack and even adolescents, males and females were involved in the fighting. The Lachish reliefs do not portray the involvement of females in the fighting. Wound pattern analysis may elucidate whether this is true or not.

Another similarity, also seen at Lachish (Fig 7.4), is the presence of healed head injuries in people buried at hillforts at Maiden Castle and Poundbury Camp (Late Iron Age of Dorset – first century BCE to first century CE). Redfern (2009:417) is of the opinion that the presence of healed injuries shows that assaults using projectile weapons occurred several times in a person's lifetime. The author is of the opinion that it is not possible to state categorically that head wounds were the result of projectile weapons, but it is a definite indication of previous interpersonal violence. At Lachish, this may be indicative of the person participating in different wars or more likely an indication of the prolonged time of the siege of Lachish, with time for a combatant to heal (at least to show some signs of healing) before his demise during fighting or after the fall of the city.

9.1.4.2. Post-combat injuries

Kanz and Grossschmidt (2006) evaluated the theories involving the weaponry and techniques of gladiator fighting based on the evidence supplied by cranial bones found in a gladiator cemetery from first century BCE Ephesus (Turkey). These gladiators were, similar to combatants throughout the Age of Muscle, exposed to blunt and sharp force trauma during their particular form of 'structured' interpersonal violence. In contrast to battleground victims, the gladiators showed an absence of multiple perimortem trauma due to the strict nature of combat rules in the arena (Kanz & Grossschmidt 2006:207). In spite of the fact that gladiators wore helmets, a large percentage showed head injuries.

Most of the *healed* wounds, thus suffered prior to the final battle and not the cause of death, were in the anterior aspects of the crania. Of the deadly perimortem wounds, a high percentage was similar in nature and located in the parietal bones. This could only have happened if all of these injured were struck on the side of the head without the protection of a helmet. The probability that such a high percentage of these trained fighters would have lost their helmets in a refereed contest *and* suffered similar injuries to the side of the head is highly unlikely. A possible explanation is provided by the reported *coup de grâce* with a hammer, used by an arena servant dressed up as the death god, *Dis Pater* (Kanz & Grossschmidt 2006:215). It is therefore possible to discern from the pattern due to the nature and placement of perimortem wounds, that deadly force seemed to have been applied after battle, when there is no more resistance from the victim and he is without his armour.

The crania from Lachish, where men, women and children are represented, may be indicative of victims who did not die during active battle. Women and children are depicted in the reliefs after the siege as captives taken from the city as well as the brutal treatment meted out by the Assyrians (Fig 9.3). A mass slaying *per se*, is not depicted in the Lachish reliefs, but would not be inconsistent with practices during the Iron Age. In the Assyrian depictions, post-combat mistreatment of the defeated are regularly depicted at different locations (Fig 7.2, Fig 8.4, Fig 9.3 & Fig 9.4). Executions as well as mutilations took place. Blunt force trauma, as seen with a blow with a mace to the head of the Elamite king, Teuman (Fig 7.2), is not an unknown method to execute prisoners after the fighting seized. The frequency in which throat slitting and/or decapitation is depicted in the Assyrian reliefs would indicate that they regularly cut the throats of and then decapitated their enemies.

Furthermore, patterns of absence of healed trauma in specific groups of the deceased, may be indicative that their perimortem encounter may have been their unfortunate first and last encounter with interpersonal violence (Knüsel 2014:278). The elderly men, woman and children may display such a pattern, although previous violent encounters in the old men’s youth may exclude them. The possible foreign fighters from Egypt, on the other hand, as well as the Lachish soldiers (young males), may display a different pattern with healed wounds, indicative of exposure to more than one incidence of interpersonal violence – battle.

Figure 9.7: This individual's throat was slit and then decapitated; the C1, C2, and C3 vertebrae remained attached to the cranium at the time of deposition (Klaus 2014:397).

Figure 9.8: Arrows indicate the cuts across bodies and transverse processes of cervical vertebrae C2-4 (Verano 2014:361).

A problem in bioarchaeology is that throat slitting and/or decapitation are not always visible or apparent in human remains. Figures 9.7-8 are examples where cut marks on the cervical vertebrae are clear indication of perimortem injuries associated with slitting of the throat (anterior cut marks) and decapitation (marks on all aspects of the cervical vertebrae). The marks are generally on the cervical vertebrae and not on the cranium of a victim. After decapitating, the bioarchaeologist may not be able to match the disarticulated parts to a body. The depictions of the Assyrians further indicate that heads and bodies may even have been buried separately, if they ever were buried. Thrown away or discarded, would probably be more accurate to describe the way in which the Assyrians would have handled their enemies' remains. In a collection of crania, as is the case with the Lachish collection in the British Museum, cut marks on the crania, due to throat slitting or decapitation would be the exception of the rule. Unfortunately, determination of trauma and cause of death, except regarding injuries to the cranium, would not be possible.

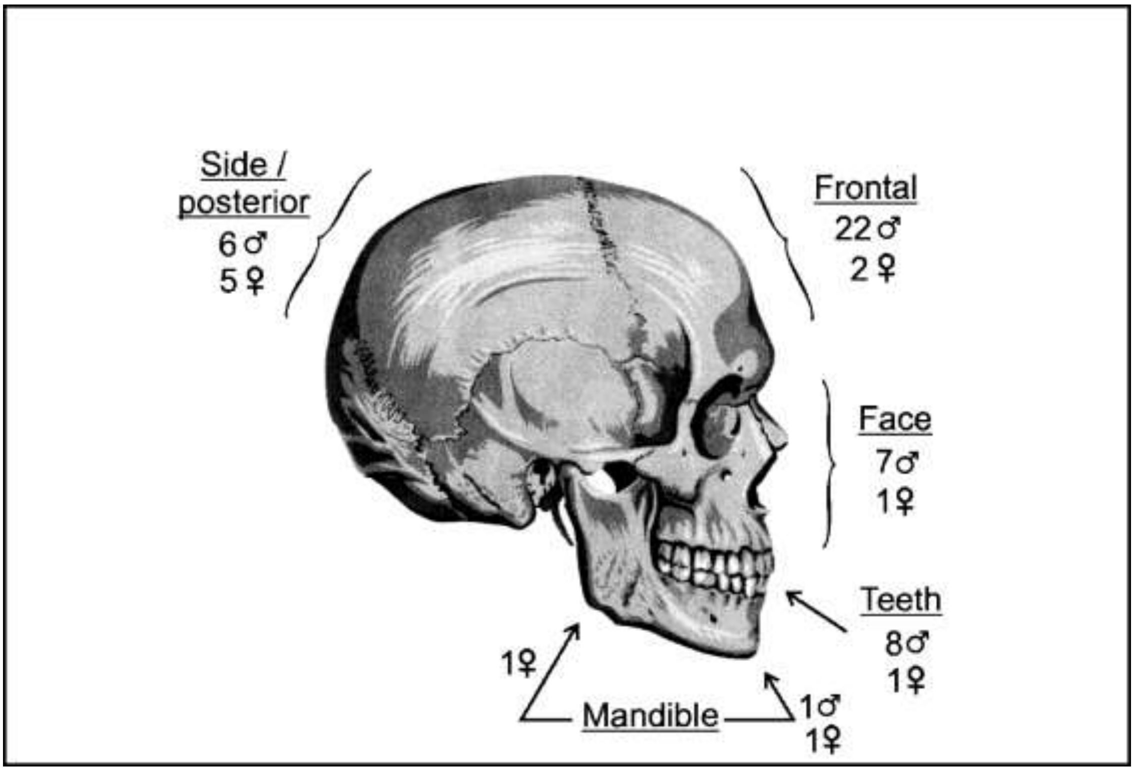

Figure 9.9: Number of traumatic cranio-facial lesions in the Prince Rupert Harbour adult crania by location and sex (Cybulski 2014:423).

Appraisal of the wound patterns in relation to *inter alia*, sex, age and location, may elucidate the circumstances regarding the death of these victims. Cybulski (2014:440) did a study of the Prince Rupert Harbour region of northern British Columbia, Canada, regarding a period of 2 000 years (cal 1000 BCE ~ cal 1000 CE).

Although from a different era and region, his findings regarding traumatic patterns to the cranium are applicable to the Lachish crania. He presented (Fig 9.9) the distribution of the lesions according to adult males and females from the standpoint of location in the skull. Thirty-eight lesions at the front of the cranium belonged to men while only five belonged to women. Cybulski (2014:422-423) concluded that the male lesions to the front of the skull largely reflected the consequences of hand-to-hand combat. What he did not mention, is the possibility that the trauma to the posterior aspect of the skull may be indicative of executions, whether post-battle or for other reasons. The male/female ratio of six to five regarding posterior head trauma, is significantly different from the anterior ratio of 38 males to five females, which may be another indicator to regard an alternative consideration than direct combat for the post-cranial trauma.

9.2. CONCLUSION

The Assyrian reliefs, in particular the Lachish reliefs, present detailed scenes *vis-à-vis* ancient war and warfare. The reliefs give a clear picture that the Assyrians were not gentle with their enemies, neither during battle nor afterwards. From these depictions the bioarchaeologist may infer the cause and manner of death that a victim may have suffered. Examination of human remains must be performed with an open mind without any preconceptions. Subsequently, the 'story' the bones tell, may be evaluated in regard to the reliefs' 'story'. At Lachish there is the opportunity, rare in Israel with its stringent laws (Greeff 2005:85), to evaluate a preserved human cranial collection from the Iron Age, preserved in the British Museum. Together with the reliefs they may elucidate an ancient episode in human history.

The 'scientific art' of bioarchaeology uses both exact scientific tests together with the 'art' of interpretation of human remains and the evidence embedded therein. A novice, pushing the correct buttons, can produce the exact results on, for instance, isotope analysis, but would not be the case in the interpretations of subtle marks on a skeleton, which may or may not be indicative of interpersonal violence. It seems as if the following tests and analysis have not been done on the Lachish collection of human remains and would be appropriate to undertake, together with the normal biological profile:

- Chronology – Radiocarbon dating

- Ancestry – Strontium isotope analysis
- Trauma – Forensic analysis

The Lachish reliefs are, according to Yadin (1963:428-437), ‘the most important “war documents” on battle in Judah’, and dates from 704-681 BCE. Radiocarbon dating from the skeletal remains, with excellent calibration for the Near East (Finkelstein 2013:7), would clarify the chronology accordingly.

At Lachish, a minimum of two peoples were at war: Judeans and Assyrians. According to the Bible in 2 Kings 19:8-9, there was furthermore an Egyptian presence during the hostilities with the Assyrians. Keita (1988:375, 388), applying his ‘art’ in interpreting metric variables and canonical variates as discriminant functions, states that a Egypto-Nubian presence at Lachish is supported by his findings. Additionally, the Lachish reliefs portray units with different styles of hair and clothes, indicative of units from different ethnic origins. It can therefore be inferred that there should definitely be remains of people from two regions of origin: Judeans and Assyrians. The presence of people from additional geographical regions of origin seems highly possible, with Kieta’s research already supporting an Egypto-Nubian presence. Whether the remains of the defeated and the victors were mixed, might also be a question of interest and a variable to be considered. Strontium isotope analysis will elucidate these questions.

Keita (1988:376) states that the only other study that examines the Lachish series as its major focus, was the study of Risdon in 1939, ‘using metric variables in the now discredited Coefficient of Racial Likeness’. Greeff (2013:152) concurs that, other than craniometrical evaluation, no further bioarchaeological examination of the Lachish series has been undertaken. An evaluation based on current forensic principles and analysis may (will) elicit, for example, wound patterns such as portrayed in Figure 9.9. These patterns can be evaluated in conjunction with the Assyrian reliefs, in particular those portraying the Lachish campaign, to discern whether there is a congruity between modern-day scientific answers to an ancient event and how that event was portrayed in contemporary art. Such an analysis can only enhance the knowledge of a region in turmoil, even up to this day.

10. SUMMARY

Every individual human being lives a life of set patterns. Every individual forms part of a group or groups. Such groups are also recognisable by patterns. Patterns in different groups are usually named according to the area of humanity it represents. If a group is from a specific ethnic origin, such a pattern is described as *culture*. If such a group is a phalanx of slingers or spearmen, the pattern is described as tactics. To expand contemporary knowledge, every aspect of the existence of *Homo sapiens* may be examined according to these patterns and consequently analysed and the results presented – to make these phenomena perceivable.

The pattern of killing fellow men in a socially and morally perceived acceptable way, is known as war. The only major changes in this pattern happened according to changes in technology, to better achieve the set goal: killing ‘them’ – the universal appellation for those who are not part of one’s own community – with less risk to ‘us’.

The dictum – *They have it. We want it. Let’s get it* – is nowhere more applicable than on the land bridge between Africa and the Middle East that constitute Israel. There are probable few places on earth with a more bloody history than Israel. Part of that bloody history is the Assyrian empire with its let’s-get-it-wars. Chronologically these wars fall into the Iron Age of the Ancient Near East. The technology used renders it additionally in the Age of Muscle, where the weapon lethality index is dependent on the power and ability of individuals with their individual weapons.

The weapons of the Iron Age, as part of the Age of Muscle, before the invention of black powder, are known through archaeological exploration: artefacts, documents and depictions. A complementary source of knowledge arises from the examination of the effects of these weapons on their victims. Forensic analysis, developed to reconstruct, *inter alia*, the circumstances during and around the time of death, elucidates the interpersonal violence surrounding a victim’s death. If there are more than one victim, as is the case of a mass grave, forensic analysis may reveal patterns that may elucidate and make the reasons for the mass grave and the event that precipitated it perceivable. Forensic analysts analyse the effect of energy transfer on the human body, with the particular distinction between blunt force and sharp force. The type of weapon may then be inferred, to help establish the event of death.

During the Assyrian reign, the siege of Lachish was lavishly depicted in reliefs that are available to study *vis-à-vis* war and warfare applicable to the Iron Age in the Ancient Near East. For the biblical archaeologist it offers the unique opportunity to study an event described in the Bible in accordance with the excavation of an archaeological site, Lachish (Tell ed-Duweir), in corroboration with depictions from another site, Kuyunjik (Nineveh). Furthermore, it offers the bioarchaeologist the unprecedented opportunity to study a collection of human remains from Israel, stored in the British Museum, without the restrictions enforced in Israel.

Modern science, not previously utilised to examine the Lachish collection, can determine the chronology through radiocarbon dating, discern the geographical areas of origin for combatants from potentially different regions and forensically help to elucidate the circumstances surrounding the event that precipitated the deaths of the people in the mass grave. If we perceive the event better, the knowledge of the era increases, with hopefully better understanding of *Homo sapiens* and one of its major patterns – war.

With better understanding of ancient war and warfare, mankind may learn to curb its seemingly inherent propensity for war, because, as Arthur Koestler (1905 - 1983), a Hungarian-born British writer and journalist said (Microsoft Encarta 2009: *sv* Arthur Koestler):

> The most persistent sound which reverberates through men's history is the beating of war drums.

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