

CHAPTER 1

INTRODUCTION

1.1 Hypothesis

All the interest in disease and death is only another expression of interest in life (Thomas Mann [1875 – 1955] German Writer: *The Magic Mountain*).

Disease is as part of life as it is part of death. It is hardly possible to imagine life without disease. No individual will arguably live and die without suffering some form of physical or mental disease. Therefore it is not strange for humankind to fear disease and ultimately death. The ancient population in the region of Syro-Palestine in the Southern Levant of the Middle East, especially the nations of Israel, feared disease perhaps even more because of their religion. They believed that their Elohim, Yahweh, reserved disease as punishment for their iniquities (Gn 12:17; Ec 23:29–32). Even seduction by Satan (Lk 13:11, 12 and 16) was thought to bring disease upon them:

And behold, there was a woman who had a spirit of infirmity eighteen years, and was bent over and could in no way raise *herself* up. But when Jesus saw her, He called *her* to *Him* and said to her, 'Woman, you are loosed from your infirmity.' 'So ought not this woman, being a daughter of Abraham, whom Satan has bound – think of it – for eighteen years, be loosed from this bond on the Sabbath?'

A selection of various epidemic and other diseases that are described in the biblical Scriptures will be examined and described to find out whether these diseases are similar to what is known to medical science today. It will be equally important to observe whether some of the diseases mentioned in the Bible are analogous to modern diseases.

The biblical descriptions of disease are however limited by a number of reasons (Douglas 1996: s.v. Disease):

- The purpose of the Scriptures is theological rather than medical. It is for instance sufficient to record that a boy was 'paralyzed' and in 'great distress'

(Mt 8:6), for the object was to indicate the severity of the illness and the gravity of the prognosis against which to contrast the greatness of the cure and the divine power of the Christ.

- Contemporary medical knowledge was poor in relation to modern science. The author was perhaps merely describing the macromorphological signs of the disease.
- Contemporary public knowledge of diseases of the majority of the population was poor and would not have understood more advanced descriptions.
- The then ancient population understood the names given to diseases but the names might have gotten lost with the eventual different translations, as what has perhaps happened to leprosy.

Paleopathology has come to the rescue of the question of what these diseases were. Steinbock (1976: ix) defines paleopathology as the study of diseases in ancient human populations as revealed by their skeletal remains. Roberts and Manchester (1995:9) however divulge the limitations of the paleopathological skeletal studies also include the following:

- Acute infective diseases are unlikely to have left any evidence of abnormal bone change (see also Jones 1992:5, 63).
- The skeletal material of the human remains is at times in such disarray that individuals are impossible to be recognized as such because only fragments of skeletal material are found.
- Environmental influences on skeletal remains known as taphonomic changes are described in Chapter 3.
- Woods et al. (1992 as quoted by Roberts & Manchester 1995:9) fear that the hazards of selective mortality and the individual variation on an individual's risk of disease and death may not be possible for the paleopathologist to solve. Diagnoses in paleopathology are made with reference to the knowledge of modern pathology. The agents of disease stimulate bone reactions that are likely to be the same for the paleolithic hunter as they are for present day individuals.

The intrinsic problem of the region of Syro-Palestine in this interaction between diseases quoted in the Bible together with the biblical limitations mentioned above and the limitations of the science of paleopathology is that there is not enough skeletal material available on which to conduct meaningful studies (see Chapter 9). This problem is discussed on the basis of possible reasons why there is not enough material available. Although hundreds of sites have been successfully excavated in the Syro-Palestine region over the previous century, very little was done in the field of paleopathology. Manchester (1984:162) believes that a wider view and interest of disease in antiquity have led to the development of the discipline of paleoepidemiology. To understand the diseases mentioned in the Bible we soon realize that most fall into the categories of epidemic or endemic disease. There is far too little skeletal material available for individual studies, therefore it is almost impossible to describe diseases, categorize them and draw up statistical values for scientific data studies (Capasso 2000:11). The aims of paleopathology are to trace the history of disease, and to determine the effects of disease on past populace. Roberts and Manchester (1995:201) fittingly allege that:

The pattern of disease or injury that affects any group of people is never a matter of chance. It is invariably the expression of stresses and strains to which they were exposed to everything in their environment and behaviour. It reflects their genetic inheritance [which is their internal environment], the climate in which they lived, the soil that gave them sustenance and the animals or plants that shared their homeland. It is influenced by their daily occupations, their habits of diet, their choice of dwellings and clothes, their social structure, even their folklore and mythology.

Paleopathology, together with other forms of evidence in reconstructing the history of disease, is providing the link between the past and the present and can reveal how health and disease have changed through changes in diet, environment and climate. Roberts and Manchester (1995:202) believe that the important message is not to study paleopathology for its own sake. Genuine research questions must be asked when confronted by the pathological data to provide meaningful interpretation.

1.2 AIM

One of the aims of this research is to identify certain diseases mentioned in the biblical Scriptures and determine whether their symptoms are comparable to modern diseases. Through the implication of the tools of the paleopathological discipline human remains can be scientifically examined and this can lead to a more accurate diagnosis. Arguably the most controversial disease in the Bible would undoubtedly be leprosy. Although no positive identification of leprosy has ever been found in the region of Syro-Palestine, this study will still attempt to search for alternatives. The etymology of the word *tsāra'at* translated as leprosy will be examined as well as attempting to find other diseases that may better fit the descriptions offered in the biblical texts (Lv 13 and 14). The argument that no skeletal remains with telltale leprosy lesions have ever been found is no proof that it does not exist, may hold some truth.

This argument will be substantiated by the facts that few epidemic and communicable diseases always leave signs or marks on skeletal tissue. It has been proven that as few as 10% of syphilitic patients ever show bone impairment (Møller-Christensen 1965:604). The cultural treatment of lepers in biblical times are to be investigated as they were banned from the community to live and die in exile in the desert. They were most probably interred in shallow unmarked graves, never to be found by archaeologists. The insufficient descriptions of this and other diseases in the biblical texts disqualify the diseases described to be true leprosy. Both biblical symptoms of leprosy and symptoms of true leprosy will be described with the hope that one-day this matter will be laid to rest.

Where the archaeologist may have failed to present proof of any such disease, science may have evolved to establish new tools with which to improve ways to more accurately examine human remains for pathological signs. Biomolecular science has in the last 15 years been able through DNA technology to identify a number of diseases accurately. DNA technology has improved to the point of

correctly diagnosing a disease without the need to have confirmation through morphological signs of lesions.

As there is a serious shortage of human skeletal remains, the few cases that are available can be scrutinized by molecular scientists and geneticists in future.

It is the aim of this study to examine the possible reasons how it came about that so little paleopathological literature is available in the region of Syro-Palestine. The field archaeologist needs to recognize the importance of the discipline of paleopathology, as much as, or more than all the different fields of the present-day multidisciplinary aspects of archaeology. The pioneers who had discovered Syro-Palestine in the archaeological scene were Edward Robinson in 1837, Charles Warren in 1867, Flinders-Petrie in 1890, George Reisner and C S Fisher from 1908 to 1910, W F Albright in 1926 and K Kenyon from 1952 to 1958 (Le Roux 2003:40-46).

1.3 RESEARCH HISTORY

Paleopathology is that part of science which deals with specifically the history of disease and in the process, uses all the relevant information at its disposal, viz: a) documentary; the biblical scriptures, b) pictorial and c) pathological (Lock et al. 2000:611).

The patriarchs of paleopathology began serious study in this field towards the end of the nineteenth century during excavations in Egypt, especially Nubia, which took place in advance of the raising of the Aswan Damwall in 1909. Work was at first done on mummies, mainly by Ruffer, Wood-Jones and Smith (Lock et al. 2000:611).

The history of paleopathology in the biblical world was a natural outflow from neighbouring Egypt. In the period from circa 1850 to circa 1930 British surgeon Sir Marc Ruffer (1859-1917) made many important early contributions and was

commonly regarded as the 'Father of Paleopathology'. Early research literary material came from the pens of Thomas J Pettigrew (1791-1865): *History of Egyptian Mummies* in 1834; Ruffer: *Remarks on the histology and pathological anatomy of Egyptian mummies* in 1910; Derry: *A case of hydrocephalic in an Egyptian of the Roman Period* in 1913; Cave: *Evidence for the incidence of tuberculosis in ancient Egypt* in 1939; Macalister: *Excavations* in 1930 to 1960 (Jones 1992:5, 61-62).

Interest in the then subdivision of archaeology and anthropology namely the new discipline of paleopathology, started after the publications of Lorton in 1907, Ruffer in 1910, Smith and Wood-Jones in 1909 (Ortner & Putschar 1981:5; Brothwell & Sandison 1967:viii).

The era between 1930 and 1960 saw a period of relative stagnation in paleopathology worldwide, partly due to the criticism of several established racial osteometric models and theories and the subsequent shift away from the study of bone to the study of living populations in anthropological circles (Jones 1992:5, 62). From 1960 to the present one could perhaps call this the paleopathological renaissance period. Several important studies followed in the wake of a number of newcomers to the field in the form of paleopathological subspecialities and the accepted new multidisciplinary shape of the discipline. Several important syntheses and collections of paleopathological knowledge have appeared, although none have dealt with the biblical world (Jones 1992:5, 62). Jones lists the important contributors as Brothwell and Sandison (1967), Janssens (1970), Steinbock (1976) and Ortner and Putschar (1981). Added to the roll of honour one cannot forget the superspecialists in their field like Møller-Christensen (leprosy 1961), Hackett (syphilis 1976) and Stuart Macadam (stress indicators 1985); (Jones 1992:5,65 and also see Roberts & Manchester 1995:225).

The 1990's saw a new generation of biomolecular scientists arguably introduced by Paäbo's work describing molecular cloning of ancient Egyptian mummies' DNA (Paäbo 1985:644). To date, pathogen DNA has been identified in archaeological

remains from leprosy (Spigelman & Donahue 2001); bubonic plague (Drancourt et al. 1988); trepanesoma cruzi (Guhl et al. 1999); tuberculosis (Haas et al. 2000); (Wright & Yoder 2003:54).

1.4 METHODOLOGICAL CONSIDERATIONS

This dissertation is based on a selective research of biblical texts dealing with mostly specific diseases. Leprosy is foremost in being described in several passages in the Old and New Testament, amongst others Leviticus 13 and 14, Matthew 8:3 and Luke 5:12-13. Other diseases like tuberculosis and syphilis are deduced through symptomatic descriptions within Deuteronomy 28:22. Famine with accompanying plague as described in several verses like for instance Genesis 12:10, Isaiah 14:30 and Luke 15:14 have left their marks in the forms of cranial lesions like cribra orbitalia, long bone signs like Harris' lines and hypoplasia lesions and marks on teeth.

Paleopathological research focuses on the various natures of evidences like skeletal material including teeth, fabricated cultic and artistic artefacts, pseudopathology and taphonomic changes in human remains, even the laws governing the scientific examinations of remains influence paleopathology. Paleopathology, now being a multidisciplinary discipline, would even include the science and studies of coprolites and genetics.

1.5 SOURCES

Although the ideal situation for research for this dissertation would have been an empirical investigation, it unfortunately could only be the destiny of a fortunate few who can do their research *suo loco*. For the rest the obvious course can only be the written text.

The primary source in the study is the Bible. The ideal would be to be able to use the original texts. However, the *New King James Version* was selected with

reference to the *King James Version*, *The New Jerusalem Bible*, *The Good News Bible* and the *New International* version. I have made extensive use of electronic editions in my research project. Good use was made of the electronic media in the form of CD-Rom programs – the likes of Logos Library System 1997, e-Sword 2001 and Encarta Reference Library. A comprehensive list of references has been made and is contained in the general list of references.

The main reason to make use of the electronic media was the ease with which data can be acquired through the various search functions. Another obvious reason would be the minute space that a programme takes up. One could easily store a total of 600 books (like the Logos Library System) on three CD's, or even better yet, taking no space at all on the computer hard drive.

This dissertation was researched within the scope of two major trends: the one the theology and the other the medical field of study. It is especially in the theology leg of the research that extensive use was made of the electronic media, namely the Logos Library Systems and the e-Sword programme. Various Bible translations that were used were obtained from these programmes like the King James Version (KJV), the New King James Version (NKJV), the Good News Bible (GNB), the New Jerusalem Bible (NJB) and the New International Version (NIV). Full use was made of the Bible Encyclopaedias, the International Standard Bible Encyclopaedia (ISBE) by J Orr (1997) and the Anchor Bible Dictionary by Freedman (1996), as well as a selection of Bible commentaries like Matthew Henry's Concise Commentary (1996), Through the Bible Commentary – Hudson & Kroll (1997), KJV Bible Commentary (1994).

Dictionaries obtained from electronic sources were *Nelson's New Illustrated Bible dictionary* – Youngblood and Bruce (1997), *Merriam-Webster Collegiate Dictionary*, Douglas (1996) – *The New Bible Dictionary*. Biblical language dictionaries in electronic form were also utilized, like Swanson's *A dictionary of biblical languages with Semantic domains: Greek* 1997, Liddle's *Greek-English Lexicon of the New Testament and other early Christian literature* (1992), Louw et

al. *Greek-English lexicon of the New Testament based on Semantic domains* (1989). Culture orientated books that were found to be very enlightened on culture in ancient times were by Packer et al. (1997), *Nelson's illustrated manners and customs of the Bible*; Jefferys' (1992) *A dictionary of Bible tradition in English literature*; Hurlbut's *Travelling in the Holy Land* (1900) and Gower's *The new manners and customs of Bible times* (1987). The latest addition to Logos Library System, incorporation Libronix, contains all the back issues of Shank's Biblical Archaeological Review. From e-Sword came Jamieson et al. *Commentary Critical and Explanatory on the whole Bible* (2000) and Albert Barnes' *Notes on the Bible*.

On the archaeological front Stern's (Ed) *The new encyclopaedia of Archaeological Excavations in the Holy Land* (NEAEHL) was invaluable to my research work on exhumed skeletons at most of the Syro-Palestinian excavation sites.

On the medical front the Dorland's 1967 *Illustrated Medical Dictionary* by Agnew, and Edwards (1995) *Davidson's principles and practice of medicine* contained an endless array of medical terms and medical diagnostic information.

No research in paleopathology is worth doing without honouring the great scholars of this discipline. Names like Møller-Christensen (leprosy), Hackett (treponematosi), Angel and Stuart-Macadam (anaemia and porotic hyperostosis), Risdon (biometrics) and Acsádi and Nemiskéri (paleodemography) will be remembered as pioneers. Native to Syro-Palestine, a number of archaeologists are worthy of mentioning: Arensburg, Goldstein and Nathan.

Internationally acclaimed works on paleopathology are also worth mentioning: Steinbock (1976) and Ortner and Putschar (1981) on bone diseases and the paleopathological description thereof. There are thousands of other worthy scholars with excellent contributions to the science in the multidisciplinary form of paleopathology. This dissertation is but a drop in the vast ocean.

CHAPTER 2

PALEOPATHOLOGY IN SYRO-PALESTINE

Anthropologists often obtain data on health, disease and death from ancient populations using the methods of paleopathology, the study of ancient disease. The practical side and objectives of the discipline of paleopathology in Syro-Palestine are no different to any other area where this science is practised. Paleopathology not only give us a glimpse into conditions in ancient populations, but it also contributes to our evolutionary perspective of disease. By looking at populations in different environments over time, we may be able to gain insights into long-term relationships of human biology, culture and disease.

The primary source of paleopathological information is skeletal remains. Inspection of bones is augmented with X-rays, chemical analysis and other laboratory methods. Such studies can tell us something of an individual's history of health and disease, age, sex and cause of death. Certain diseases such as osteoarthritis may affect bone directly. Other diseases such as syphilis and tuberculosis may leave indications of the effects on the skeletal system. Physical traumas due to injuries or violence also often leave detectable fractures or signs of healing.

2.1 DEFINITION, HISTORY AND DEVELOPMENT OF PALEOPATHOLOGY AS AN ARCHAEOLOGICAL DISCIPLINE

In the introduction to his famous work: *Handbook of Historical-Geographical Pathology*, August Hirsch (1881) pointed out the rationale of epistemologically orientated texts on diseases of the past, which seemed to correspond with the rationale behind his textbook:

... a presentation of the existence and behavior of diseases in individual historical periods and at individual sites on the surface of the earth, to show whether and which changes of form these have undergone in time

and space, which causal relationships there are between disease factors influencing specific times and specific places on the one hand and the existence and form of the individual diseases on the other, and how these relate to each other in their spatial and temporal prevalence [Hirsch 1881 as quoted in Hermann and Hummel 2003:143].

Paleopathology, as discussed here in a non-empirical approach, will mainly consider diseases that affect the skeletons of the ancient populations of Syro-Palestine in the western Mediterranean region of the Near or Middle East. Skeletal remains are basically the only material in this area that is left for posterity for scientists to work on. However, bone is the most ubiquitous source of paleopathological data (Miller et al. 1996:221). Human remains have to a greater or lesser degree been recognized by paleopathologists and anthropologists as a valuable source of information to interpret lifestyles of ancient peoples. It is in the discipline of paleopathology that the answers lie whether certain diseases were found that are described in the biblical and extra-biblical Scriptures and to what degree, if at all, these diseases were part of life in the period mentioned and what effect it may have had on the culture and or the history. Ortner and Putschar (1981:6) describe a paleopathological programme at the Smithsonian Institution in Washington. This programme has as its objectives:

- The identification and classification of all paleopathological specimens in the vast skeletal collections of the National Museum of National History.
- To build a reference collection of clinically documented cases of skeletal disease including gross specimens, photographs and roentgen films.
- To gather together bibliographic source materials from the literature on bone pathology and on paleopathology. The bibliographic material, together with photographs and detailed descriptions of bone disease studies are to be made available for further studies.

Can something similar and comparable be established in Israel for instance? The first two objectives if replicated in an Israelite framework, already disqualify themselves because of the strict Halakah laws on human skeletal remains enforced in that country (see discussion thereupon in Chapter 5).

2.1.1 Workable definitions of paleopathology

To define the term *paleopathology* in the wake of its importance as the pivot around which this whole study revolves I used a number of different scholars' views on their definitions of the subject. Paleopathology as defined by Steinbock is the study of diseases in ancient human populations as revealed by their skeletal remains. Other means of preserving human remains are mummified tissues, corpses preserved in peat bogs in Europe, also those preserved in ice in the northern parts of Europe and Asia. Ancient art forms and ancient literature on the specific period can also be utilised (Steinbock,1976:ix). This definition of Steinbock's in which he refers to the fact that 'ancient' literature forms part of the realisation of resources to the study, is a preamble to the second part of this dissertation, namely the use of biblical texts to further this study.

Janssens' definition of paleopathology differs from Steinbock's in that he denies the presence of literary sources. To him paleopathology is the study of disease in the past, particularly those times when no literary sources existed (Janssens 1970:1). Together with human paleopathology Janssens also added animal paleopathology as well as paleophytopathology, the study of ancient plantlife. Janssens included into his own definition the short but comprehensive definition of Sir Marc Armand Ruffer, arguably the father of paleopathology, penned in 1914: 'The science of the diseases which can be demonstrated in human and animal remains of ancient times'.

Jones (1992:5,61) defines paleopathology as the 'study of ancient health and disease in man and animals from the evidence of archaeological remains'. The field of paleopathology is very broad, he adds; it includes the study of disease processes in plants, lower and higher animals, and hominids from the earliest eras from which there is evidence to the recent historical past. Jones questions the term *pathology* and refers to the incorrect use thereof in the sense of 'lesion(s)' or 'disease process(es)' rather than to correctly mean the 'study' of such conditions (Jones 1992:5,61).

Larsen (1999:2) reminds us not to forget the main object of paleopathology: Studies of ancient human groups and individuals rely on information gleaned from skeletons for addressing issues such as physiological stress, nutritional ecology and activity patterns. The study also tests hypotheses and draws inferences about diet and nutrition; health and disease, demography, physical behaviour and lifestyles in the past. He believes archaeologists must, through these biocultural studies, seek to envision past populations as though they were alive today and then ask what information drawn from their studies of skeletal tissues would provide understanding of them as functioning, living human beings and members of societies (Larsen 1999:4).

In the nature of the evidence, the various specimens that archaeological excavations have obtained were grouped by Jones (1992:5,61) as follows:

- decarnated skeletal remains, including teeth;
- preserved soft tissues and hair. The earliest paleopathological studies were done on Egyptian mummies by the Egyptologist Margaret Murray (1863-1963) and important advances in the study of preserved tissues using the most modern equipment are still being made in an ongoing manner. Hair is important for the assessment of the nutritional status of the individual and for the racial and population profiles (Jones 1992:5,63);
- blood, biological pigments and stains of biological origin;
- coprolite, soil from the burial sites, and ancient cesspits.

Zias (1991:147) states that paleopathology is the study of ancient disease and its medical and historical implications for human evolution. During the period that humans and animals have inhabited the earth, many of the disease processes that befell them can be deciphered in the osteoarchaeological record. This record of skeletal remains, artefacts, art and ancient literature enables modern paleopathologists to understand how disease affected and influenced the development of ancient peoples (Zias 1991:147). An understanding of the presence and patterns of ancient diseases in ancient human skeletons

contributes significantly to our understanding of modern diseases (Bosch 2000:1248). On the question why people study paleopathology, Roberts and Manchester (1995:2) believe paleopathology illustrates how people interacted with their environment and how they adapted to it over thousands of years.

2.1.2 History of paleopathology

The scientific phase of paleopathology appears to have emerged near the turn of the late 18th and early 19th century. Prior to 1850 the interest in human paleopathology ultimately emerged from curiosity and interest in the Egyptian mummies that flooded the European market at the time. Archaeologists had for many years simply thrown away the human and animal remains found during excavations and concentrated exclusively on objects of material culture, without realising that it was just this biological material which could provide invaluable information that could help them not only to understand mankind as biological beings, but also to explain the many cultural changes which influenced those articles in which their main interest lay (Živanović 1982:33). The work of Thomas J Pettigrew (1791-1865) as quoted by Jones (1992:5,63), a surgeon who studied a large number of mummies and then went on to write what may have been termed the first book written on archaeology and particularly on the paleopathology of the mummies of Egypt, proved to be extremely popular at the time.

2.1.2.1 History of paleopathology in the Middle East and Egypt

It seems that the British and other European workers had more than a casual and curious interest in paleopathology in the latter part of the 19th and 20th century (Angel 1981:509; Jones 1992:5,65). This curiosity was at first centred around human and other faunal mummifications in Egypt. French naturalist Louis Charles Lortet spent years (1906 – 1909) studying syphilitic lesions in mummies in Egypt (Jones 1992:5,63), arguably the greatest excavation of skeletons and mummifications ever dealt with by archaeologists in Egypt, and during the

archaeological survey of Nubia, south of Egypt. The cemeteries and tombs from which these remains emanated, dating from predynastic times, through the long period of the thirty historic dynasties, then through the Ptolemaic and Roman periods, down to early Christian times, cover a total span of more than 4 000 years. The remains, in various degrees of completeness, were more than 30 000 skeletons and mummies. A systematic pathological survey of the ancient human remains in Nubia was done by Smith and Wood-Jones – a first in paleopathology (Ortner & Putschar 1981:5; also Brothwell & Sandison 1967:viii). The 1910 excavations in Nubia were important for the future of paleopathology. The most advanced methods of that period were used for the study both of human remains, such as X-ray photography of mummies, and of the signs of disease and physical injury, and for the first time the indications of disease in an ancient community were recorded in detail. It was just at that time that the foundations were laid for the use of all the technical resources of contemporary medicine and surgery in paleopathological studies. In this way it became possible to make the most likely diagnosis of any disease (Živanović 1982:34). English pathologist Marc Ruffer (1885-1927) made many important contributions to descriptive paleopathology as well as the scientific study of mummified human tissues. Ruffer is commonly regarded as the 'father of paleopathology' (Jones 1992:5,61); however this epithet may belong to Rudolph Virchow. Pales credited Virchow with the title 'la Paternité de la paleopathologie' – The father of paleopathology (Jones 1992:5,62).

Ruffer is said to have coined the term 'paleopathology' (Jones 1992:5,61; Lock et al. 2000:611). The term had probably been coined before, but then forgotten (Angel 1981:509). Haw puts a name to this person, probably being R W Shufeldt, who was writing in the *Popular Science Monthly*, an American magazine in 1883 (Lock et al. 2000:611). Ruffer left a lasting imprint on the discipline of paleopathology with his pioneering work done in formulating the so-called Ruffer's solution, a rehydration agent used on human mummified tissue that is the basis of the modern agent still in use today. Another pioneer not to be forgotten is Møller-Christensen. His report (1953) on the skeletal material from

the medieval leper cemetery in Denmark is perhaps unique in the history of paleopathology (Ortner & Putschar 1981:5)

This period also sees the introduction and application of several new scientific methods and technologies. Flinders Petri, an influential scholar of Egyptian archaeology, was probably the first to use roentgenology on mummies in Egypt (Jones 1992:5,63).

The period from about 1930 to 1969 reflects relative stagnation in paleopathology in the biblical lands and in the rest of the world. This was probably due to racial matters concerning osteometric models and theories and the subsequent shift of interest away from the study of bones to the study of living populations in anthropological circles (Brothwell (ed) 1968:2).

2.1.3 The cultural aspects of paleopathology

The biological remains of ancient populations may have information to answer the questions concerning the physical as well as the cultural anthropology of most populations of the past. That is after all what biblical archaeology is all about – understanding the total social design of humankind and its interaction with nature. In achieving this goal we will be able to understand the culture of each group and thus have a clearer insight into the record of mankind as it is found in the legacy of literature and art. It has always been necessary to find these answers in order to do the proper hermeneutical studies of the Bible. These questions posed may be in respect to morphology, racial affinities and ethnic relationships, diachronic changes in a geographical region, their mortality rate, life expectancy and their diseases (Disi et al. 1983:515). It is indeed priority number one to seek and find the cultural dimensions of a people. A definition of culture according to Seale:

The term *culture* is enormously complex, for it includes not only the society's ways of using material things, such as tools and weapons and shelter and clothing and food, but also language, morals and manners, religion and science, economics and art, government and family relationships, and even its ways of sitting down and making love and committing suicide and whittling sticks [Seale 1974: s.v. Culture] Italics mine.

Wright and Yoder (2003:45) concur with Seale, saying that the science of paleopathology is interested in the implications that cultural practices and the environmental changes had on the diseases of human populations in ancient times.

2.2 THE OBJECTIVES AND METHODOLOGY OF PALEOPATHOLOGY

The objectives of paleopathological research would include the following (Miller et al. 1996:220):

- the diagnosis of the impact of specific diseases in archaeological human remains;
- analysis of the impact of various diseases in human populations through time and space;
- clarification of evolutionary interactions between humans and disease.

Basic to all these objectives is the need for accuracy in diagnosing diseases in human archaeological remains. The need for tests for diagnostic accuracies were complied with and conducted by Miller et al. (1996:221). These experiments were carried out on dry bone and the resultant diagnosis suggested important limitations that need to be considered in the development of methods in paleopathology. Experimental results show that only 28,6% accuracy was obtained in recognizing specific diseases and 42,9% accuracy for recognizing the more general categories of disease. These experiments were conducted at the Smithsonian Institute and the Arizona State University. The results of the tests stated above, conducted by only Ragsdale and Ortner (two of the authors of this article), clearly reveal the fact that in using a more general diagnostic category for more easily recognizable diseases, a much higher percentage rating of correct diagnosis can be achieved. Those who participated in the workshops included specialists in the fields of osteology, paleopathology and medicine. Miller et al. conclude that despite their ability to provide specific diagnosis from skeletal remains, it is necessary and strongly recommended that lesions should be described using objective criteria alone. Diagnoses can be provided, but

descriptive data are paramount. By including general disease categories in paleopathological research, a stronger methodological basis is provided for comparative research involving multiple observers (Miller et al. 1996:229). The diseases found in the Bible belong mainly to the general, relatively easily recognizable category.

Human remains had been the primary evidence of past disease patterning (skeletons or bodies, inhumed, cremated or exposed). Other forms of evidence as secondary sources have contributed significantly to the reconstruction of the past history of human diseases and this has been specifically so for diseases that do not affect the skeleton. These are historical written sources, iconographic representation and the consideration of patterns of diseases in traditional living populations that help to form understanding of the evolution of the paleoepidemiology of disease (Dixon & Roberts 2001:181). In addition we find a variety of archaeological evidences like artefacts, ecofacts and structures, reflecting the lifestyle, diet and economy, environment, climate, trade, hygiene, social and political systems that make up the biocultural approach to studying disease. The multifaceted and multifactorial natures of the occurrence of disease in human populations are obviously better than the analysis of only one form of evidence, according to Dixon and Roberts (2001:182).

Much of the research of the paleopathologists depends on accurate diagnosis of specific diseases in human skeletal remains in the multifaceted and multifactorial technique mentioned above. Nevertheless, despite other limitations, diagnosis is then still possible and is mostly in agreement amongst different scholars (Miller et al. 1996:221).

Furthering the objectives regarding paleopathology, Craffert has an interesting point of view on this subject. In his definition of paleopathology, the discipline is concerned with the study of ancient conditions of health and disease of archaeological remains (Craffert 1999a:3). Craffert also mentions an aspect of paleopathological research, namely that skeletons as well as their immediate

surroundings as found in excavations, form a major part in the object of study for the archaeologist and the paleopathologist. In the case of bodies preserved as mummies, a wealth of information about the people's health and physical condition can be extracted from the soft tissues, including the viscera of the individual. Information of a variety of aspects of human life and interaction can be obtained from skeletal remains, like age, sex, blood group and stature, to name but a few. Imprints left by certain diseases on the skeleton are the cornerstones on which the discipline of paleopathology is built.

The importance of a skeleton's immediate surroundings which form a major part of the object of study for the archaeologist and paleopathologist always necessitates further investigation. I imagine that an untrained archaeologist in paleopathology may only regard macro artefacts as relative to the skeletal find (namely pottery, jewelry, weapons etc). Others, semi-knowledgeable in paleopathology, may be vaguely aware of the importance of soil samples containing for instance fossilized human excrement, known as coprolite, but may deem it unimportant. It may only be a specialist in coprolite studies or a trained paleopathologist knowledgeable in the field of coprolite research who will know and act upon this information. Then only may other members of a full component of the multidisciplinary team become involved. A geologist may find the consistency and pH of the soil important to the research to establish possible taphonomic influences that there might be on and in the skeletal remains. It may then follow that the whole team may become knowledgeable to the importance of coprolite, for future references.

2.3 THE STUDY OF COPROLITES (COPROLITOLOGY)

2.3.1 The science of coprolite studies

Coprolite, derived from Greek *kopros* (dung) and *lithos* (stone), are fossilized (desiccated or mineralized) excrements of vertebrate and invertebrate, marine and terrestrial animals (Jouy-Avantin et al. 2003:367). Coprolite is also described

and known as: paleofaecal material, fossilized faecal material or petrified dung that is found in the soil from a burial site or from ancient cesspits.

Central to the pragmatics of the definition of specifically biblical archaeology is the understanding of the lifestyles of ancient populations. This would entail having a clear notion of the sociocultural, socioeconomical, socioreligious and sociohistorical aspects of life within a specific time/space frame. This study is centred around the health and disease component of the ancient population and all the social aspects mentioned above may have an influence thereupon.

The first record of parasites from ancient remains is that of Ruffer (1910) in Jarcho (1966) who recognized eggs of *Schistosoma haematobium* in the kidney tubules of two mummified Egyptians dated between 1250 and 1000 BCE (Pike 1967:184; Jarcho 1966:29).

Studies of coprolite, which always require coprolite destruction in the laboratory, can provide a wealth of information on the identification of the producer, on the producer's behaviour and on a larger scale, on the ecology of the site in which the producer has lived. Coprolite is first and foremost archaeological material and needs careful analysis, similar to any other archaeological discovery (Jouy-Avantin et al. 2003:368). The most significant contribution of coprolite analysis is in the field of dietary reconstruction, both of the community as a whole from the analysis of cesspools and latrines and of individual members (from mummies – to be more unambiguous, from the investigation of abdominal and enteric contents within the canopic jars in which the organs of the mummies were kept – or from the enteric remains to be found in the abdominal cavities of corpses preserved in peat bogs in Europe, or even in the immediate surroundings of the remains of a single human skeletal entity). The identification of parasites in these deposits will contribute to an assessment of the general community health. Furthermore, the study of individual coprolites and intestinal contents in the case of burials may assist in the evaluation of diet and dietary variations between members of a community (Calder 1977:148). As far back as the 1960's Heizer and Napton

(1969:567) had already alleged that coprolite is the most precise method available to archaeologists for determining ancient dietary patterns and food-preparation practices. They named the array of assessments done on human coprolites but are concerned that almost no examination had been done on faecal material by pathologists, students of communicable or deficiency diseases, or laboratories interested in ancient and prehistoric human sanitation fields (Heizer and Napton 1969: 567). Even coprolite studies of prehistorical people revealed that they ate just about anything that was easily available. A diet of various nuts, grass seeds, wild onions, persimmons, grapes and even flowers were found. Remains of animals were also found, but rarely have scientists discovered traces of antelope, buffalo or wild elk. It seems that large animals were too difficult to kill so they went after mice, pack rats, fish, lizards, birds and bird eggs and not to forget an array of insects like grasshoppers and ants (Williams 2002:12; Bryant & Williams 1975:107).

In recent studies Rhode has presented a paper on faecal steroid analysis and was able to show that even the biological sex of an individual, the coprolite, can be determined (Rhode 2002:912). The reliable method in determination of the sex of an individual in this manner may still have great implications for the paleopathological and anthropological disciplines in future.

2.3.2 The methodology of coprolite studies

The majority of published reports are concerned with the identification of undigested materials in coprolites. A considerable amount of literature discuss the methodological details of coprolite analysis; in health (Wittenberg, 1961:86) and in general (Callen & Cameron 1960:35-37; Heizer & Napton 1969:563-565). There are basically two different approaches according to Calder: the 'wet' and the 'dry' methods of analysis, not to be discussed in detail here. The basics of the methodology however is that the more time consuming and destructive method of 'dry' analysis is used on a smaller scale than the 'wet' method, which uses a method of flotation and *trisodium phosphate* as a dissolving agent. Even despite

the fact that the dissolving agent seems to recreate the original odours, this method is to a certain extent the one of choice (Calder 1977:142).

Whatever method is used, it is imperative to protect the microscopic contents of the coprolite sample. Procedures have been developed to ensure that the different pollen grains and parasites are protected by specifically designed technologies for each type of specimen (Calder 1977:143). The implications arising from the tests may need to be cautionary ones, according to Calder. For although coprolites can contain a wealth of information about diet, they do not necessarily reflect all the foodstuffs eaten, as even some keratinous materials are capable of digestion by the human gut (Calder 1977:148).

There are many scholars who concur that most diseases, including epidemics of various natures, do not leave bone lesions for various reasons (Janssens 1970:16; Miller et al. 1996:224; Goldstein 1969:285; Zias 1991:149; Arensburg et al. 1985:74). For this reason the science of coprolite studies may be invaluable in the search of diseases that macro- and micro signs of a number of pathologies cannot reveal.

The saying that goes: 'We are what we eat' has to apply to the living as well as the dead. What you eat can reveal a lot about your lifestyle and health, are the words of Stokstad (2000:530) as well. That is why archaeologists try to piece together ancient diets by picking through coprolites to find some answers, says Stokstad. Skeletal remains can give us a multitude of information, mostly only of a macroscopic diagnosis of a disease or trauma which may or may not have contributed to the death of the person. It may be that a study of coprolites can open a new world of information about the physical anthropology and pathology of a population. Jones (1992:5,63) concurs that coprolites have become increasingly more important to the discipline of human paleopathology as new technologies become known.

From the point of reference that we are what we eat, it follows that what we eat, our diet, will reveal not only our physical state but may also reveal diseases as well and much more (anaemia is but one example). Remarkable work has been

done in the field of coprolite studies by Jane Cahill et al. in 1991. Two distinct features, amongst others pollen and parasites, were found in the soil of cesspits underneath the two 'toilets' that were excavated in Jerusalem dated in the seventh to sixth centuries BCE. At least one of them was still in use during the siege of Jerusalem in 586 BCE by the Babylonians. One of these toilets was unearthed by the Packer expedition and the other by Kathleen Kenyon. It was regarded by these teams of scientists that the two distinct factors involved in their findings needed further investigation. Regarding the importance for the field of physical anthropology and paleopathology the basic factors for further investigation were:

- the finding of numerous different pollen grains in the soil samples in the laboratory, and
- numerous different human parasites that were discovered (Cahill et al. 1991:65).

Two relatively new sciences were called upon to be involved with in the laboratory tests, namely *palynology* (involving pollen) and *archaeoparasitology* (involving parasites).

2.3.2.1 *Palynology*

Cahill et al. (1991:66) believe the importance of palynological studies has played a significant role in the reconstruction of prehistoric economies and diet. Palynology is an important archaeological subdivision that is concerned with various pollen grains found in soil and in coprolites alike. Pollen grains are extremely durable. It has been found that keratinous particles such as *opercula* and *byssus* threads, *siliceous* remains such as *radiculae*, and cellulose materials such as seeds and plant fibres can survive digestion and can be successfully recovered by procedures such as flotation, coupled with the use of trisodium phosphate (Calder 1977:148). Identifiable pollen grains have been found in rocks over 2,2 billion years old. This durability ensures the preservation of pollen in archaeological deposits and permits the use of caustic chemicals to separate fossilized pollen grains from archaeological soils. These pollen grains are

important for their individuality and are easily distinguishable by their shape. Most plant families produce uniquely identifiable types of pollen. It can thus be used to identify individual plant families from which they are derived.

There are two major types of pollen:

- airborne pollen – carried from plant to plant by wind currents, and
- animal borne pollen – transported by animals and insects.

Animal/insect borne pollen is mostly found in archaeological soils as a result of human activities such as harvesting, processing and storage areas for food. Pollen of this kind is commonly used to construct ancient diets (Cahill et al. 1991:65). It was found that pollen counts can be used to reconstruct ancient environments. For instance, a high count of tree pollen in a specific area in a specific time period, followed by a reduction in tree pollen count in a later time period, followed by a rise in pollen cereal grains and grasses, points to the clearance of land and the start of an agricultural period.

Pollen found at archaeological sites may be used to determine both site function and seasons of occupation. Different plants release pollen at different times of the year. Thus the presence of certain pollen grains can tell if a site was used or not. Pollen trapped in excavated floors can reveal the use of the rooms, whether they may have been for living or ceremonial purposes. Pollen trapped in implements and inside pottery can tell us what kinds of plants were worked on or stored in them. It follows then that these microscopical pollen grains can inform the archaeologist much of what he needs to know anthropologically what otherwise only major finds of pottery and altars for instance can reveal – more importantly in the absence of these and other artefacts in reconstructing an archaeological excavation site.

2.3.2.2 *Archaeoparasitology*

This is likewise a relatively new science, an emerging field concerned with the extraction and identification of parasite eggs from archaeological deposits. Like pollen, the eggs of intestinal worms are equally durable. The oldest finds of intestinal parasitic eggs date back 10 000 years in a find in North America (Cahill et al. 1991:66). Identification and distribution of ancient parasites have shown that human intestinal parasites have been with us for a very long time. The different parasite species identified living in mankind and at times causing various diseases are pinworms (*enterobius vermicularis*); tapeworms (*genus taenia*), a parasitic intestinal *cestode* worm originating from raw or undercooked beef or pork; wireworms (*Haemonchus contortus*); and whipworms (*trichuris trichiura*). Studies of Egyptian mummies have revealed infections with blood flukes (*schistosoma*) and *trichinella* (cause of *trichinosis*). There are of course a host of other human parasites that will not be discussed here. Pike (1967:188) mentions that besides the problems in recognizing eggs which have been preserved for long periods of time, there is the difficulty of determining the origin of the eggs in many instances; whether the eggs are of human parasites or not.

Whereas pollen found in coprolite can tell us a lot about the diet of the individual, certain parasites are signs of infection but probably did not cause any debilitating diseases. Many of these parasites can however cause anaemia. Anaemia as a stress factor will feature strongly in the rest of this study in Chapter 7.

In the wake of this relatively new science it may be accepted that the study of coprolites in cesspits, latrine deposits and in burial site soil *per se* may become increasingly popular in the anthropological sense. Coprolite studies may become an essential tool in obtaining a complete view of the relative health or disease of an ancient population. As seen above it can also give us insight into the social anthropology of a population, reconstructing social life in all its dimensions.

2.3.3 Recent developments in coprolite studies

Recent techniques in molecular biology in coprolites have come to light, eliminating contamination problems, therefore making it possible to obtain ancient DNA fragments in the specimens. The recovery of DNA from ancient tissues is now possible; with the development of the *polymerase chain reaction* (PCR, the amplification of specific DNA sequences) and the advent of molecular archaeology, genetic information about ancient human populations is becoming readily accessible, including gender and race (Sutton et al. 1996:263). Such information can also be coupled with dietary data; even gender-based differences in diet are possible to detect (Jouy-Avantin et al. 2003:371; Stokstad 2000:530).

2.3.4 Discussion and future of coprolitology

Coprolitology was integrated within the subject of paleopathology in this dissertation at this early location, for the study of coprolites seems to have found a permanent place in the paleopathology discipline by virtue of the fact that it aids in the search for ancient diseases. Far too few skeletons have emerged in the Syro-Palestine region to effectively aid in paleopathological studies (see discussion in Chapter 9). Coprolite studies may add valuable information to science in disclosing ancient dietary fashions, the health of the defecator by looking for *helminthiasis* or any other form of parasite. Coprolitology may even confirm the sex of the defecator (Sutton et al. 1996:263). DNA studies on coprolite may elucidate numerous other disease related information in the near future.

Heizer and Napton had already in 1969 voiced their concern that this uniquely preserved material (coprolite) can be used to carry out research in fields such as palynology, ethnobotany, pathology, nutrition, physiology, environmental sanitation, epidemiology and forensic medicine (Heizer & Napton 1969:567). The question is posed whether scientists have to their full capability used this exciting new field of study to further their knowledge in these fields to satisfy the

disciplines of archaeology and anthropology. Viewed critically I see too little being done.

I propose that every single identifiable skeleton that is excavated from an interred site, be it in the ground or inside a cave or other place of burial, must be subjected to thorough soil analysis in the generalised area around the skeleton, and specifically in the abdominal area below the sternum and between and below the lower ribcage down to the sacral part of the vertebral column. This may prove to be more difficult in the ancient elitist Israelite population in the period of the Second Temple Period (37 BCE – 70 CE) (Hayford et al.1997 s.v. Second Temple era), when secondary burials became popular and ossuaries were used which contained the full skeleton in disarrayed form (Craffert 1999b:11). The rest of the population which were inherently poor, were however interred in open graves or mass graves without the option of secondary burials. It is here where we may discover the richest finds. Cesspits, pits used for the collection of waste matter and water, especially sewage, should be identified at excavation sites in presumable living quarters and should be scanned by knowledgeable scholars in coprolite studies, or samples can simply be taken for laboratory analysis.

2.4 TECHNOLOGICAL CHANGES AND THE NEW INTER-DISCIPLINARY CHARACTER OF PALEOPATHOLOGY

The period from 1960 onwards was characterised by a progress in technology as well as subspecialisation and superspecialisation in paleopathology and an increase in the number of published reports, according to Jones (1992:5,62). He mentions that far too little new publications were done on biblical paleopathology. This may have something to do with restriction in the laws of both the Palestinian and the Jewish authorities, as we will see later. Major advances were made in the field of paleonutrition and improvements in the diagnostic criteria for the evidence of several diseases in skeletal remains, especially syphilis (Hackett 1976:ii) and leprosy (Møller-Christensen 1961:738).

Other new technological advances that we encounter in the modern period are computed axial tomography (CAT-scans), fibre optics that allow intra-somal studies of cranial cavities of skeletons and a-traumatic sampling of internal tissues of mummified corpses. Attempts to reconstruct faces were already carried out in the 19th century by German anatomists in order to reproduce likenesses of the skulls of celebrities such as Schiller, Kant and Bach. This art form today has gone a step further and reconstructed the presumable remains of king Philip II of Macedon, the father of Alexander the Great, who probably died more than 2 300 years ago. Thus technology enhances our anthropologic understanding of the ancient human being (Renfrew & Bahn 1996:408) with the advent of DNA development and successful cloning of DNA, the potential for obtaining direct knowledge of the biological nature and make-up of the ancient inhabitants of the biblical lands (Paäbo 1985:644).

The growth of the discipline of paleopathology depended to a large extent on the fields of specialists aiding the down-to-earth biblical archaeologist. The help of medical pathologists and anthropologists was the obvious first choice to acquire in the period when mostly mummies and skeletons were studied during the archaeological survey of Egypt and Nubia at the turn of the 19th century; G Elliot Smith (1871-1939), Frederic Wood-Jones (1879-1954) and the English pathologist Marc Armand Ruffer (1859-1917) made many important early contributions to descriptive paleopathology and the scientific study of mummified tissues (Jones 1992:5,61).

What Dever calls the 'New Archaeology' begins with the stratigraphic excavation methods that were being supplemented by newer field and analytical methods by the 1970's. The most typical aspect of the new archaeology in practice was its interdisciplinary character. This approach, now commonplace in the field, includes disciplines such as geomorphology, geology, paleobotany and paleozoology, climatology and paleo-ecology, hydrology, physical and cultural anthropology, and many more of the specialised branches of the natural and social sciences (Dever 2002:59)

In 1934 Angel had a similar experience when Clyde Kluckhohn insisted that the archaeologist should learn about climatology, geology, soils, paleobotany, paleozoology, paleo-ecology, human biology and disease patterns as well as anthropology in order to practice archaeology to understand the *living* culture of any region (Angel 1981:510).

The difference between the views of these two scholars is obvious. In the nursery stage of archaeology (viz 1930's) the emphasis was on the person as an archaeologist to acquire this cognizance of these other fields. No doubt many of them did possibly just that, in congruence with their predecessors, the tyros of archaeology who had little choice but to be 'self-schooled' in all the specialised subdivisions of their field. Logically this was not achievable by any means. The proposal to incorporate the specialist *per se* was the natural outcome in years to come. In other words these people were foremost specialists in other fields and later joined the teams of archaeologists.

As archaeology was considered at first the ancillary branch of biblical or theological studies, it has risen above the epithet as a result of its new transformation. Archaeology soon became a fully fledged autonomous discipline. Dever characterised Syro-Palestinian archaeology with three words: specialised, professional and secular (Dever 2002:62).

Paleopathology as a discipline in its own right has travelled the same road in essence. It used to be a subdivision of physical anthropology but gradually underwent an attainment of independence, and was rightfully incorporated into the new archaeology advocated by Dever. This was however not achieved before paleopathology acquired its own specialists to form a full complement under one roof.

If one considers what fields of specialisation were drawn into the disciplines of both archaeology and paleopathology it is clear to see the parallelism. All new

specialised fields complement the ecological, physical and cultural anthropological fields of studies and knowledge known up to that point.

2.5 CONCLUSION

In the introduction to this chapter it was inferred that a paleopathological programme similar to that of the Smithsonian Institution be constructed in Israel for argument's sake, and the question was raised whether it would be a feasible proposition. With the same objectives in mind, we have already seen that because of the *human remains factor* it will not be feasible at present. However if one should take the third objective mentioned and elaborate on it, it may be a plausible proposition and it may have a future in this field of study. This third objective was spelled out as to gather bibliographic source materials from the literature on bone pathology and on paleopathology. This bibliographic material, together with photographs and detailed descriptions of bone disease studies are to be made available for further studies (Ortner & Putschar 1981:7). One of the objectives of such a localized programme for the Middle East will have to be specialization in both workforce and in the regional diseases, be region-specific and have a general database for comparative diseases amongst others. It should also include information on various disciplines (be multidisciplinary within the boundaries of paleopathology) since different ecological and taphonomic factors may have distinct influences on the study materials. The future of paleopathology may lie in the hands of the biomolecular scientists and therefore modern facilities must be made available for DNA studies. Laboratories should also be made available for coprolite studies since these studies are still crucial in determining the diet and the ecology of ancient populations. If all these prerequisites are

complied with, then the paleopathologists and anthropologists may perhaps be stimulated in taking notice of the importance of ancient human remains to further understanding of the history, the anthropology and the evolution of diseases amongst other benefits that the discipline of paleopathology can offer, especially for the region of Syro-Palestine. Seeing that the religion of the region is inseparable from the archaeology of the region, it follows that the theology of the region will stand to gain immensely from a partnership in the multidisciplinary discipline of archaeology in Syro-Palestine (Dever 2002:61).

Archaeologists hopefully will stop ignoring the skeleton that crosses their excavational path (see Chapter 9 for archaeologists' present mind-set). Regardless of the seemingly difficulties and other problems a centre like proposed will be still be feasible, and I am sure that analogous ideas have crossed many serious scholars' minds in the past.

CHAPTER 3

ETYMOLOGY OF BIBLICAL TERMS TO BE USED; HEALTH AND DISEASE

Diseases are the tax on pleasures. Not much different to what the religious opinions of the Israelites were some 3000 years ago.
Quote by John Ray [1627-1705], an English naturalist.

In order to locate the biblical terminology that will be required in the process of writing this dissertation (from the biblical Scriptures), the initial response of the reader will be to ask the question, which Bible? The answer is not all that obvious for there are literally hundreds of different versions of the Bible available. Van Heerden (1999:29) tries to illuminate the situation that we face when we have to explain why there are so many disparities. Bibles differ from each other because:

- they are based on different original texts;
- there are different canons;
- there are different translation methods.

This information may still not assist us much in making a choice as to which Bible to use in our search for explicit terminology that would be found across a broad spectrum of translations (Van Heerden 1999:30-41). The perspective with which we read the different texts still does not provide an answer because we are looking for specific terminology and not interpretation thereof. The next best thing to an answer is to accept the disparities and choose accredited and recognized translations and in some instances even avail to popular translations. Because of the variety of terminology that is going to be used no one translation will suffice. The basic translation that will be used throughout will be the New King James Version. When there may be discrepancies, other translations will be used and the particular translation will be annotated at the point of referral. It must be mentioned at this stage that certain words in the texts quoted are accentuated in this version (in Thomas Nelson Publishers 1982 [electronic edition]), and is printed in italics to emphasise specific meanings of the texts.

3.1 ETYMOLOGY OF 'EPIDEMIOLOGY' AND DISEASE

3.1.1 Etymology of 'epidemiology' in Greek

From an interpretive (or meaning centred) approach to the history and development of the Greek word '*epidemios*' the Theological Dictionary of New Testament Greek (Kittel & Friedrich 1985: s.v. *Epidemios*) explain it thus: *nósos* means sickness – *noseó* means 'to be sick' and figuratively 'to be full of (unhealthy) ambition'; plague, (*plēgē*) a widespread contagious disease, often associated with divine retribution – also 'pestilence', 'calamity', as well as 'licentiousness' (Louw et al. 1989: s.v. Plague). The modern meaning of the noun 'epidemic' is as follows: affecting or tending to affect a disproportionately large number of individuals within a population, a community or a region at the same time, it is derived from *epidēmio*; *epī* – around, *dēmos* – people; to live as a foreigner, be a visitor for either a relatively short or long time, an epidemic (Swanson 1997: s.v. Epidemic). The Greek adjective *epidēmios* refers to 'confined to a certain people'; 'indigenous' or 'characteristic of a certain region'.

Epidemiai is the title of one of the writings attributed to Hippocrates. Translated it means 'observations made while travelling among certain people' or 'stories about certain sick people', in other words 'case histories' (Swanson 1997: s.v. Epidemic).

However it may be that the word *epidemic* is today encompassing all or most of the above factors in its historical meaning. Fortunately the Greek 'medical' terminology has been accepted into the modern medical literature to a large extent. To emphasize this, Horstmanshoff (1990:177) presents the following:

Athens, about 400 BC: Two physicians are discussing a patient in a language now deemed 'dead'. We can catch a few words: ...*arthritis*, ...*rheumatism*, ...*crisis*, ...*prognosis*, ...*asthma*, ...*tetanus*, ...*anthrax*, ...*dysentery*, ...*pleuritis*, ...*hypochondria*, ...*anatomy*, ...*epidemic* ...

All these terms are still in daily use today. Horstmanshoff asks the question whether the usage of the ancient terminology still has the same meaning. In other words, are the diseases mentioned scientifically identifiable in both time periods? Have the infectious agents for instance changed over the more than three millenniums? To answer this and other questions concerning ancient medicine we can only turn to the discipline of paleopathology to empirically and scientifically attempt to find the relevant 'evidences' (Horstmanshoff 1990:177). We are left with the ancient physician's diagnosis, prognosis and treatment versus his modern counterpart who is using the most accurate technological equipment and procedures. There is no doubt that there is no contest. What the pathologist is left with is in most cases a skeleton with possible osteological signs of pathology.

The ancient physician, if one can use the term physician in the broad sense (in comparison to modern day highly trained physician) may have been erroneous in many respects, from the diagnostic stage to the prognosis and treatment. I may add that we can only judge the ancient physician/priest by written reports, especially as far as the biblical and extra-biblical texts are concerned. Leprosy in the Bible is an excellent example of the above as we will see later. Horstmanshoff came to the conclusion that the ancient physicians did not possess the scientific training, scholarly attitudes and social standing which we are anachronistically inclined to ascribe to them. The physicians of antiquity were primarily craftsmen. They were rather philosophers and rhetors than naturalists or field biologists (Horstmanshoff 1990:197).

3.1.2 Etymology of 'epidemiology' in Hebrew

Next we turn to the etymology of the Hebrew equivalent of epidemic. To understand the etymology of the Hebrew word *makkā*, we turn to the Harris' *Theological Wordbook of the Old Testament* (1999). The word *makkā* in Hebrew would indicate *blow, wound, plague, slaughter, defeat*. The Revised Standard Version also has *affliction* (Dt 28:59, 61; 29:22), *sickness* (Dt 18:59) and *disaster*

(Jr 19:8; 49:17). Of the forty eight occurrences of *makkā* in the Old Testament, two thirds of them were translated by the term *plēgē* in the Septuagint (LXX), from which the English term *plague* is derived. The word is used with four main nuances of meaning, according to Harris 1999: s.v. Epidemics:

- It is used literally of a 'blow' or 'stroke' in the manner of beating or whipping (Dt 25:3; Pr 20:30). According to the law of the Old Testament the number of strokes received in formal punishment was limited to forty (Dt 25:3). A similar idea of 'scourging' is used figuratively of the Lord of hosts who 'smote Midian' (Is 10:26).
- The word *makkā*, in certain contexts, is translated as 'wound' (I Ki 22:35), for example when king Ahab was fatally struck by an arrow, it is graphically stated as *the blood ran out of the wounds into the midst of the chariot*; compare the wounds from God's arrows in Psalm 64:7 [Hebrew Bible]. Other occurrences can be found in 2 Kings 8:29, 9:15; 2 Chronicles 22:6; Jeremiah 30:14; Isaiah 1:5-6, Jeremiah 10:19; 14:17; 15:18; 30:12; Nahum 3:19; Micha 1:9; Isaiah 30:26.
- In the interest of this study, *makkā* may also be rendered 'plague' or 'affliction'. In Old Testament times plagues seem to have been synonymous with epidemic disease, often sent as punishment for sin, both for the Israelites and the enemies of the Holy Land. *I will bring more plagues upon you, sevenfold as many as your sins* (Lv 26:21). A 'very great plague' (*makkā*) occurred in the wilderness as the people were gluttonously eating the quails (Nm 11:33). This plague might have been a severe stomach disorder. The Philistines were yet impressed with the reputation of the God of Israel who 'smote' the Egyptians with every sort of plague in the wilderness (1Sm 4:8).
- *Makkā* (Hebr) is used to depict 'defeat', as when an army or people is smitten by 'slaughter' (1Sm 4:10, 14:30). Frequently the verb *mākka* 'to smite' is combined in a cognate construction with *makkā*, resulting in the expression 'to make/smite with a very great' or 'great slaughter' – compare Joshua 10:10, 20; 1 Samuel 6:19, 19:8, 23:5; 1 Kings 20:21 (Harris 1980: s.v. Epidemics).

3.2 PLAGUE AS AN EPIDEMIC DISEASE

'Plague', Greek *plege*, as we have seen, is mostly translated to denote 'any epidemical disease'. It is also widely used in a general sense in Exodus 11:1 where it refers to the hardships that God will inflict upon the Egyptians:

And the Lord said to Moses, "I will bring yet one *more* plague on Pharaoh and on Egypt. Afterward he will let you go from here. When he lets *you* go, he will surely drive you out of here altogether".

The KJV also uses the term *plague* to refer to any painful affliction. When the woman with a chronic haemorrhage was healed, she felt that she had been healed of a 'plague' (Mk 5:29).

And straightway the fountain of her blood was dried up; and she felt in *her* body that she was healed of that plague.

The NKJV, however translated 'plague' with affliction (Mk 5:29)

Immediately the fountain of her blood was dried up, and she felt in *her* body that she was healed of the affliction.

We have no evidence that the Bible ever refers to bubonic plague, which would claim the lives of millions of people in the common era times (Packer et al. 1997: s.v. Epidemic).

3.3 AN EPIDEMIC DIAGNOSED

The question is posed whether it was possible for the ancient people, in particular the Israelites, to have been knowledgeable about diagnosing the advent of an epidemical disease. There seems to be no specific record of a diagnosed epidemic in the ancient literature other than the warnings and purity prescriptions found in Leviticus 13 and 14 in connection with biblical leprosy. The manner in which epidemiology is conducted in modern times started with an English doctor, John Snow, who observed that the London cholera epidemic occurred mainly in regions served by the Broad Street pump. After the pump was shut down the epidemic subsided. Today, the origin of the epidemic is identified as a priority.

The causative microbe or agent or source may then be more easily identified (Packer et al. 1997: s.v. Epidemic).

The course or progress of the epidemic is next focussed on the following (Microsoft Encarta 2003: s.v. Epidemiology);

- the age is important, for children and older people may be more susceptible to certain diseases such as influenza and cholera;
- sex, such as a greater incidence of heart attacks among men;
- creed or nationality, such as the higher rate of the birth defect *spina bifida* among children born to Irish parents;
- socioeconomic factors, exemplified by the greater incidence of tuberculosis among the poor and the homeless in crowded cities.

These factors need to be taken into serious consideration when working with paleopathological material when working on an assemblage of human remains, especially in studies necessary to show epidemical situations in a community.

The control of epidemics in the Old Testament period may be seen in the Mosaic laws. Perhaps the key passage that deals with this matter is Leviticus 22:4–6:

Whatever man of the descendants of Aaron, who *is* a leper or has a discharge, shall not eat the holy offerings until he is clean. And whoever touches anything made unclean *by* a corpse, or a man who has had an emission of semen, or whoever touches any creeping thing by which he would be made unclean, or any person by whom he would become unclean, whatever his uncleanness may be— the person who has touched any such thing shall be unclean until evening, and shall not eat the holy *offerings* unless he washes his body with water.

Additional dietary laws included the prohibition that Israel could not eat anything that had not been killed. The reason for this was that a communicable disease might have caused the animal's death.

According to Falwell et al. the Word of God is quite specific; 'If one that is unclean by a dead body touch any of these, shall it be unclean?' the priests would give this answer: 'It shall be unclean.' Uncleanness is communicable; unholiness is

transferable. Additional dietary laws included the prohibition that Israel could not eat anything that had died, that is, was not killed. The reason for this was that a communicable disease might have been the cause of the animal's death (Falwell et al. 1994: s.v. Communicable).

3.4 A BRIEF HISTORY OF EPIDEMIC DISEASES

Epidemics have often been more influential than statesmen and soldiers in shaping the course of political history, and diseases may also colour the moods of civilizations. René Dubos [1901 – 1982].

Hippocrates (ca 466 – ca 377 BCE), arguably the greatest physician of antiquity, regarded as the father of medicine, was probably born on the island of Kos, Greece. Among the most significant Hippocratic ideas was the insistence that disease is a natural event, rather than something caused by the gods or supernatural forces. He advocated that air, water and indoor spaces (dwellings) be examined to find the causes of disease in the individual as well as epidemics in a community. The Hippocratic ideas also offered sensible advice about housing, town construction, drinking water and other factors that can influence health. His book *Epidemiai* presented a group of carefully observed case histories. In a sense Hippocrates should be regarded as the father of 'epidemic diseases' as well as being known as the father of medicine (Horstmanshoff 1990:181)

Deficiency diseases as an epidemic will also be discussed in relation to the great famines of the Old Testament (Genesis 12:10; 26:1; Joel 1:17–18; 2 Kings 6:28; Jeremiah 14:1–6.). The reason for including deficiency diseases under epidemic diseases is that the anaemia caused by the lack of iron in the diet is also partially responsible for a lowering in the body's natural resistance to infections and thus made the individual more susceptible to an epidemical disease (see Chapter 7). The lines and marks on teeth and long bones (Harris lines) and the porosities found in crania can be examined and dated by various methods to determine a possible period of a 'stressor' like a famine, which then can be confirmed by

written sources. Even when a cause is not specifically known, a disease can almost always be understood in terms of the physiological processes that have occurred.

3.5 DISEASES OF ENDEMIC NATURE

To understand the term *endemic* opposed to *epidemic* we must first understand the concept of infection and infectious diseases.

Infection is an invasion of the body by pathogenic (that which cause disease) microorganisms with the resultant reaction of the tissues to their presence and to the toxins generated by them. The microorganisms may be bacteria, viruses, fungi, protozoa and helminths (worm or wormlike parasites). There are many ways and means to become infected, which will only be discussed in the manner in which these microorganisms find their way from person to person or from animal to animal or vice versa (Agnew:1967: s.v. Infection). The emphasis now falls on the transference procedure and the term thereof would be 'infectious disease'. This is defined in Agnew 1967 as follows: '*Caused by or capable of being communicated by infections*'.

Diseases which are of an epidemic disposition must by definition be infectious diseases. The emphasis now falls on the spreading of the disease, whether it is contained or widespread. A worldwide epidemic of assault will be expressed as a pandemic. An endemic disease is defined by Agnew (1967: s.v. Endemic): Greek 'endemos' = dwelling in a place, a disease of low morbidity that is constantly present in a human community. Endemy: Any endemic disease.

Mish and Morse (1993 s.v. Endemic) also define it as: from Greek endemia = action of dwelling, from endemos endemic, from =en in + demos = people, restricted or peculiar to a locality or region (endemic disease; an endemic species) (Liddell 1992: s.v. Endemic).

Certain diseases can be both endemic and epidemic simultaneously. Some parasitic diseases like malaria would fall into this category. By virtue of the definition of en- and epidemic, in South Africa in relation to Africa malaria is both endemic and epidemic. Malaria is confined (endemic) to the northern and north eastern parts of our country but malaria has reached epidemic proportions in the African continent. Similarly malaria will be treated as an epidemic disease in the Southern Levant, but paleopathological diagnosis of skeletal remains will depend on the region in question. Other diseases like tuberculosis and leprosy will be regarded as epidemic regardless of region when dealing with biblical texts. It is however necessary to also keep migration of individuals in mind. Diagnoses will be made of an epi- or endemic more accurately only in the event of numerous specimens under observation (Orr 1999: s.v. Endemic).

3.6 OBSERVATIONS ON HEALTH AND DISEASE APPLICABLE TO THE BIBLICAL WORLD

A quote from Jean Martin Charcot (1825-1893 – French pathologist and neurologist) :

Disease is very old, and nothing about it has changed. It is we that change, as we learn to recognize what was formerly imperceptible.

Modern science may disagree on the statement that disease does not change, but the wisdom may lie in the second half of the quote. The first part justifies attention in some stage of this dissertation. Through the efforts of paleopathologists there are many inferences to be made about the health and diseases of ancient mankind which are applicable to the biblical world.

3.6.1 History of disease in the Bible

Corrin (1992: s.v. Diseases and healing) begins with the history of disease in the Bible directly after the fall of man in Genesis chapter three. God curses the guilty couple with pain in childbirth and discomfort associated with corruption and rebellion against the created order (Gn 3:16-19). Exiled from Eden because of

their sin, Adam and Eve become progenitors of a race imperfect in body and spirit. The tree of life is denied them, they shall 'surely die' (Gn 3:17). God promises his chosen people freedom from disease in Exodus 15:26:

...and said, "If you diligently heed the voice of the LORD your God and do what is right in His sight, give ear to His commandments and keep all His statutes, I will put none of the diseases on you which I have brought on the Egyptians. For I *am* the LORD who heals you".

The opposite is also asserted: disobedience of God's law violates a moral ecology of which created physical nature is also an expression, and the consequence is disease (viz Jos 1:5-7; Ac 12:23). God may heal such self induced disease if repentance is shown, proving God's redemption and forgiveness (Is 35:5-6). God's sovereignty in judgement and mercy is asserted:

I kill, and I make alive, I wound, and I heal; neither is there any that can deliver out of my hand (Dt 32:29).

The diseases that God brought upon his own disobedient people as well as surrounding nations who thwart the divine purpose are real and not imaginary. Pestilence, plague and famine were of the most frequented diseases of Old Testament times (e.g. Jr 38:2; 42:17) (Corrin 1996: s.v. Disease and healing). Diseases associated with famine are mostly recognizable in skeletal remains but acute pestilence and plague diseases, as we have seen in Chapter 2, mostly leave no bone lesions (Janssens 1970:16 ; Miller et al. 1996:224; Goldstein 1969:285 ; Zias 1991:149; Manchester 1984:162).

3.6.2 Sickness and disease in the Old Testament and the New Testament times

3.6.2.1 Terminology

- In the Old Testament: The term 'sickness' in the Old Testament has various forms in the Hebrew language: *Chalah* (Gn 48:1); *choli* (Dt 28:61); *talachu* (Dt 29:21); *machalah* (Ex 23:25); *daweh* (Lv 15:330); *'anash* (2 Sm 12:15).

- In the New Testament: Likewise, the term 'sickness' has various forms in the New Testament: *astheno* (Mt 10:8); *kakos echon* (Lk 7:2); *kakos echontas* (Mt 4:24); *arrhistis* (Sirach 7:35 and Mt 14:14); *arrhostema* (Sirach 10:10).

3.6.2.2 *Sickness in the Old Testament*

The instances where diseases are recorded in the Old Testament are few, if one compares disease with the number of deaths recorded in the historical books of the Bible (Macalister 1997: s.v. Sickness). A disease that is specified in the Old Testament for instance is Bathsheba's child whose disease is termed as '*anash*', not unlike *trismus nascentium*, a common disease in Palestine (a motor disturbance of the trigeminal nerve, causing spasms to the maseter muscle, a characteristic of tetanus, often observed in an infant at birth) (Agnew 1967: s.v. Trismus). Asa's disease of his feet, possibly gout, is also specified in 1 Kings 15:23:

The rest of all the acts of Asa, all his might, all that he did, and the cities which he built, *are* they not written in the book of the chronicles of the kings of Judah? But in the time of his old age he was diseased in his feet.

Craffert clarifies the use of the terms *disease* and *illness* in modern etymology. Disease does *not* equal illness (Craffert 1996:5). He explains this statement with the following example: A person may be predisposed to or have a disease and yet not be ill. Craffert argues that since the advent of bacteriology and germ theory, it has been recognized that infection is a necessary but not sufficient condition for disease to occur. They refer to the persistent paradox in modern medical systems: many patients seeking medical care (those who have an illness) do not have an identifiable disease, while at the same time, many people with diseases do not define themselves as ill and thus do not seek medical help (Craffert 1996:5).

An unspecified fatal illness described in the Bible is that of Elisha (2 Ki 13:14). We can thus see that there is a serious component to the term illness. In the

language of the Bible, leprosy is spoken of as a defilement (uncleanliness) and should be cleansed (Lv 13 and 14), rather than as a *disease* to be cured.

Geographically Palestine, from its position and physical conditions, ought to be a healthy country. That it was not so, depended on the unsanitary conditions in which the people lived and their inability to recognize zymotic diseases. In ancient times Palestine was regarded as healthier than Egypt. Hence the diseases of Egypt are referred to as being worse than those of Palestine (Israel):

And the Lord will take away from you all sickness, and will afflict you with none of the terrible diseases of Egypt which you have known, but will lay *them* on all those who hate you [Dt 7:15].

and:

Moreover He will bring back on you all the diseases of Egypt, of which you were afraid, and they shall cling to you [Dt 28:60].

The sanitary regulations and restrictions of the laws of Moses (Priestly Code) would doubtless have raised the standard of public health, but it is unlikely that these were observed over any large area (Macalister 1999: s.v. Disease).

3.6.2.3 *Sickness and disease in the New Testament*

Craffert (1999a:14) states that disease conditions have meaning in a specific cultural system but have very little, if any, meaning outside that framework. It can be established that certain well known diseases that existed in the New Testament times are recognizable in modern times, either with local names or without being identified as a specific disease. Endemic and epidemic diseases like malaria, schistosomiasis and typhoid fever were common diseases that caused feverish symptoms in ancient times. Fevers are often mentioned in the New Testament times; Matthew 8:14-15; Mark 1:30-31; Luke 4:38-39; John 4:52 and Acts 28:8. Leprosy are mentioned only three times in; Matthew 8:3; Mark 1:42 and Luke 5:12-13, showing a different approach to this disease than what the Old Testament had. The diseases described in the New Testament takes on a slightly different format than that of the Old Testament because of a different

cultural setting. The diseases mentioned above are the ones that mostly leave signs and lesions in bone tissue, namely porotic hyperostosis and relevant cranial lesions, Harris' lines in long bones and dental hypoplasias in the event of fever related diseases, and very specific lesions left by leprosy (Craffert 1999a:15). Satan also, for instance, plays a new role in the New Testament period. The seduction by Satan (Mt 9:34; Lk 13:16) is a new dimension of mental attitude to diseases as demonology was feared.

3.6.3 The biocultural nature of disease frequency

A striking feature in the study of the history of disease is the constant nature and the different distribution of disease with the passage of time. Many diseases which have been recognized in the skeletal remains from antiquity present the same physical characteristics as its counterpart today. Diagnoses of paleopathological disease can only be made with reference to the knowledge of modern pathology. The agents or pathogens of diseases that caused lesions to tissues or stimulated bone reactions in the paleolithic human being, are the same as for the twenty first century person. It is the overall world frequency of disease and the different geographical patterns of disease which have changed during the history of human populations (Roberts & Manchester 1995:10).

Many diseases have spread through the movement of people, mostly because of trade routes being opened, sometimes with devastating effects. It is only to be expected that when one population moves from one region to which it has become adjusted, to another, they show increased susceptibility to the disease of the area into which they had moved (Banks 1959:200). Of greater interest to the paleopathologist are those diseases that have travelled with the moving populations and even more so by the individual. Human and animal infectious diseases have spread worldwide through the integration of people and their animals (Banks 1959:205). As mentioned, the individual trader on the trade routes is the main culprit, but so are warring factions especially in ancient times (Roberts & Manchester 1995:11). Diseases may also spring forth from the ground

as Roberts and Manchester explain: 'Until the advent of agriculture in all parts of the world, many people lived in harmony with their environment. The equilibrium was destroyed with deforestation and agricultural development, ploughing, crop rearing and tending flocks increased exposure to tetanus because cultivated soil with organic refuse tends to be a good medium for the tetanus bacillus'. This disease in antiquity was invariably fatal. Later on mankind introduced what became house pets, dogs and cats as their companions. These animals carried with them new parasites to which mankind was immediately exposed and 'new' diseases developed. With cattle husbandry came tuberculosis, the pig was the carrier of *taenia solium* worms and dogs and sheep were subject to *hydatid* disease (a cystlike attachment to the testis or oviduct). Roberts and Manchester (1995:12) continue by mentioning that the virus causing measles is similar to the virus that causes distemper in dogs. Because of the change to an agricultural way of living, people gave up their nomadic existence and close communities were formed, resulting in towns and later in cities. It is here where people started living in very unhygienic conditions with little or no waste disposal. This led to waterborne infections like cholera, typhoid and infantile gastroenteritis. The pathogenesis of disease in Syro-Palestine is no exception to the rules of worldwide spreading of disease. Each geographical area nurtures its own array of diseases, some healthier than others, others more detrimental to humans than others. To overcome these ecological facts, mankind's cultural response was tested.

The pattern of infections in tropical countries has changed little over centuries, mainly because of limited civilised development in these countries. We find then that presently the disease culture may be the same as in past millennia. In general chronic infections do serious damage to important organs of the body; liver and kidney damage in *schistosomiasis*, the heart in *trypanosomiasis cruzi*, the lungs, bone and lymph nodes in tuberculosis. The bone marrow reserves are affected through malaria and hookworm infections, the intestines in tropical sprue and the nervous system in leprosy. These disease conditions produce chronic ill-

health in millions of people today and it is safe to say that it affected percentage wise the same in ancient times (Edwards 1995:66).

The response of the Israelites inhabiting Syro-Palestine for many centuries was adherence to their religious terms and the Deuteronomistic laws and sanitary codes laid down by Moses. This may have been their salvation in this arid landscape. Their set apart lifestyle and dietary laws were unlike any other nation in biblical times (McGee 1997: s.v. Infectious diseases).

3.6.4 The impact of old Israelite culture on disease and mortality

To understand the impact of the biblical cultures on disease and mortality it may help to view this cultural phenomenon within the boundaries of the biblical Scripture. Deist distinguishes between the world *in* the text and the world *of* the text. This distinction is for discerning the cultural function of a text in its world of origin (or later reception). It neglects a very important aspect of the cultural world of the biblical text, namely the cultural world discussed or presupposed by these texts. One therefore has to distinguish between the cultural world pictured, discussed and affected by a text. One can only begin to speak of or evaluate the rhetorical or ideological function of a text in a particular environment once one has established the relationship between the cultural world pictured in the text and the real world *discussed* in the text. The texts create a world and we do not know how far they reflect reality (Deist 2000:228).

Tax (1964:68) has observed that natural selection operates through either differential mortality and/or differential fertility and that some causes of death such as infanticide, accidents or warfare are the direct results of cultured activity. The remarkable sanitary code that the Israelites had in the time of Moses (Lv 15) rendered them relatively disease free in comparison with surrounding nations who did not have such strict sanitary laws (see also Janssens 1970:16). Douglas states that Israel as a nation might not have survived their time in the wilderness, or the many vicissitudes through which they passed, without their sanitary code

(Douglas 1996: s.v. Hygiene and sanitation). The sanitary code deals with public hygiene, water supply, sewage disposal, inspection of food, and the control of infectious disease. McGee (1997: s.v. Infectious disease) believes that the most interesting aspect about the code is that it implies knowledge which in the circumstances of the Exodus and the wilderness wanderings they could scarcely have discovered for themselves, for instance the prohibition to eat pigs and animals who died of natural causes, the burial of excreta and the contagious nature of some diseases. The spread of disease was thus effectively controlled. The word *quarantine* comes to mind as the Jewish use of a period of forty days of segregation for patients with certain diseases (Lv 12:1-4). McGee states that the drawing of blood from slaughtered animals eliminates certain germs and spore of infectious diseases. The code also excluded from their diet animals particularly liable to parasites to which the consumer may also be allergic; the pork meat acts as a protein allergen (McGee 1997: s.v. Infectious disease).

McGee concludes that throughout the history of Israel the wisdom of the ancient lawgivers in these respects has been remarkable. In times of pestilence the Jews have suffered far less than others. As regards longevity McGee relates that in Prussia the mean duration of Jewish life averages five years more than that of the general population. There were times when the life expectancy of the Jews was actually twice that of their gentile neighbours (McGee 1997: s.v. Disease). This fact and other facts regarding diseases that leave lesion on bones will be discussed in later chapters.

3.6.5 Paleodemography of the inhabitants of Palestine

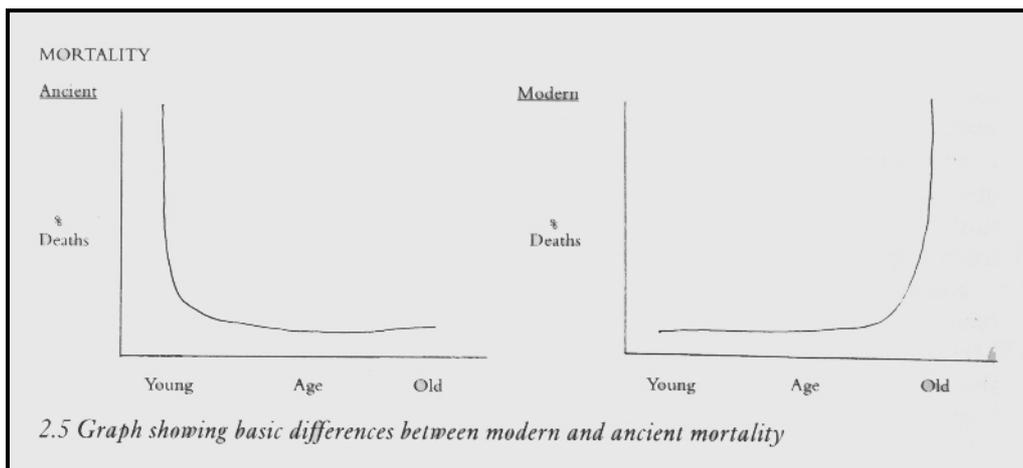
Paleodemography is the study of ancient human populations, including their size, growth, density, and distribution, as well as statistics regarding birth, marriage, disease, and death (Microsoft Encarta 2004: s.v. Demography; Angel 1969:427). In this study basically only the life expectancy and the disease elements of paleodemography will be addressed.

The difference in the statistics of birth and of death tabled and averaged would result in life expectancy. Angel (1969:430) believes that mortality is less important in relation to group survival than is disease, up to the point where the death rate reverses a population's natural increase. Health is the critical factor in the survival and physical efficiency of a population because sick people are more of a handicap to a society than a few deaths. Thus adult longevity is the best single measure of adult health and social functional efficiency. Infant death ratio sheds light on adult female health stresses and the child death ratio indicates the stresses during growth which may predispose toward adult illhealth (Angel 1947:18). Boshoff and Steyn (2000:73) report a skeleton found in Limpopo which was estimated to be an adolescent individual aged between 14 and 17 years old, with signs of chronic disease apparent. What makes this case unusual is that adolescent individuals are not commonly encountered in the skeletal record, as people are usually healthy during this age period. In communities where the mortality rate of infants and children are high and the life expectancy is low, then it is most likely that the middle range of ages (adolescent) would be the healthiest period. An increase or decrease in life expectancy is important for the studious paleopathologist for determining social health changes in a society. A decrease could demonstrate epidemiological, famine or periods of war while an increase may point at an improvement in socioeconomical conditions within a society in ancient times, according to Angel (1947:19). He warns that such an increase in modern times would lead to other social issues, as overpopulation is only but part of the issue.

3.6.5.1 *Life expectancy in general*

The life expectancy in the biblical world differed immensely from one country and nation to another and seems to be directly proportional to the economic and cultural state of the country concerned. Van den Heever and Scheffler (2001:40) give some statistics and notes on disease in the Greco-Roman world. The health of most people were severely compromised, mainly because of the general, even universal unhygienic conditions that prevailed almost everywhere. Quality of life

for those who made it to adulthood, must have been atrocious. Parasites were very common in everyday life and half the hair combs excavated at Qumran, Masada and Murabatt were infested with lice and nits, probably reflecting conditions elsewhere (Zias 1991:148). The Greco-Roman cities were pest holes of infectious diseases. The landless people migrated to urban areas in search of employment. The opening up of new labour force opportunities were not because of economic growth but rather because of the high mortality rate due to the dreadful health conditions among the urban non-elite. The infant mortality rates averaged thirty percent or more. The life expectancy was very short, compared with modern day Western standards. Children in general, suffered from disease and malnutrition. About sixty percent of those who survived their first year of life would be dead by the age of sixteen. A child born among the lower classes during the first century had a life expectancy of little more than twenty years (Van den Heever & Scheffler 2001:40).



The graph clearly shows the differences between modern and ancient mortality as well as initial life expectancy at birth albeit not in years (Roberts & Manchester 1995:25).

Acsádi and Nemeskéri (1970:155) give an abridged table of the Taforalt cave population in Morocco in the Neolithic Era and the most characteristic value of the table is the expectation of life at birth: a remarkable 14,7 years. To put this in context, the life expectancy changes as survival continues. This is clearly demonstrated in the 'Ulpianus' life table that Acsádi and Nemeskéri used to

determine the life span and mortality in the Roman Empire. The expectancy of life between 0-20 is 30, 20-25 is 28 and so on to 60 when life expectancy is only 5 years (Acsádi & Nemeskéri 1970:217). The average life span of slaves in the Roman Empire era was only 17,5 years, that of the clergy a sizeable 58,6 years, measured on the same table (Acsádi & Nemeskéri 1970:224).

In observations made on the pathology of the Jewish population in Israel (100BC – 600CE) Arensburg et al. (1985:75) note that the average life span was considerably lower among women than for men and that it is very likely the result of high rates of maternal mortality which in fact was a worldwide phenomenon in ancient times.

3.6.5.2 *Life expectancy of infants*

Amongst all the observations made from statistics of excavation sites and the resultant tables which are drawn up, it is usually noticeable to the extreme that there are very few statistics of children noted. In the description of Arensburg et al. (1985:80, table 4), there were only five unsexed children's crania found amongst Jewish remains from several periods in Israel in their study field. These five crania were found alongside 196 crania from other age groups. Even from birth to six years the relation was still only 34 children against 167 adults.

In Janssens' own observations of the Natufian period excavations in Erg-el-Ahmar in Palestine he found one child, two adolescents, two adults (20-30 years) and one over thirty years. He also found amongst Neanderthals 80% to be dead by the age of 30 and 95% by the age of 40 (Janssens 1970:60). Janssens' attempt to find an answer to this situation leads to acknowledging that the mortality among children must be higher as seen from the above. Are children's skeletons less well preserved in the soil? The answer may be that taphonomic processes that have taken place. Janssens describes statistics produced in St Urner-en-Plomeur (Bretagne) where soil is remarkably good for preservation. In Iron Age excavations where 225 skeletons were found, a total of 50% of these

skeletons were of babies' and young children's skeletons that were found (Giot & Cogne 1951 in Janssens 1970:9). Alesan (1999) discusses the bias that was identified in the case of children, mostly affecting infants but also children between the ages of 1 to 5. This was interpreted as a census error due to taphonomic reasons and to an exclusion of differential funeral rites. For example, a life expectancy at birth may be 28 years, estimated from observed data. When the bias was removed, the estimated life expectancy at birth dropped to 23 years. The use of the 'Brass logit' system that makes allowances to sketch a possible mortality profile for this 'vanished' population: low life expectancy, high infant mortality and hard life conditions are perhaps the cause of the low levels of survivorship in old age (Alesan et al. 1999:285). This problem will also be described under 'taphonomic processes in infants' in Chapter 4 where an attempt is made to answer the question of 'where have all the children gone?'

3.6.5.3 *Adult life expectancy*

Cohen (1949:222) relates that life expectancy in Israel was rather short, but did not mention figures. According to the Talmudic chronicle, Rabbi Meir visited the town of Mamla and noticed that all the inhabitants had *black hair*. The reason being that the people died young there, and there were no grey haired men or women. He asked them, 'Are you descended from the house of Eli, of whom it was written, "all the increase of thine house shall die in the flower of their age?"' They replied, 'Rabbi, pray on our behalf', and he said to them, 'Go, occupy yourselves with charity and you will be worthy of reaching old age' (Cohen 1949:222). I do not believe that increasing the life expectancy statistics that easily, but it is worth doing for various other reasons.

Life expectancy in the biblical world varied between 30 and 45 years while some scholars estimate that the average life expectancy in the Greco-Roman Empire was as low as 25 (Craffert 1999a:8-9). Craffert concurs with Janssens and others that women generally lived much shorter than men. Girls also died earlier than boys – which might have something to do with better care for boys. Craffert also

mentions that the child mortality rate was 30%. He compares this rate to a current modern mortality rate of 25% among children in third world countries, and a life expectancy of 40 years. Dio Chrysostom, a contemporary of the gospel writers, sums it up:

Men, however, who are so fond of life and devise so many ways to postpone death, generally did not even reach old age, but lived infested by a host of maladies which it were no easy task even to name, and the earth did not supply them with drugs enough, but they required the knife and cautery as well [Dio Chrysostom, Diogenes 6:23, translated by Cohoon 1961:263] [Craffert 1999a:9,10].

The proverbial 'three score years and ten' life expectancy in the book of Psalms which translates in modern literature as 70 years, must by statistical figures as mentioned above, have been many years less.

The days of our years *are* threescore years and ten; and if by reason of strength *they be* fourscore years, yet *is* their strength labour and sorrow; for it is soon cut off, and we fly away [Ps 90:10 in the KJV].

And in the NKJV:

The days of our lives *are* seventy years;
And if by reason of strength *they are* eighty years,
Yet their boast *is* only labour and sorrow;
For it is soon cut off, and we fly away [Psalm 90:10, NKJV].

Nevertheless, as would be expected, some individuals did reach a very advanced age in biblical times and passing references to such individuals are common (e.g. Gn 24:1; 1 Ki 1:1). Jones (1992:5,67) states that life expectancy in the biblical world averaged 30 to 40 years. The advances of Greek society alone are credited by some with the extension of average longevity of about five years to roughly 40 – 45 years. It appears that during the Roman period in Jericho, one fourth of the population survived beyond 50 years. These statistics are not shared by many scholars.

3.6.6 The socioeconomic profile of the later Iron Age period in Palestine

This period was typical agriculturally oriented according to Malina et al. (1996: s.v. Socio-economics). Eighty to ninety percent of the population were farmers who eked out a living on small farms. Most of the rural people were poor and illiterate. Wealth was restricted to a small group of the elite in the cities, like the aristocracy, the religious and the military leaders. This group totalled only 2 – 5% of the population but was served by the large group. The city chiefly centred around the needs of the elite group. The basic configuration of modern cities did not exist (like sewerage and running water). Because of the dense population in the cities, their general conditions were appalling. Bad hygienic conditions in the cities (and in the country) and meagre medical services led to a high death rate (Malina et al. 1996: s.v. Socio-economics). Endemics and epidemics, famine and malnutrition were part of everyday life. The cities in particular were breeding grounds for various kinds of diseases.

3.6.7 The personal effects of a culture of illness and disease

In a society of a life expectancy of a mere mean average of less than thirty years, death was lurking around every corner. Not only did people die from an array of incurable diseases (for that time), but seldom did many years pass without some form of war, be it offensive or defensive, with the usual horrors of war to follow. Not only did man wage war against man but also against women and children as many a city was annihilated, sometimes even ordered by Yahweh; to strike the enemy with anathema (Orr 1997: s.v. Anathema).

Life was hard beyond comprehension of modern mankind. Life comprised of pain and suffering from birth to grave. As we have seen, few people if any died of what is commonly known as old age. Pain was in fact a common denominator in all ancient people (Craffert 1999a:5; Jones 1992:5,69; Goldstein 1969:286). It has long been known, says Goldstein, that on the basis of paleo-osteopathology, that mankind has suffered disease and pain throughout its biological history

(Goldstein 1969:286). Pain by definition gets new meaning when one has to consider that painkillers like any other medicine were either non-existent or extremely primitive. Modern humankind usually uses toothache as a measure of pain, but seldom realises the morbidity of dental disease *per se*. Scholars estimate that about 5% of all deaths were caused by dental disease (Craffert 1999a:5). Surgical operations were not generally part of everyday medical treatment in Palestine, nor in most other countries. This premise does of course not include circumcision as a proper operation. The few recorded evidences of trepaning however confirm operations and this phenomenon is mentioned here to emphasize the excruciating pain an operation of this magnitude would have caused the patient. Other known surgical procedures may have been amputaion of a limb in emergency situations.

3.6.8 Disease and illness

It must be made clear that disease does not equal illness, nor vice versa. Craffert gives the definition: '...diseases in the scientific paradigm of modern medicine, are abnormalities in the structure and funtion of body organs and systems while illnesses are experiences of disvalued changes in states of being and in social function' (Craffert 1996:11). The definition of Kleinman et al. 1978 (in Craffert 1996:251) concurs that disease refers to the malfunctioning or maladaptation of biological or psychological processes as opposed to illness as the experience of disease or perceived disease. Illness and infection are not synonymous. One can be ill without any invasion of the soma of microorganisms, for example germs, viruses and bacteria. A headache that causes nausea and the experience of feeling ill can be the result of stress. A person may have no experience of illness, but may have a life threatening disease with the likes of high blood pressure. Furthermore every person harbours many different colonies of bacteria or viruses that are not disease producing because they are kept in check by the human immune system.

3.6.9 Diseases and sickness in biblical texts and culture

Diseases, according to Capasso (2000:14) evolve over time. The causes of diseases and the victims of the diseases coevolve under the laws of natural selection (the basis of Darwinism). These laws will be applied to the study of human pathology and used to reconstruct the phylogenetic relationship of extant human diseases.

The discovery of the natural history of disease of the Syro-Palestine coevolving with the population can shed new light not only on the origins of modern diseases, but can also reveal the trends in the relationships between humans and their diseases (Capasso 2000:15). Unfortunately our current paleopathological knowledge of the region is very limited, not only because the materials are scanty and poor, but primarily through disinterest in this field and other reasons that will be discussed in Chapters 5 and 9.

3.6.10 Reading of biblical texts on diseases

3.6.10.1 *Biblical references to disease*

Disease and sickness have plagued the human race since God evicted Adam and Eve from the Garden of Eden according to the Old Testament. God curses the guilty couple with pain in birth and discomfort associated with corruption and rebellion against the created order, as we find in Genesis 3:16-19.

To the woman He said:
'I will greatly multiply your sorrow and your conception;
In pain you shall bring forth children;
Your desire *shall be* for your husband,
And he shall rule over you.'

Then to Adam He said, 'Because you have heeded the voice of your wife, and have eaten from the tree of which I commanded you, saying, "You shall not eat of it":

'Cursed *is* the ground for your sake; In toil you shall eat *of* it
All the days of your life.

Both thorns and thistles it shall bring forth for you, And you shall eat the herb of the field.
In the sweat of your face you shall eat bread, Till you return to the ground,
For out of it you were taken;
For dust you *are*,
And to dust you shall return'.

God gave the earth to the children of men to be a comfortable dwelling place, but after the sin of Adam and Eve it is now cursed. Yet Adam is *not* cursed himself, as the serpent was, according to Henry & Scott (1996) on these four verses:

Adam's employments and enjoyments are embittered to him. Labour is now part of his duty, part of his sentence. Uneasiness and weariness with daily duties is his just punishment. Had Adam not sinned, he would not have died. Now death ends his punishment. Travailing pains would now be part of humankind. Henry describes the crucifixion of the Son of Man in line with humankind's suffering. Sin brought death, Christ died; travailing pains came with sin, the travail of Christ's body and soul on the cross; curse came with sin, Christ's crucifixion was the ultimate curse; thorns came with sin, Christ wore a crown of thorns; sweat came with sin, Christ's ultimate bloody perspiration; sorrow came with sin, Christ was a man of sorrows, his soul was exceedingly sorrowful in his agony [Henry & Scott 1991: s.v. Gn 3:16–19].

Although not history but rather seen as reflection on suffering and death, Genesis 2:17 adds to this: Exiled from Eden because of their sin, Adam and Eve became progenitors of a race imperfect in body and spirit. The tree of life is denied them:

but of the tree of the knowledge of good and evil you shall not eat, for in the day that you eat of it you shall surely die [Gn 2:17].

In general, obedience to God's commands and laws is said to afford freedom from disease. Henry sees God as the great Physician. If we are kept well, it is He who recovers us. He is our life and the length of our days. We are kept from destruction and delivered from our enemies, to be the Lord's servants (Henry & Scott 1996: s.v. Ex 15:26).

...and said, 'If you diligently heed the voice of the Lord your God and do what is right in His sight, give ear to His commandments and keep all His statutes, I will put none of the diseases on you which I have brought on the Egyptians. For I *am* the Lord who heals you' [Ex 15:26].

The opposite is also asserted: disobedience of God's laws violates a moral ecology of which created physical nature is also an expression, and the consequence is disease, versed in Isaiah 1:5-7:

Why should you be stricken any more? You will revolt more and more; the whole head is sick, and the whole heart faint. From the sole of the foot even to the head *there is* no soundness in it; *only* a wound and a stripe and a fresh blow; they have not been closed, nor bound up, nor soothed with oil. Your land *is* wasted, your cities burned with fire. Strangers devour your land right before your eyes, and *it is* wasted, as overthrown by strangers [Is 1:5-7].

In Deuteronomy 32:39 God reveals His omnipotence, sometimes in relation to His power over life and death. Remarking on Deuteronomy 32:39, Henry and Scott state that whatever judgements are brought upon sinners, it shall go well with the people of God.

'Now see that I, *even I, am* He,
And *there is* no God besides Me;
I kill and I make alive;
I wound and I heal;
Nor *is there any* who can deliver from My hand [Dt 32:39].

In Old Testament times, God was associated with healing. Malachi 4:2 for example spoke of the Sun of Righteousness rising with healing in his wings:

But to you who fear My name
The Sun of Righteousness shall arise
With healing in His wings;
And you shall go out
And grow fat like stall-fed calves [Mal 4:2]

The effect of the judgement on the righteous, is contrasted with its effect on the wicked (Mal 4:1). To the wicked it shall be as an oven that consumes the stubble (Mt 6:30). To the righteous it shall be the advent of the gladdening Sun, not of condemnation, but of righteousness; not of destroying, but by healing (Jr 23:6) (Jamieson et al. 2000: s.v. Malachi 4:2).

David praised God as the One that heals all your diseases in Psalm 103:3:

Who forgives all your iniquities,
Who heals all your diseases.

Barnes sees this pronouncement as referring to some particular instance in which the psalmist had been recovering from a dangerous sickness. The Hebrew word rendered 'disease' as *tachālū'iyim* which should be translated as 'sickness' in Deuteronomy 29:22; it is 'diseases' as in Psalm 103:3, 2 Chronicles 21:19 and in Jeremiah 14:18). The thinking here in Psalm 103:3 is that it is proper grounds of praise to God that He has the power of healing disease. Whatever the skills of the physician are, healing virtue comes from God alone (Barnes 2000: s.v. Psalm 103:3).

3.7 CONCLUSION

To conclude this chapter, the following biblical verses dealing with sickness and disease may be recognized in their modern equal form.

- Wasting diseases, suggesting tuberculosis that would leave lesions in skeletons: Leviticus 26:15, 16.
- Skin infections, probably scurvy or a disease called itch that is far more malignant in the Middle Eastern countries than elsewhere (Jamieson et al. 2000: s.v. Deuteronomy 28:27). It is highly unlikely to have left any bone lesions.
- Affliction resulting from sin. In Psalm 107:17 and Isaiah 3:16, 17. This verse may refer to a sexual disease. As seen in Chapter 6, the chances of referring to syphilis are rather remote seeing that *bejel* was more prevalent in Syro-Palestine in biblical times. Gonorrhoea was probably the better diagnosis.
- Epidemic outbreak of tumors, as found in 1 Samuel 5:9: most scholars believe this to have been severe cases of haemorrhoids (emerods) with probably no bone lesions apart from Harris' lines.
- Famine, described as scarcity of food in Leviticus 26:26 and 1 Kings 17:7-16. Nutritional deficiencies invariably would have left lesions in bone, more so in children and infants, producing cribra orbitalia, Harris' lines and dental hypoplasia.

CHAPTER 4

BIBLICAL DISEASES AND OSTEOLOGY IN PALEOPATHOLOGY

Paleopathology may be regarded as a subdivision of medicine or as a branch of general medical science which has at its disposition human remains, and has to rely mostly on skeletal remains in the region of Syro-Palestine from archaeological sites. The study of the occurrence and the traces of diseases in individuals and in populations is an element of this discipline, so it is necessary to understand the influence of a specific environment and the culture of the population (Živanović 1982:5). Miller et al. (1996:224) advocate a thorough knowledge in osteology, anatomy and histology of bone tissue as a prerequisite for accurate diagnosis of paleopathological conditions in human and faunal remains. The knowledge of histology of bone tissue is necessary to understand the ways that bone responds to various influences and conditions that affect it. Hence I deemed this chapter important in the holistic approach to paleopathology.

4.1 DISEASES THAT LEAVE SKELETAL SIGNS

This section will concentrate on diseases and epidemics in biblical times that leave lesions and signs on and in the remains of ancient populations in the region of Syro-Palestine. As discussed earlier, there are many scholars who insist that very few diseases leave lesions on bone; others still insist that it is factual that most epidemic conditions are acute illnesses that lead to death before the disease can make an imprint on the skeleton (Zias 1991:149).

To a certain degree I would respectfully disagree with these learned scholars in some of their statements. In some regards their remarks may be relatively true, like the use of the phrase 'few diseases leave signs and lesions' on bone. There are a number of acute illnesses like malaria and various helminthic diseases that

does not lead to immediate death, but becomes chronic conditions that do have time to have an influence on the skeleton. These lesions are present in the form of Harris' lines and dental hypoplasias (see Chapter 7). The archaeologist of a century ago who was confronted with a skeleton to diagnose a disease from the signs and lesions present in the subject, may sometimes have done so in a fair number of cases in some specimens. Paleopathology as a science has developed to such a finely tuned art that I believe a high standard of accuracy is now the expected norm. The worrying factor is more 'the ones that got away' – the skeletal specimens that were macroscopically inspected but little or no pathology was found because of the lack of sophisticated technological equipment that had not yet been invented in the nineteenth century. Far too many of these skeletons were hastily reinterred to comply with the laws of the land.

There is however no comparison to be drawn with a twenty first century highly specialised paleopathologist looking at the same specimen. Admittedly, both may be equally competent in the observational stage of the macroscopical study but that is where the comparison ends. With modern technological advances in the field of medicine and secondary thereto, in the paleopathological field, the diagnostical possibilities are at a level never even dreamt of by earlier scholars. Technological advances have not reached their peak by far and can with conservative estimations double every ten years (see the cellphone and computer industry from 1985 – 2005). It is almost frightening where this may lead to in the near future, not only in the paleopathological discipline, but in every field of technology.

The technology of X-rays, even computed axial tomography (CAT-scans), and electron-microscopical research is considered to be old-fashioned compared to the chemical analysis technology of deoxyribonucleic acid (DNA) and other relevant studies. What this may mean is that diseases of many enigmatic natures cannot hide from scientific progress anymore. New worlds of scientific studies are opening up at an alarming rate because it may possibly just prove decades of scientific studies obsolete and many scholars wrong.

There will come a time when all scholars will accept that there are proven methods to show that even acute epidemic diseases can be shown to exist in the skeletal remains of human beings with present day technology, and this may be sooner than later.

In a review of diseases and related problems of biblical times, certain conditions will be left out because of the enigmatic background thereof and which may forever be unsolved and undiagnosed. The sudden deaths of Ananias and Sapphira are described in Acts 5:1-10. The cause of death may never be determined through lack of information. It may however be a tactic devised by the author of the book of Acts to warn his readers, the early Christians, that you cannot evade the wrath of an omnipresent God whenever you attempt to deceive him.

4.1.1 Classification of bone diseases

In the bioculture of the discipline of paleopathology, most of the material under assessment for diseases are obtained from skeletons, hence the classification exclusively for diseases found in bone:

- a) *General infections of bones*
 - Osteitis
 - Periostitis
 - Osteoporosis
 - Osteomyelitis
 - Tuberculosis
 - Leprosy
 - Treponematosi
- b) *Tumors of bone (neoplasms)*
- c) *Diseases of joints*
 - Arthropathies
 - Arthritis

- Rheumatism
- Rheumatoid arthritis
- Osteoarthritis
- d) *Diseases of the jaws and teeth*
 - Caries
 - Periodontal disease
 - Abscesses – chronic and acute
 - hypoplasia

Many of the above mentioned diseases were present in the population from the beginning of the history of mankind and still prevail amongst the nations of the region, even up to the present time. It has been shown in the coprolite studies that certain species of worms were prevalent throughout, starting with the Neanderthal population and the Natufian population from 10 000 BCE to the Early Bronze Age period of 3 500 BCE. Dental caries as well as periodontal disease were some of the other general diseases during the same period.

It must be stressed that most diseases were not known by the same names as we have today and some diseases were not even recognized as diseases as such, like tuberculosis and polio which was rather seen as a punishment because of sins: as in John 9:1 (Gowers 1987: s.v. Medicine).

And His disciples asked Him, saying, ‘Rabbi, who sinned, this man or his parents, that he was born blind?’

... and in some texts as signs of demon possession as in Matthew 12:27:

‘And if I cast out demons by Beelzebub, by whom do your sons cast *them* out? Therefore they shall be your judges.

Since the whole of the biblical literature is pre-scientific, the nature of disease and illnesses as it is described, presents problems and difficulties in the interpretation thereof. To make matters more interesting we will have to place the description of a disease within a designated genre and then decide on the context in which it was written before attempting to make an informed decision on the diagnosis. In

other words, decide whether it is an objective historical account or if it is a nonobjective or tendentious account (Sussman 1992:6,7). The problem is not simplified by some clearly tendentious references to diseases like that found in Leviticus 26:16, which rely on empirical reality to some extent:

I also will do this to you: I will even appoint terror over you, wasting disease and fever which shall consume the eyes and cause sorrow of heart. And you shall sow your seed in vain, for your enemies shall eat it.

The approach will be to interpret biblical descriptions and references to diseases and their symptoms in terms of modern day scientific medicines. At times the reading of the literary description too literally may, according to Sussman (1992:6,7), lead to conclusions far from the ancient reality or even the author's intention. Sussman refers to the 'hardening' of Pharaoh's heart in Exodus 4:21:

...But I will harden his heart, so that he will not let the people go.

and Exodus 7:3:

And I will harden Pharaoh's heart, and multiply My signs and My wonders in the land of Egypt.

The hardening of Pharaoh's heart has been taken as representing coronary arteriosclerosis. This error results from translations and not from the Hebrew text, where *'ahazeq* (from *hazaq* – to grow firm, strong) is used, suggesting that the reference is to Pharaoh's resolve, rather than to a heart disease (Sussman 1992:6,7).

It is thus important and necessary to carefully analyse the meaning of the crucial descriptive words (medical terms) used in the text. The use of these words in cognate languages and their use in connection with observable or well known phenomena is helpful (Sussman 1992:6,7). To further assist the diagnosis Sussman suggests that when a common disease is suspected, account must be taken of social, economic, cultural and other factors that may influence the prevalence or the incidence of a particular disease. A simple example is the association between gastro-intestinal infections and the use of cisterns for long

term storage of water. The water is likely to become polluted with sewage, especially in densely populated areas. Profound diarrhoea is suggested by Sussman (1992:6,7). In 2 Chronicles 21:15, as will be seen later, these illnesses do have an effect on the skeleton (see Chapter 7).

and you *will become* very sick with a disease of your intestines, until your intestines come out by reason of the sickness, day by day.

And dysentery is referred to in Acts 28:8:

And it happened that the father of Publius lay sick of a fever and dysentery. ...

The findings of paleopathological examinations at archaeological sites can yield direct evidence about the nature and distribution of disease. Sussman believes that the critical application of modern medical knowledge together with the principles of epidemiology, will often lead to a possible diagnosis with a calculable probability of being correct (Sussman 1992:6,8). Sussman also warns that the author or editor of a biblical text may not have described actual events regarding an illness but rather an interpretation of history of his own experience. A variety of medical traditions may have influenced these authors and editors. Some of the earliest influences in the Old Testament are likely to have been Egyptian and Mesopotamian and later on influences of the Graeco-Roman world (Sussman 1992:6,8).

4.2 OSTEOLOGY IN PALEOPATHOLOGY

Most of the descriptive literature in skeletal paleopathology (see 5.2) depends on the scholars' knowledge of gross bone pathology according to Ortner and Putschar (1981:6). To understand the pathology of bone it is imperative first to understand the normal anatomy and physiology of bone. The description of morbid conditions in the skeleton depends on the fundamental ways that bone cells respond to the stimulus of disease (Ortner & Putschar 1981:36; Miller et al. 1996:224).

4.2.1 Bone as an organ of the body

Bone is in many aspects an extremely important organ of the human body. The functions of the skeleton are:

- It protects and sustains the soft tissues of the body, especially the all important organs like the heart, lungs and brains.
- Through providing attachment to all muscles, bone makes movement possible.
- Bone provides the biological mechanism (hematopoiesis) by means of the bone marrow which is an important source of erythrocytes (red blood cells).
- Bone provides a hard framework that supports and anchors soft organs of the body.
- Bones provide storage of fat in the internal cavities. Bone matrix itself serves as a storehouse or reservoir of macrominerals like calcium and phosphorous, potassium, sodium, sulphur, magnesium and copper. Stored mineral can be released into the bloodstream in ionic form when necessary (Marieb 1992:158; Roberts & Manchester 1995:65).

The study of bone is called osteology, from Greek *osteo* – bone and *logos* –word or treatise. As far as the discipline of paleopathology goes, bone is described as the most ubiquitous source of paleopathological data that can be found (Miller et al. 1996:221). A working knowledge is therefore essential concerning its structure and its chemistry and in understanding the changes it undergoes when under the influence of injuries and diseases that directly attack bone tissue or indirectly through the surrounding soft tissue.

4.2.2 The physical and biophysical structure of bone

4.2.2.1 *The physical properties and histology of bone*

Bone tissue develops from fibrous membranes and hyaline cartilage at about six weeks intra-uterine. When a bone forms from a fibrous membrane, the process is called *intramembranous ossification*, and the bone is called a membrane bone. Bone formation from hyaline cartilage is called *endochondral ossification*, and the resultant bone is called cartilage bone. Membrane bones are all flat bones like the skull and the clavicles. Three steps take place to form proper bone (Marieb 1992:160):

- formation of bone matrix within the fibrous membrane;
- formation of woven bone and the periostium;
- formation of compact bone plates.

The endochondral ossification process begins in the third month of development and is more complex. The processes are according to Marieb (1992:164):

- formation of a bone collar around the shaft of the hyaline cartilage model;
- cavitation of the hyaline cartilage shaft;
- invasion of internal cavities by the periosteal bud and spongy bone formation;
- formation of the medullary cavity;
- ossification of the epiphyses.

During infancy and childhood, long bones lengthen entirely by growth of the epiphyseal plates, and all bones grow in thickness by a process called *appositional growth*. Most bones stop growing during adolescence or in early adulthood. However, some facial bones like the nasal bones and the mandible, continue to grow almost imperceptibly throughout life (Marieb 1992:187) .

4.2.2.2 *Bone remodelling*

Knowledge of bone remodelling is important in the differentiation between normal bone and diseased bone for the remodelling area is a distinct trait of previous disease or fracture, much needed in the diagnosis of potential paleopathology. In adult skeletons, bone deposit and bone resorption occur at one time or another at all periosteal and endosteal surfaces. According to Marieb (1992:166) this process constitutes bone remodelling. She explains the process in healthy bone; the mass stays constant, indicating that the process of resorption and deposit takes place at an equal rate. However, there is a time lapse between the phases causing remodelling not to be uniform. In the femur for example, the distal part is fully replaced every six months, whereas its shaft is altered much more slowly. Buikstra and Cook (1980:453) state that bone remodelling is sensitive to environmental stress factors and therefore it is a viable indicator of general health.

4.2.2.3 *Bone deposit*

Bone deposit occurs when a bone is injured or when stronger bone becomes necessary (e.g. physical work or exercises). Sites of new matrix deposits are seen in the presence of an *osteoid seam* (an unmineralized band of bone matrix about 10 to 16 μm wide). Calcification takes place within days when calcium and phosphate salts precipitate and tiny crystals of *hydroxyapatite* form. The enzyme *alkaline phosphatase* is essential for this process to take place (Marieb 1992:167). Macroscopically and microscopically distinguishable, deposits must be taken into consideration when making a diagnosis of possible pathology, as is the necessity to identify resorption. It must be taken into account that because of the general lack of human remains material in Syro-Palestine, it cannot be afforded to leave anything to chance. These macromorphological markers or symptoms should be recognizable by every archaeologist in the field.

4.2.2.4 *Bone resorption.*

Bone resorption is accomplished by osteoclasts. These are large cell-like macrophages. Through an enzymatic process that digests the organic matrix and the conversion of calcium salts into soluble forms, demineralization occurs. Osteoclasts then *phagocytise* the demineralized matrix. Calcium and phosphates when released, enter the interstitial fluid and then into the bloodstream (Marieb 1992:169).

4.2.3 **The biophysical properties of bone**

Numerous biophysical factors can influence the mineral composition of bone tissue (Živanović 1982:11):

- The lack of activity leads to a loss of mineral components from the matrix.
- Physical exercise or manual labour leads to a build-up of mineral components. Seeing that up to ninety percent of the population in biblical times were involved in agriculture, manual labour was most common, and their bone structure accordingly robust.
- Biochemical factors such as food and the hormonal action of the *parathyroid* and *thyrotropic* hormones of the anterior lobe of the pituitary gland, have distinct influence on bone.
- The action of Vitamin D on the skeletal tissues in conjunction with sunlight, of which Palestine had no shortage, is essential.

All these considerations (4.2.2.1 through 4.2.3) must be borne in mind when studying bones from archaeological sites. The mineral composition, structure, weight and the porosity of bone tissue are equally important in the study of osteology in paleopathology. Even as there is a possibility of the loss of calcium salts from the bone tissue leading to the onset of *osteomalacia*, so too is there an opposite process leading to a deposit of calcium salts in the form of a solid mass. A mild deposit is called calcification whereas a heavier deposit which results in the creation of denser layers in the form of stones in the tissue is known as

petrification (Živanović 1982:115). The process of petrification, also known as petrification, can sometimes be very swift, lasting only a few months. This happens when there is a very high content of calcium in the form of limestone present in the soil and ultimately gets dissolved in the water, as is the case in karst caves and mountain streams. The water would then be saturated with calcium carbonate salts and the process of mineralisation of the bone will start under ideal circumstances. It is therefore important to regard petrified bones very closely and critically. Thus not every petrified bone is ancient, nor is every ancient bone petrified (Živanović 1982:13). Živanović explains that the porosity of bone tissue makes postmortem deposits of mineral components possible through the surface roughness, not only in the trabecular portion but also inside the lacunae. Flooding of the burial area by rain or melting snow leads to the dissolution of salts found in the soil. The water would then be able to penetrate into the trabecular spaces. In the event of subsequent drier periods during hot summer months, the water would evaporate leaving the deposited salts to remain. Over a period of time this process may cause petrification of the bone tissue (Živanović 1982:13).

It happens then that bone tissue that had been interred for a long period, gradually assumes the characteristics of the soil enveloping it. The soil and bone may even form a unity. Bones which have been buried may contain not only inorganic but also organic ingredients; the latter may wash away in time. Water may bring with it material from various objects from the surroundings, like plant material, manures and fertilisers, whether natural or artificial. All this may have an influence on the paleopathological diagnosis (Živanović 1982:15).

4.2.4 The chemistry of bone

Bone is a complex tissue formed of mineralized fibres – a vascular network lying in a collagen matrix that is filled with calcium phosphate crystals. Bone tissue consists of three major components according to Martin and Armelagos (1979:527):

- an inorganic fraction – bone ash;

- an organic matrix – collagen and
- water.

These three components occur in the approximate proportion of 17:20:15 in fresh bone powder. Collagen, a protein, comprises of 90% of the organic portion of dry, fat free bone. Other organic materials include various proteins, reticulin, proteoglycans (ground substances) and water. At the histological level, bone comprises primarily of multi-cellular units called *osteons* (Martin & Armelagos 1979:528). Bone has a cellular matrix which is composed of collagen fibres embedded in a ground substance of muco-polysaccharides. The function of collagen is to provide nucleation centres for initiating the calcification of bone.

The mineralized layers of bone are arranged concentrically around a central vascular canal and are bound to the protein fibres in the form of hydroxyapatite crystals. Also found in bone are the macro-minerals like calcium, potassium, magnesium, strontium, chlorine and fluoride (Price et al. 1985:419).

Postmortem changes in fossilized and archaeological bone are important for the paleopathologist. Diagenetic processes alter the original composition of bone following its decomposition in the earth, through activities such as leaching, decomposition and exposure to ground water. These activities serve to enrich, deplete or substitute for original elements in the bone (Price et al.1985:420). Bone chemistry analysis can provide objective information on diet and subsistence, environment, status, disease, stress, residence and the like.

Archaeological bone chemistry includes chemical studies of human bone and nonhuman faunal remains (mainly bone, but also tooth and shell) from archaeological contexts. Topics of interest are paleodiet studies and in latter times have included extraction of DNA and analysis of lipids, in addition to trace elements and stable isotope studies (Katzenberg & Harrison 1997:265).

4.2.5 Taphonomic processes

One of the commonest sources of error in the diagnosis of paleopathological remains, according to Nawrocki (1995:47), is to be misled into diagnosing abnormalities where none exist. Experienced archaeologists often fail to recognize the many conditions which can mimic disease and overlook the changes, artefacts and simulations which their material may present. This phenomenon is known as *pseudopathology*. The mostly external factors that can cause these changes in human remains is called *taphonomy*.

Nawrocki (1995:49) defines taphonomy as the study of the processes that cause sampling bias or differential preservation in bone or fossil assemblages. Taphonomy literally means 'the laws of burial' (from the Greek *tafo* – burial, *nomos* – laws).

The study of disease free bones (osteology) is essential to understand the patterns of changes that render a specimen to change from a healthy to an afflicted or diseased bone. However nature, through certain ecological processes, may interfere by causing perhaps healthy bone (and other burial remains) to begin to bias or skew the sample, altering or removing individuals from possible future study. In essence, the assemblages of bones examined by scientists represent scattered 'fallout' from the ecosystem and may or may not accurately mimic characteristics of the living community (Nawrocki 1995:50). This is in essence what the study of 'taphonomy' is all about. Nawrocki also refers to the history of this relatively new science as it was initially proposed around the middle of the nineteenth century but has only been established as an organised field of study since the 1970's.

Nawrocki (1995:50) classified and subdivided taphonomic processes into three categories, each subsequent category is generally accompanied by a calculable loss of paleopathological information. Environmental factors are external

variables, such as climate and the effect that animals or insects may have on the remains.

- Chemical influences are due to the presence of water and the chemical composition of the soil.
- Cultural factors are variables that characterise human mortuary activities in the form of embalming and autopsy procedures.
- Individual factors are such as body size and age at death.

Environmental factors are the most likely to affect the osteological remains that will be discussed in this study. Nawrocki (1995:51-52) divides this factor into biotic and abiotic.

4.2.5.1 *Biotic factors*

Biotic factors involve the action or presence of living organisms (Nawrocki 1995:52):

- Large carnivores (dogs, hyenas) are known to scavenge human remains, mostly in the case of cave burials. There is also the possibility that burrowing animals (rodents) may interfere with the natural process of decaying.
- Necrophiliac insects can invade bodies and can cause damage to bones through disarticulation of joints.
- Plant activity may affect remains by their roots that can invade long bones and skulls to create mechanical damage and dispersing remains.
- Roots can also secrete acidic by-products that may etch bone surfaces.

4.2.5.2 *A-biotic factors*

- Abiotic factors include temperature, exposure to water and sunlight, soil pH and depth below the ground surface. At the molecular level, water hydrolyzes collagen proteins which leads to rapid degradation of bone

tissue. Percolation of ground water brings acids and other chemicals into the bone (Nawrocki 1995:51).

The pH of the soil and the water also has detrimental influences on the osseous remains. Nawrocki states that the variation in bone decomposition can be seen within and between individuals in the same community. Different bones of the body, even different areas of the same bone, vary in the amount and distribution of cortical (dense) and trabecular (spongy) bone. Vertebral bodies, ribs, sternum, carpals and tarsals are composed mainly of spongy bone with a very thin cortical covering. Surface area also plays a role in presenting more or less area for taphonomic processes to have an influence on the particular bone. Spongy bone with a large surface area per volume will thus decay much more rapidly. Disease processes and trauma may also affect skeletal preservation. Osteoporosis, characterised by a marked demineralisation of the bone will thus undergo rapid degradation in the soil. Cortical markings by disease, for example *cribra orbitales*, provide an uneven and rough surface, again more susceptible to changes in the buried state (Nawrocki 1995:53).

4.2.6 Bone in infant taphonomy

The statistics relative to researching bone lesions must take every skeleton possible into consideration in the search for specific diseases like this study prepares to do. One of the most enigmatic mysteries of paleodemography that have puzzled scholars for decades is the question of 'what has happened to the infants?' when excavations reveal skeletal remains. The statistical tables drawn up for most archaeological sites clearly show an abnormality regarding the number of infants' and children's skeletons.

Paleodemographers, confronted by such a marked and extended anomaly, have been divided in opinion. Most scholars would without argument accept the scarcity of infants in cemeteries (Guy et al. 1997:222). Some, like Acsádi and Nemeskeri (1970:62) refuse to admit that infants' bones may be worse preserved

in the earth than those of adults. They looked at other explanations. They proposed that children were interred in shallow graves which would have been more exposed to the act of ploughing. Erosion of soil would then also play a role by perhaps washing the remains away. The problem encountered with this proposal was perhaps the location of some cemeteries. These were areas where erosion could not have taken place. Other possibilities were suggested to solve the mystery like: infanticide was suggested and even poor people would get rid of infant bodies in secret (Guy et al. 1997:224). Infant bodies were sometimes deposited in earthenware jars and interred under the floors of homes (Le Roux 1995:109). Le Roux believes that this process should not be considered a normal burial ritual but may be a Canaanite idol burial-ritual to inter an infant beneath the foundations of a dwelling to gain favour from an idol, to Molech for instance. She quotes Joshua 6:26:

Then Joshua charged *them* at that time, saying, 'Cursed *be* the man before the LORD who rises up and builds this city of Jericho; he shall lay its foundation with his firstborn, and with his youngest he shall set up its gates.'

The answer may lie in blaming taphonomic processes that may be responsible for the disappearing of whole skeletons. For many decades scholars realised that their statistical tables were erroneous since they were aware that the headcounts of infants were abnormally low or sometimes even totally unaccountable for (Guy et al. 1997:224). Angel (1969:430), believed that infant remains disappeared more readily than adults and that he even rectified his paleodemographic statistical curves according to this conjecture, which he credited, but was unable to demonstrate.

Guy et al. (1997:225) examined the bone characteristics during the first year of life. Their research led them to examine the bone minerals in these infants. The bones were examined on a quantitative as well as a qualitative data basis. Other tests were done on the mineral matter and mechanical properties, such as compressive strengths relative to densities, and physico-chemical properties of bone (the resistance of the bone to demineralisation or mineral dissolving in an acid medium). The conclusion was reached that the low mineralization as well as

the quality of the bone minerals explain the poor preservation of these skeletons in burials. Under some pressure, notably that of overlying sediments, these skeletons poorly resist crushing into the ground. The bones are then easily attacked by the acid products of organic matter decomposition or by acid soils. Guy et al. (1997:226) put forward that bones can either remain or disappear. The two possibilities suggest the existence of a threshold (before three years of age) separating the two types, the infant type (soft, ill-structured bones, rich in interstitial water and poorly protected against chemical and mechanical aggressions) and the 'adult' type, when bone seems to form within a few months when babies start walking.

Cemeteries excavated in Hungary by Guy et al. (1997:227) were found to contain 0% infants between the ages of 0-1 years. This figure was determined after an anticipated figure of 76 infants were expected.

The paleodemography of Palestine has revealed similar statistics. The answer may lie in a full research in the geological and pedological (scientific study of soils) characteristics of the soil in every region when a questionable statistical abnormality is founded (Živanović 1982:34).

In any comparative study of paleodemographical importance, as well as any paleopathological research based on disease, the study of Guy et al. (1997:227) in this regard must be given serious consideration before statistical values can be produced. In the study of paleopathological signs distinguishable in ancient or prehistorical skeletal remains in a specific demarcated geographical area must not be seen as evidence from which any conclusions from statistical research can be drawn. The influence of possible taphonomic processes must be kept foremost in mind when deciding to scientifically investigate specimens for paleopathological purposes.

4.2.7 Bone in other taphonomic processes

It is clear to see with what difficulties the paleopathologist has to cope. Not only can skeletons 'disappear', for which adjustments must be made in final results, but it must be constantly kept in mind that what one sees macroscopically may not be what one thinks it is. Jones (1992:5,64) describes these pseudopathological changes in human remains as relatively common and such changes as bending or warping of long bones are due to grave soil pressure over time, tracks made by roots or insects which mimic venous or arterial imprints in bone, or scratches and erosions due to carnivorous animals, all of which may appear pathological in their origin.

Such alterations in skeletal remains may be particularly enigmatic – at times one may not be sure if certain lesions in ancient bone represent disease processes or are the result of numerous environmental factors. Jones targets the diagnoses of syphilitic marks on skulls from Egypt from the predynastic period as an example. These skulls were diagnosed as signs of early existence of syphilis, even earlier than in any previously known part of the world (Jones 1992:5,64). These pseudosyphilitic bony changes of the skull resembled true syphilitic bony changes so closely that the claims of ancient syphilis in Egypt remained unchallenged for more than a decade until it was shown that such changes were actually due to a combination of the effects of insects and sandy burials upon the skull. Jones also relates the incidence of *ochronosis* in ancient Egypt which later also proved not to be (Jones 1992:5,64). *Ochronosis* is a rare autosomal recessive condition (Jones 1992:5,66).

X-ray films of the intervertebral discs of Egyptian mummies often present an impression indistinguishable from the densification of the intervertebral spaces characteristic of *alkaptonuric ochronosis* seen in modern cases, and thus several claims for the common existence of *ochronosis* in ancient Egypt have now been shown to be the result of artefacts owing to the processes of mummification (Jones 1992:5,69).

4.2.8 Recent trends in archaeological bone chemistry

One of the most promising lines of bone research is the ability to analyze bone chemically. The latest technology makes it possible to analyze fossilized remains. Isotope studies can reveal information on past climates and information on paleodiets (Katzenberg & Harrison 1997:282). Stable isotope research is used widely as indicators of ancient diets and climatic conditions. Stable carbon isotopes are used to describe maize intensification in agriculture, stable nitrogen isotopes in relationships of diet and stable oxygen and hydrogen isotopes are of great use in determining climate studies using fossilized faunal remains (Katzenberg & Harrison 1997:273-275). Isotope studies open the window of understanding the relationship of paleopathology and paleoclimate and paleodiet, an indispensable link in the chain of understanding the morphogenesis of paleodiseases (Katzenberg & Harrison 1997:282).

4.2.8.1 *Trace element studies*

Trace element analysis as a paleodiet indicator is as important in the osteological make-up as calcium is to the general health of bone tissue. Trace element analysis has largely been replaced by detection and control of diagenesis, mainly for the possibility of discerning. Diagenesis is the recombination or arrangement of constituents (as of a chemical or mineral substance) resulting in a new product (Merriam Webster Dictionary). In this context it would refer to geology.

A multi-element approach as in Katzenberg & Harrison (1997:281), attempts to use multiple indicators for both diet and diagenesis. Trace elements such as strontium (in both bone and teeth) and barium are the most reliable dietary indicators of the various trace elements in bone.

4.2.9 Infections that affect osseous tissue

4.2.9.1 *Traces of diseases, injuries and pathological changes in bone*

Bone tissues and bone as an organ are sensitive to many disorders in humankind caused by the action of internal and external factors that afflict the organism as a whole. Bone reacts to physical and chemical injury, to incorrect diet, to disorders of the metabolism and to hormonal irregularities. Other factors that have influence on bone structure are hereditary influences and those of the environment. Unknown factors are those leading to neoplasms and auto immune diseases.

The response reaction of bones under these attacks differs from, and depends upon functional, inherited and acquired characteristics which influence the behaviour of the bones in changing living conditions (■ivanović 1982:77). It is not always clear why certain diseases affect only certain bones or in some cases a specific bone or even just a part of a single bone. Several other diseases affect the whole skeleton.

In paleopathology the problem arises of how to discriminate between isolated local and generalised disease of the skeletal system. In many cases only parts of a skeleton may be found and if diseased, diagnosis may rest on slender evidence. All diagnoses must be made in the light of many other factors such as geographical and cultural knowledge. ■ivanović (1982:184) explains that if a fractured bone is discovered, it is not known whether it occurred pre- or postmortem, whether it be a physical injury or due to a disease, or in the light of traditional or ritual cultures; the breaking of bones. One also has to be wary of the breaking of bones during life or after death, which may occur for a whole series of different reasons, many of which cannot even today be imagined or explained.

4.2.9.2 *Bone infections*

Infections are those reactions that are caused by physical influence, bacterial toxins or unknown stimuli such as what is seen in arthritis and certain tumours.

The result of an infection is inflammation. Inflammation is described by Agnew (1967) as a condition into which tissues enter as a reaction to injury or invasion of pathogenic organisms or of unknown stimuli. The classical signs of inflammation (due to infection) are: (a) pain (dolor), (b) heat (color), (c) redness (rubor) and (d) swelling (tumor) and occasionally adding (e) loss of function (Agnew 1967: s.v. Inflammation).

Infectious conditions in bone usually result from a primary focus in some soft bodied organ like tonsils, lungs (pneumonia), sinuses, throat or ear. In ancient times (also known as the pre-antibiotic era) these relative insignificant infections of modern times, would be followed by bacteraemia and the consequent haematogenous spread of the pathogens to more distant organs, including bone. Ortner and Putshcar (1981:104) state that for reasons unknown, commonly only a single bone was involved in this secondary infected process in immature individuals whilst in adults multiple bones were infected in two thirds of examined cases. It was also found that in ancient times the tibia and the fibula were the most commonly involved bones (Roberts & Manchester 1995:129).

Other bony responses are derived from tuberculosis and syphilis. Periostitis can be the result of infection or may be sterile (aseptic) due to bruising of the bone periost – resulting in periostosis which is the abnormal deposition of subperiosteal bone (Janssens 1970:72).

4.2.9.3 *Osteomyelitis*

Osteomyelitis is an infectious condition of bone caused by a pyogenic organism. Osteomyelitis is a name which indicates that the solid compact wall of a bone, together with the relatively loose and bloody marrow or medullary interior cavity are affected by the infection. Although not present in skeletal remains, it is medically a known fact that the fibrous covering of the bone, the periosteum, is also affected. Thus all three layers; periosteum, cortical hard exterior and the softer medullary cavity, may be involved in the bone infection. Sometimes the

terms periostitis, osteitis and osteomyelitis are applied respectively to infection of these separate layers. Since bone is a single separate biological unit, such arbitrary division of terms is perhaps superficial (Roberts & Manchester 1995:125) and it is preferable to use the single term osteomyelitis for all infective lesions of bone. Osteomyelitis may remain localised or it may spread through the bone to involve the marrow, cortex, cancellous tissue and periosteum, resulting in a sequestrum of bone tissue with resultant deformity (Agnew 1967: s.v. Osteomyelitis). A sequestrum is defined as dead tissue, usually a bony fragment, that separates from surrounding living tissue. Gradually and intermittently this bony fragment, the so-called sequestrum, together with puss, will be discarded by the body and may extrude through the skin. In effect the enlarged, deformed and mechanically less efficient new bone, called the *involucrum*, may be the sole structural support of the specific skeletal part. These deformities will show clearly on radiographs in paleopathological examination and are frequently seen in diagnosed traumas of males, usually suspected to be soldiers (Roberts & Manchester 1995:126).

Biblical references to texts that may refer to an osteomyelitis condition are Job 2:7-8. and 30:30 (Janssens 1970:70):

So Satan went out from the presence of the LORD, and struck Job with painful boils from the sole of his foot to the crown of his head. And he took for himself a potsherd with which to scrape himself while he sat in the midst of the ashes.

And in Job 30:30:

My skin grows black and falls from me; My bones burn with fever.

Job may have suffered from an unknown infection which could have caused a typical form of osteomyelitis. Osteomyelitis may present as the result of skin infection which could be a simple pimple or secondary infection from eczema (Janssens 1970:75). Osteomyelitis, as is often seen in tuberculosis, fungal infections, or from bacterial infections from other organisms, tends to run a slower and less dramatic course, with less severe pain and less or no fever, often resulting in bone destruction (Encarta: s.v. Osteomyelitis).

Bone infections may attack only individual layers of the bone, such as the periostium and the cortical layer or several layers. Pyogenous bacteria may reach the bone component by way of the blood or from the periapical region of an abscessed tooth, nearby sinuses, arthritis from inflammation of soft tissues or from lacerations caused by some object piercing the skin and bringing with it some alien bacteria (Živanović 1982:223).

The response of the infection on the human being depends on the resistance factor of the individual, the virulence of the invading organism, the age of the individual and the route that the infection penetrated the individual (Živanović 1982:222). Acute destructive bone infections destroy bone and lead to necrosis, a sequestrum of bone tissue and soft tissue scar that may become calcified or even ossified. Great deformity results and is easy to be detected by the paleopathologist. Milder infections may become chronic and become localised and may become encapsulated within bone and may only be revealed by X-rays. Radiologically it will reveal a cavity suggestive of a cyst or granuloma. Among the non-specific inflammatory diseases of the bones, paranasal sinus infections are the most common. Through paranasal sinusitis the infection may spread via the eustachian tube to the middle ear and the mastoid cells behind the ear. Trepanation of the skull may have been, amongst others, the surgical treatment for the opening of the mastoid cells (Živanović 1982:234).

To conclude this topic of infected bony lesions it may be of interest to learn what Roberts and Manchester have to say on viral infections. Almost invariably, viral infections are fatal or resolved before inflammatory reaction in bones occurs. Direct evidence of viral infections is therefore absent in human skeletal remains, but the potential for their identification may be in the application of modern DNA extraction methods of human remains from archaeological contents (Roberts & Manchester 1995:134).

4.2.9.4 *Poliomyelitis*

Poliomyelitis must *not* be seen as a viral infection that causes bone reaction. Poliomyelitis is a viral infection of the central nervous system which is manifested clinically as the paralysis of one or more muscle groups (Marieb 1992:409). The disease is most common in early life, hence its alternative name is 'infantile paralysis'. Paralysis of a limb at this early age results in muscle wasting and possible failure of growth in the bones of the affected limb. Therefore, marked inequality of bone growth in opposite limbs, a feature which will be apparent in skeletal remains, may suggest poliomyelitis. Mephibosheth, son of Saul, first king of Israel, may have suffered from poliomyelitis as could be described in 2 Samuel 4:4:

Jonathan, Saul's son, had a son *who was lame in his feet*. He was five years old when the news about Saul and Jonathan came from Jezreel; and his nurse took him up and fled. And it happened, as she made haste to flee, that he fell and became lame.

And confirmed again in 2 Samuel 9:13:

His name *was Mephibosheth*.
So Mephibosheth dwelt in Jerusalem, for he ate continually at the king's table. And he was lame in both his feet.

Janssens (1970:111) mentions that paralysis of the lower limbs after a fall is practically unheard of and never occurs in childhood. Therefore 2 Samuel 4:4 compels us to consider poliomyelitis. A stele of the Egyptian priest Ruma from the XVIII th dynasty (1500 BCE) shows his right leg atrophied and a *talipes equinovarus* has developed. A similar fate was described for pharaoh Siptah.

4.3 CONCLUSION

When examining dry bone specimens the macromorphology may seem solid and impregnable to the average observer. Živanović (1982:1) describes bone as a very complex organ, made up of organic and inorganic material and is composed of a variety of tissues like for example marrow, blood vessels, nerves, cartilage

and connective tissue in the living individual. The changes that occur within bone at the microscopical level when the individual ceases to exist and after interment is what concerns the paleopathologist. When studying bones from archaeological sites, all internal and external factors that can influence bone must be kept in mind, for the mineral composition, the structure, the weight of the bones, the porosity and various other aspects like colour and shape of the bone specimen at hand, may solve many paleopathological and anthropological problems and could be indispensable in making an accurate diagnosis (Živanović 1982:11). Finally, understanding the histology of bone will augment the ability to grasp the biomolecular science in the study of DNA technology.

CHAPTER 5

PALEOPATHOLOGY AND REBURIAL LAWS

Any society's existence and survival depends on the laws and regulations promulgated by the authorities to secure order. This would include laws pertaining to the heritage of the society as well. The Israeli heritage laws are very important and must protect the people's history as well as to a certain extent the development of science. The proverb that *you do not know where you are going if you do not know where you are coming from*, holds truth. A quote by A J P Taylor, a British historian (1906-1990) seems to illustrate the importance of history best:

History enables us to understand the past better—no more and no less. Any historian who is dissatisfied with this conclusion should take up some useful profession such as knitting.

However, few western countries have as strict laws governing excavations and reburials of ancient human remains as some of the modern countries of the biblical world, and Israel in particular. The implications that the restrictions have on the science of paleopathology are numerous and are especially detrimental for the future of this discipline. Some of the restrictions are:

- the restriction on the length of time permitted for the study of human remains;
- the restriction of the application of special techniques and technologies on and to the specimens;
- the resultant possible elimination of the opportunity for future studies of problems which were not touched upon initially during the examination in the laboratory and in the field;
- these laws also restrict or prevent the restudy of osteological samples years after an initial assessment (Jones 1992:5,65).

5.1 RESTRICTIONS AND THE EFFECT THEREOF

These laws and restrictions may be of frustration value at the present time. At the most they cause stagnation in the scientific studies in the field, but worst of all is the effect that it may and will have, by present-day standards, on the future studies in the scientific world which to a larger or lesser degree, is dependent on the studies of these excavations and resultant scientific outcomes drawn from it.

Keita (1988:378) reaffirms these fears with statistical proof, the effect which can be seen in recent craniometric *restudies* of skulls from Lachish. It was determined that only 39% of the specimens had been assessed correctly in the initial studies performed soon after their excavation. Had these skulls been reburied instead of deposited in the British Museum of Natural History, much of the data on the population of Lachish would have remained forever incorrect (Keita 1988:378). Other important sources of data for the anthropological and paleopathological studies of the ancient Israelites are the many thousands of burials at the Jericho necropolis and the cemeteries at Qumran that contain approximately 1 200 burials which still remain largely untouched (Haas & Nathan 1967:69).

One can appreciate, understand and respect so many religious, social and traditional motivations underlying the establishment of reburial laws, but clearly, mute witnesses to their times, skeletons nevertheless have stories to tell about life in Israel, stories that scientists studying their remains can extract from their bones through the use of many wonderful means of technology. And it has all to do with the improvement of humankind through science. Jones proposes that skeletal remains be housed in museums that would ensure an honourable resting place, rather than the comparative anonymity of a cursory examination and a haphazard reburial (Jones 1992:5,66).

If the Israeli government has such a sincere conviction on the respect of the dead, the question comes to mind why the multitude of dead or dying Jews from the holocaust (1939 – 1945) are depicted all over the world and even within the

borders of present-day Israel. Is it not a case of severe double standards? By showing the severity of the holocaust, are they, the lawmakers of the government, seeking sympathy from the whole world at the expense of the dead in the most disrespectful way?

In my opinion the responsibility lies with the religious groups of Jews, Christians and Muslims who all have a legacy in the greater part of the modern Palestine to support a motion to relax the laws and regulations that prohibit scientific anthropological studies done with great respect and thus prohibit gaining knowledge of their own legacy.

5.2 LAWS IN OTHER COUNTRIES AS COMPARISON

All scholars in paleopathology and anthropology will agree that the data that can be obtained on paleopathological and skeletal studies in the region of the Southern Levant are almost ommissible in comparison to most other countries in the world. There is no doubt an even greater need for understanding the cultural make-up of the biblical lands for it will enhance the understanding of the scriptures of the Holy Books to a greater extent. Even among her neighbours, Meinhardt proclaims, Israel's new restrictive policies make her a pariah in the archaeological world. In Egypt, ancient burial sites are frequently uncovered. Turkey places no restrictions on the excavation of ancient burials, though recent ones are rather avoided. In Jordan, archaeologists are forbidden from digging at Muslim grave sites, but there are no restrictions to other religions' burials. Cyprus has no regulations against excavations of human remains. The closest parallel to the Israeli situation can be found in the United States of America where Native American groups put constant pressure on burial excavations. However the law there determines that a relationship must be proven between the bones and those who want them back. The law does not prohibit the examination of bones, according to Meinhardt (1996: s.v. Law). This is not so in Israel. Human bones have to be returned to the religious authorities at the location of the excavation immediately. In practice, Meinhardt states, archaeologists may examine

prehistoric remains, but they prefer not to mention the fact lest the ultra-Orthodox extremists decide to change their minds. Donald Ortner has gone on record as saying that the standpoint that the law takes in this regard is the modern equivalent of burning books. The fact that prehistoric remains are treated differently may be because the Orthodox Jews do not believe that the earth was created yet in that period, according to Meinhardt (1996: s.v. Law).

5.3 LAW AND RELIGION

The faction that may influence the lawmakers are the Orthodox Jews, Einhorn (1997:46) concurs with Shanks and Meinhardt. Led by Athra Kadisha (Aramic for 'The Holy Site'), the society for the preservation of Jewish holy sites strives to protect ancient Jewish tombs from everybody, including scientists. These people are a minority group of Israel's population but they vehemently oppose the excavation of graves on religious grounds (Einhorn 1997:48). For anthropologists on the other hand, the bones of individuals and populations, their origins, age, health status, diseases, dietary habits and genetic affinities are an indispensable source of information regarding the history and lifestyle of the ancient populations inhabiting the land.

Archaeological excavations have for long conformed to an arrangement worked out in 1950 between the Ministry of Education and Culture and the Ministry of Religious Affairs which oversees the Israel Antiquities Authority (IAA) (Meinhardt 1996: s.v. Law). These bodies agreed that excavations of human remains are different to other relics excavated in that respect should be shown in the handling thereof.

However clashes between archaeologists and ultra-Orthodox groups have put the above practical compromise in jeopardy, this after a rescue excavation in 1992 ended up in court. The decision of the then director of the IAA, Amir Drori, contains an appropriate balance between the needs of archaeological investigation, the needs of the population and the consideration related to human

dignity. Another decision then made was that the police are not to hold archaeologists criminally liable if they were to uncover human remains by accident. The police are not to monitor excavation sites, not to confiscate bones and are not to investigate complaints directly. This decision shows that prior to this the police were clearly involved in such activities. The police's duty, it was decided upon, was to make sure that excavation could proceed in an orderly manner without undue interference by protesters. However the message was clear: Ancient human remains are not proper objects for study, says Shanks (1996: s.v. Law), after studying the decision. Bones were to be treated with dignity and were to be available for study – a procedure ratified by Israel's highest court, is now defunct. The directive on the taboo of excavating Jewish grave sites now extends to all burials, regardless of religion and race.

This in the practical sense means that physical anthropologists must constantly be available at a site to gather information in the small interval between the call to the Ministry of Religious Affairs and the arrival of the bone collectors. In that period they have to study the bones for pathology and other anomalies, do biometric studies and take photographs. This new arrangement proves to be very stressful to the whole excavation team, Meinhardt (1996: s.v. Law) believes.

There is, Einhorn (1997:49) agrees, a history of conflict between the public interest in archaeology and in particular the sciences of anthropological and paleopathological research, and the religious convictions of the orthodoxy, supported by the sociopolitical authorities. This has to do with human remains; when once buried, they should not be touched. This conflict has been exacerbated because of urban development. This is presently frequently seen in and around towns and cities where, because of the ongoing development, new roads and public services become imperative. The resulting earthworks would invariably necessitate rescue excavations of tombs that lie in the wake of massive earthmoving equipment.

5.4 UNDERSTANDING THE JEWISH LAW (HALAKAH)

The attitude of the Orthodox opposed to the excavations is reflected in a rabbinical decision handed down in 1975 by Rabbi Ovadia Yosef, Chief Rabbi (Sephardi) of Israel (Rishon Le-Zion). It is supported by the Chief Ashkenazi Rabbi of Israel in 1981, Rabbi Shlomo Goren (Shanks 1996: s.v. Law).

The clearing of human remains (usually bones) from tombs is forbidden under Jewish Halakah, the Jerusalem Talmud and the Jewish Law. Shanks (1996: s.v. Law) says that according to authorities cited by Rabbi Breitowitz, human remains may be disinterred and moved if they were buried at a place without the permission of the landowner. They may also be moved if the remains are likely to be damaged by water or sewer backups. Directly applicable to archaeological excavations, the remains may be moved if threatened with vandalism. In addition a grave that damages or interferes with the rights of the public may be removed. The *poskim* (religious authorities) have made clear that the law permitting relocation applies not only to a single grave but to a cemetery as well.

5.5 THE BURIAL PERSPECTIVES IN BIBLICAL TIMES

The biblical Scriptures do not devote too much attention to burial processes. The Machpela Cave in Hebron that was purchased by Abraham (Gn 23) and its subsequent use by later patriarchs (Gn 49:29-33; 50:25-26) is but one of a few examples. There is little said about rules relating to burial in the Bible except for showing concern to avoid defilement through the dead. Burial customs changed in the Second Temple period. Burial then took place in two stages, primary interment in burial niches (*loculi* or *kokhim*), followed by the collection of bones into ossuaries and reburial. Apart from the religion of resurrection that may have been the prime reason for this shift in burial customs it may also have another side; Einhorn sees this new custom as may have been rooted in the need to spare the land for the needs of the living while also showing respect for the dead (Einhorn 1997:51). This new custom brought its own new rules, like the transfer

of the remains from one grave to another is forbidden. The selling of grave sites was not allowed. Initially the Mishnah and Talmud ruled that when a city expanded, the sages were able to give the interests of those living in the city priority over the dead, meaning clearing of tombs within a city were allowed in the wake of expansion (Einhorn 1997:53).

5.6 THE DEFINITION AND STATUS OF THE RULES OF THE HALAKAH TODAY

Halakah – a noun derived from the Hebrew root *hlk* means “to walk”. It is usually translated as ‘law’ and denotes a specific ruling, a legal statement or discussion, the general category of legal material or that portion of rabbinic literature which is not Haggadal. Halakah concentrates on specific activity in which Jews should be engaged in personal, social, national and international relationships as well as other practices and observances of Judaism (Porton 1996: s.v. Halakah). The studying and observing the entire Halakah was viewed as being essential to life on earth and there is no difference in the ranking among matters in the Halakah which we today might label as ethical laws, civil laws or ritual laws, because all of them play the same essential role in God's design of the universe. God is the ultimate source of the Halakah.

To show that Halakah laws are not cast in concrete, Porton (1996: s.v. Law) mentions that the rabbis did not view these laws and commandments as an imposition. It is also said that if the majority of the people could not follow a particular law, or if its implementation would cause a substantial loss, it could be rejected (Safrai 1996: s.v. Halakah). Because the laws were given to the Jews so that they might live by them, almost any specific rule could be abrogated in a time of emergency. If there were uncertainties about a specific practice one needs only observe how the common people acted in order to discover what was acceptable.

It is unlikely that it is as easy as using the above 'loopholes' in the Halakah to have the laws changed to accommodate science in the sense of relaxing the laws to allow the disciplines of paleopathology and anthropology to open up all ancient cemeteries and other relevant relaxations. No, it will be an uphill battle of no small magnitude. The question is just how much has been done in this regard and how much enthusiasm there is from the scholars worldwide and also, who will stand up to the challenge.

The Halakah is the product of the efforts of many generations of scholars without any legislative institution empowered to enact a systematic code of laws. To date there is no code that combines all of the rules in a way that eliminates the need to have recourse to other sources. Einhorn (1997:54) mentions that the *Shulchan 'Arukh* was a codification that was accepted by the World Jewry, yet not as a binding law. However the *Shulchan 'Arukh* is the starting point for anything to do with enquiries into Jewish law. The Halakah rules over burials and have governance over Jewish communities not only in Israel, but in every country where there is a sizable Jewish community having a set apart cemetery. Einhorn (1997:56) relates the case histories of rulings in Ottensen cemetery in Germany (1997:55) and a cemetery in Vienna, Austria where the authorities complied to the regulations of the *Shulchan 'Arukh*.

5.7 CONCLUSION

Excavation of graves is carried out only when the graves will otherwise be destroyed through development or plunder, with of course the permission from the IAA (Israelite Antiquities Authority) and the Ministry of Education and Culture. The Orthodox factions however demand that the bones be excluded from the definition of Antiquities (IAA). All bones have to be handed over to the Ministry of Religious Affairs as soon as studies are completed. The Orthodox groups remain negative to any tampering with graves. They exert political pressure and sometimes even physical violence to obstruct excavations permitted under the law. Policies, rules and laws regarding antiquities are included in the Antiquities

Law 5479-1989. Issues addressed therein govern excavations, museums, artefacts and antiquity sites.

Finally, it is noticable, and at the same time worrying that too few biblical archaeologists in their post-excavational reports and/or articles produced, referring to the excavations, recognize the Department of Antiquities for permitting them this inimitable opportunity to further their scientific explorational studies. Good manners in this regard may just pay handsome dividends in future dealings with these administration hierarchies. One of the few acknowledgements that I have found was that of Arensburg, Goldstein and Rak in the course of archaeological expeditions in the caves of the Judaeen desert near the Dead Sea. The remains that were found were identified as Jewish by the relevant associated material culture. Their acknowledgement reads as follows:

...we are indebted to the Israel Department of Antiquities for making available to us the material described herein. The remains were returned to the department for reinterment, according to Jewish religious tradition. The skeletons from the Roman period, probably related to the Bar Kochba revolt, were given an official military burial in the Judaeen desert [Arensburg, Goldstein & Rak 1985; 75-76].

CHAPTER 6

INFECTIOUS DISEASES: LEPROSY, TUBERCULOSIS AND SYPHILIS

Although the biblical Scriptures regularly mention leprosy *per se* or at other times lepers, leprous and even leprosy of clothes and of plaster in homes, there seems to be no proof at all of this terrible disease in Syro-Palestine. No archaeological excavation of skeletal material has so far yielded any positive results identifying leprosy in human skeletal remains. However, not having found proof is by no means proof of its nonexistence. I will attempt to show other possible diseases in differential diagnosis that may mimic the symptoms described in the biblical texts (Jones 1992: 5,65).

6.1 LEPROSY

Ortner and Putschar (1981:6) report that most scholars agree that the leprosy of the Bible is not Hansen's disease or true leprosy of today. The object is to discuss leprosy in its entirety, including the paleopathology, microbiology and histology of the disease. The macroscopical lesions in skeletons have been extensively described by M*ller-Christensen. His report in 1953 on skeletal material found in a medieval leper cemetery in Denmark is unique in the history of paleopathology, according to Ortner and Putschar (1981:6). The descriptive analysis of this material has provided important information about leprosy in ancient times. It has also expanded our knowledge of the effects of the disease on skeletal material. The paleopathologist should be knowledgeable in all the facets of the disease. Steinbock in 1976 brought out a textbook; *Paleopathological Diagnosis and interpretation* on diagnosis of ancient bone diseases. In it he attempts to establish the diagnostic criteria for paleopathology, improving the knowledge regarding various types of diseases that affect bone tissue and the morphological features associated with each disease, certainly a must for every serious scholar in this discipline (Ortner & Putschar 1981:7).

I believe that although most scholars know that leprosy as described in the Bible was not true leprosy as we know it today, they may still be aware that the entirety of the Southern Levant has by no means been fully excavated as well as that too many skeletons have escaped being examined for pathology or just plainly ignored in its entirety. It may not be too far-fetched that somewhere there may be an unearthed remote leprosy colony or village that is waiting to be discovered. Let us hope that the archaeologists working on that dig know something about the importance of paleopathology and of the morphological features of leprosy in skeletons.

6.1.1 History of biblical leprosy or **⬥āra'at**

The *bacillus mycobacterium leprae*, the microorganism responsible for leprosy was discovered in 1868 by Gerhard Arnaer Hansen and his work was published in 1874. The history of the disease goes back to India where in 600 BCE leprosy was prevalent. It spread to the Mediterranean area in the third century, probably by Alexander the Great's soldiers (Hulse 1975:88; Brown 1970:640). Hippocrates presumably wrote about *lepra* as to mean an itchy, powdery or scaly thickening of the skin which probably represented *psoriasis* or some fungal infection. John of Damascus, an Arabic author (777 - 857 CE), was the first to use the term *lepra*, and is said to have made one of life's biggest mistakes by describing a disease later to be known as Hansen's disease as *lepromatous leprosy* (Hulse 1975:87). The use of the term *lepra* was adopted by Arabic writers some time later and even later still by medieval European writers, and the rest is history. Wherever the word *lepra* that was used in early Christian translations was erroneously interpreted in modern literature as referring to Hansen's disease of today, with dire consequences (Sussman 1992:6-10). Archaeology has contributed to overthrowing the belief that biblical *lepra* (leprosy) was the same as Hansen's disease. Medical evidence has indicated that the Greek *lepra* and the Hebrew **⬥āra'at** must be very similar, if not identical (Craffert 1999a:95). In the Graeco-Roman world the term and disease coupled therewith, namely *elephas* or *elephantiasis graecorum*, was described in the same way and meant the same as

what modern leprosy or Hansen's disease mean to us. These terms were used by Celsus, Pliny the Elder and Galen (Pilch 1981:108).

In 1810 Clayton described leprosy as follows:

The whole distemper was so noisome that it might well pass for the utmost corruption of the human body on this side of the grave.

Few diseases throughout history have engendered such fear and provoked such cruel, and at the same time, pious reaction as has leprosy (Roberts & Manchester 1995:142).

Hurlbut describes the physical appearance of a leper in the most horrifying but realistic way in his book *Travelling in the Holy Land*:

Can you endure to look at those wretched people, pleading for alms from the passersby? Look at the stumps of hands from which the fingers have dropped off! See those twisted and deformed feet! (Hurlbut 1900: s.v. Leprosy)

These observations were made by Hurlbut in the late nineteenth century in Palestine. He calls this disease: *a disease that comes upon its victims like a strange law of heredity* (Hurlbut 1900: s.v. Leprosy). This is a typical observation and also a typical line of thought for people in that time, and the scene and the line of thought has not changed much, for even in the early twentieth century, there were lepers to be seen at the gates of some cities of Palestine (Macalister 1997: s.v. Nature and locality of leprosy).

The earliest purported *evidence* of leprosy is from an earthenware vessel found in Beth-shan which had a human head moulded upon it. It was found amongst sacred and cult objects in the section of the temple of Amenophis III and dates back to 1411 – 1314 BCE. The face on the moulding bears a great similarity to the 'leonine facies' of leprosy. This pre-Israelite grain storage vessel, pre-biblical, and perhaps Egyptian of origin, does unfortunately not present sufficient proof to either biblical *ḥāra'at* nor modern day leprosy (Yoeli 1955:332). Yoeli has also

identified the leonine face as symbolising the Canaanite god Mot, lord of the underworld (Yoeli 1968:1067).

The negative and fearful attitude regarding leprosy by millions of people, laymen as well as the informed, over a period of three millennia, stems mainly from the Holy Scriptures of the Hebrew nation (Tanakh), or pre-Christian era. The culture of leprosy started as an oral tradition in the period which the Hebrew nation called their Exodus in about 1260 BCE from Egypt back to the land of their forefathers, the Promised Land given to them by their God, Yahweh. It was during this period of desolation and tribulation in the desert that Moses gave them the laws, among others those pertaining to health. The first time this disease was mentioned as a sign given by God to Moses in the Old Testament was in Exodus 4:6, of the Jahwist legislation (=J) of the Pentateuch:

Furthermore the Lord said to him, "Now put your hand in your bosom"
And he put his hand in his bosom, and when he took it out, behold, his
hand *was* leprous, like snow.

This may be the basis of the story in Flavius Josephus' Apion I,31, that Moses was expelled from Heliopolis on account of him being a leper (see also Apion I,26 and Antiquities of the Jews, III, xi, 4). The second case mentioned by Macalister (1997 s.v. Leprosy) is the case of Miriam (Nm 12:10) where the disease is graphically described:

And when the cloud departed from above the tabernacle, suddenly Miriam
became leprous, as *white* as snow. Then Aaron turned toward Miriam, and
there she was, a leper.

In Deuteronomy 24:8 there is a reference to the oral tradition concerning treatment of lepers without any details:

Take heed in an outbreak of leprosy, that you carefully observe and do
according to all that the priests, the Levites, shall teach you; just as I
commanded them, so you shall be careful to do.

In Leviticus 13:1-59 and 14:1-7 of the Priestly legislation (=P) of the Pentateuch, the rules for the recognition of the disease, the preliminary quarantine periods and the ceremonial methods of cleansing are given at length (see below).

6.1.1.1 *Hansen's disease as an infectious disease*

Hansen's disease is a known infectious disease and is also described as an epidemiological disease, affecting even a continent such as Africa in modern times. Real leprosy as it is generally known as, is the most common cause of peripheral neuritis in the world today. Hansen's disease is known as a chronic granumatos disease caused by *Mycobacterium Leprae* and is one of the most crippling and disabling diseases in the world today. But the disease *is* curable today! (Agnew 1967: s.v. Hansen's disease).

The spread of the disease or method of transmission is not all that clear cut since only 5 – 10% of close family members would acquire the disease. Inhalation of moisture laden with infective bacilli is the most probable route by which leprosy is commonly contracted. The form of leprosy thus communicated is usually lepromatous leprosy and it would present as chronic rhinitis. Skin lesions would occur later and the penetrating infection would produce septal perforation after many years. Other primary bone lesions occur directly in only about 5% of cases. The organism shows a predilection for peripheral nerves, skin and mucosa of the upper respiratorial tract. Secondary lesions follow the peripheral *neuropathy*; that being skin areas rendered anaesthetised by nerve infection and so become vulnerable to tissue destruction because the patient is simply not aware of any injury (Ortner & Putschar 1981:176).

Hansen's disease is divided into tuberculoid leprosy and lepromatous leprosy by the following criteria:

- Tuberculoid leprosy: This type is distinguishable in that it is confined to a few sites of the skin and peripheral nerves. With regards to the skin lesions, a vigorous cell-mediated immune response surrounds the peripheral nerves, sweat glands and hair follicles, which are readily destroyed. There are not many organisms discernable. This type is the least damaging and the least infectious type according to Manchester (1984:167).

- Lepromatous leprosy: There is no cell-mediated immune response to the organism. The organisms are present in great abundance in the dermis, in histocytes, erector pilorum muscles and in endothelium cells of blood vessels. The organisms are carried via the blood to peripheral nerves, eye, mucus of the nose, testes and small muscles of the hands, feet and face (Agnew 1967: s.v. Leprosy). Manchester (1984:167) describes this genre as the most severe and the most infectious type, with the most widespread bodily involvement.

6.1.2 The social culture of ✪āra'at

6.1.2.1 *Leprosy in garments*

The occurrence of certain greenish or reddish stains in the substance of woollen, linen or articles made of leather is described in Leviticus 13:47-59:

⁴⁷ Also, if a garment has a leprous plague in it, *whether it is* a woollen garment or a linen garment, ⁴⁸ *whether it is* in the warp or woof of linen or wool, ⁴⁹ *whether in leather or in anything made of leather,* and if the plague is greenish or reddish in the garment or in the leather, *whether in the warp or in the woof, or in anything made of leather, it is* a leprous plague and shall be shown to the priest. ⁵⁰ The priest shall examine the plague and isolate *that which has* the plague seven days. ⁵¹ And he shall examine the plague on the seventh day. If the plague has spread in the garment, either in the warp or in the woof, in the leather *or in anything made of leather,* the plague *is* an active leprosy. It *is* unclean. ⁵² He shall therefore burn that garment in which is the plague, *whether warp or woof, in wool or in linen, or anything of leather, for it is* an active leprosy; *the garment* shall be burned in the fire. ⁵³ But if the priest examines *it,* and indeed the plague has not spread in the garment, either in the warp or in the woof, or in anything made of leather, ⁵⁴ then the priest shall command that they wash *the thing* in which *is* the plague; and he shall isolate it another seven days. ⁵⁵ Then the priest shall examine the plague after it has been washed; and indeed *if* the plague has not changed its colour, though the plague has not spread, it *is* unclean, and you shall burn it in the fire; it continues eating away, *whether* the damage *is* outside or inside. ⁵⁶ If the priest examines *it,* and indeed the plague has faded after washing it, then he shall tear it out of the garment, *whether out of the warp or out of the woof, or out of the leather.* ⁵⁷ But if it appears again in the garment, either in the warp or in the woof, or in anything made of leather, it *is* a spreading *plague;* you shall burn with fire that in which is the plague. ⁵⁸ And if you wash the garment,

either warp or woof, or whatever is made of leather, if the plague has disappeared from it, then it shall be washed a second time, and shall be clean. ⁵⁹This *is* the law of the leprous plague in a garment of wool or linen, either in the warp or woof, or in anything made of leather, to pronounce it clean or to pronounce it unclean.

When the stains on garments would spread or did not change their colour after washing, it was pronounced to be due to a fretting leprosy (*tsara'ath mam'ereh*), and such garments were to be burnt. This phenomenon may simply have been a form of mildew, such as *penicillium* or mould-fungus. The treatment of burning the affected material was most probably the correct one at the time due to the lack of any form of disinfectant (Macalister: 1997 s.v. Culture of leprosy). A quote by Father Damien (1840-1889), a Belgian missionary, when asked on his deathbed whether he would leave another priest his mantle, like Elijah did: 'What would he do with it? It is full of leprosy', was his answer, springs to mind (Macalister:1997 s.v. Culture of leprosy).

6.1.2.2 *Leprosy in the house*

The occurrence of 'hollow streaks, greenish or reddish' in the plaster of a house was regarded as affected by leprosy and the house had to be destroyed after all other cleansing procedures had failed. A full description of leprosy in the house appears in Leviticus 14:33-57:

³³And the LORD spoke to Moses and Aaron, saying: ³⁴'When you have come into the land of Canaan, which I give you as a possession, and I put the leprous plague in a house in the land of your possession, ³⁵and he who owns the house comes and tells the priest, saying, 'It seems to me that *there is* some plague in the house,' ³⁶then the priest shall command that they empty the house, before the priest goes *into it* to examine the plague, that all that *is* in the house may not be made unclean; and afterward the priest shall go in to examine the house. ³⁷And he shall examine the plague; and indeed *if* the plague *is* on the walls of the house with ingrained streaks, greenish or reddish, which appear to be deep in the wall, ³⁸then the priest shall go out of the house, to the door of the house, and shut up the house seven days. ³⁹And the priest shall come again on the seventh day and look; and indeed *if* the plague has spread on the walls of the house, ⁴⁰then the priest shall command that they take away the stones in which *is* the plague, and they shall cast them into an unclean place outside the city. ⁴¹And he shall cause the house to be scraped inside, all around, and the dust that they scrape off they shall pour out in an unclean place outside the city. ⁴²Then they shall

take other stones and put *them* in the place of *those* stones, and he shall take other mortar and plaster the house.

⁴³Now if the plague comes back and breaks out in the house, after he has taken away the stones, after he has scraped the house, and after it is plastered, ⁴⁴then the priest shall come and look; and indeed *if* the plague has spread in the house, it *is* an active leprosy in the house. It *is* unclean. ⁴⁵And he shall break down the house, its stones, its timber, and all the plaster of the house, and he shall carry *them* outside the city to an unclean place. ⁴⁶Moreover he who goes into the house at all while it is shut up shall be unclean until evening. ⁴⁷And he who lies down in the house shall wash his clothes, and he who eats in the house shall wash his clothes.

⁴⁸But if the priest comes in and examines *it*, and indeed the plague has not spread in the house after the house was plastered, then the priest shall pronounce the house clean, because the plague is healed. ⁴⁹And he shall take, to cleanse the house, two birds, cedar wood, scarlet, and hyssop. ⁵⁰Then he shall kill one of the birds in an earthen vessel over running water; ⁵¹and he shall take the cedar wood, the hyssop, the scarlet, and the living bird, and dip them in the blood of the slain bird and in the running water, and sprinkle the house seven times. ⁵²And he shall cleanse the house with the blood of the bird and the running water and the living bird, with the cedar wood, the hyssop, and the scarlet. ⁵³Then he shall let the living bird loose outside the city in the open field, and make atonement for the house, and it shall be clean. ⁵⁴This *is* the law for any leprous sore and scale, ⁵⁵for the leprosy of a garment and of a house, ⁵⁶for a swelling and a scab and a bright spot, ⁵⁷to teach when *it is* unclean and when *it is* clean. This *is* the law of leprosy.”

Verse 34, interestingly, proclaims Yahweh as being responsible for putting the ‘leprosy’ in the house. The ritual in making atonement for the house was cultic and the use of hyssop may have been a form of antiseptic. Hyssop is an aromatic herb, similar to mint, and was used as a medicinal herb. In biblical times the plant’s twigs were used to sprinkle water or other mixes during religious ceremonies (Microsoft Encarta 2004: s.v. Hyssop).

Whether hyssop had any antibiotal or antifungal properties may be illustrated in the account of how penicillin was discovered: Had Alexander Fleming not been an untidy man and apt to leave his cultures exposed on the laboratory table the spore of hyssop mould, the penicillin notatum, might never have floated in from Praed Street and settled on his dish of staphylococci, resulting in killing off the bacteriae (André Maurois [1885 – 1967], a French writer referring to the discovery of penicillin by Alexander Fleming); (Microsoft Encarta 2004: s.v. Hyssop). These facts were not presented to show the effect that penicillin has any effect on the *M.*

leprae. The disease supposed to be leprosy will be shown later in this chapter as not true leprosy (Hansen's disease) but rather any of a variety of other diseases. Macalister (1997: s.v. Leprosy in the house) sums the process in Leviticus 13:33-57 up as follows: 'When leprosy was diagnosed in a house, and the priest has confirmed that the stain is in the plaster and that it is spreading, then the affected part must be taken down, the stones and the plaster must then be cast outside the city and a new wall should be built. Should the stain recur in the new wall, then only was the whole house condemned and it had to be totally destroyed and its material cast outside the city'.

The diagnosis of leprosy in a house was erroneous since the *leprae* bacillus is known not to be capable of surviving outside its biological host. Some mild fungus may have been the cause of the discolourment of the bricks and/or plaster which may have attacked whatever organic material there was in the plaster or brick. In many instances the bricks were made of straw and clay.

6.1.2.3 *The legal attitude*

In the event of suspected infestation of leprosy in either person or house or garment it would then be declared unclean by the priest officiating the investigation. If found that there were no means provided for a cure, destruction was ordered in the event of garments, furniture and house. If, on the other hand, the disease proved to be absent, this freedom had to be declared by a ceremonial purification (Macalister 1997: s.v. Culture of leprosy).

⁴⁵Now the leper on whom the sore *is*, his clothes shall be torn and his head bare; and he shall cover his moustache, and cry, 'Unclean! Unclean!' ⁴⁶He shall be unclean. All the days he has the sore he shall be unclean. He *is* unclean, and he shall dwell alone; his dwelling *shall be* outside the camp (Lv 13:45,46).

While thus excluded from the camp or from society, lepers were required to wear mourning clothes, leave their hair in disarray and had to cry out: 'Unclean! Unclean!' so that everyone could avoid them. Any contact with lepers defiled the person who touched them.

6.1.2.4 *Miraculous cures*

In the event that the disease really was leprosy, then a miraculous cure would be the only prospect. Moses (Ex 4:7), Miriam, his sister (Nm 12:10) and Naaman (2 Ki 5:1, 10) are prominent examples of such miracles in the Old Testament. In the New Testament, cleansing of lepers is mentioned as a specific portion of Jesus' work of healing (Lk 17:11-15); (Youngblood et al. 1997: s.v. Miracles). But in the event that other nonleprosy diseases were the cause, normal prognosis would have had to run its course.

6.1.3 **Biblical leprosy as a disease**

The Old Testament descriptions of disease were intended for legal and ritual use. Sussman (1967:210) believes that there was no problem about the diagnosis of the fully developed condition of 'leprosy' and that the biblical text is concerned with the initial stages of the disease when diagnosis might be difficult. One can however not identify a fully developed syndrome from such little information as what is offered in Leviticus 13 and 14. The scientific identification of the disease is certainly not identical with that what the priest had in mind. His concern was with ritual purity, a condition with no known patho-physiological basis. The Talmudic sources are somewhat easier to assess than the biblical verses, mainly because the purpose of the Talmud is to be explanatory to the Old Testament. In the Bible the word *leprosy* refers to a variety of symptoms. There are several types of leprosy and Youngblood depict biblical leprosy as most likely to be a severe type of psoriasis, a form of disease relatively rare in modern times (Youngblood et al. 1997: s.v. Leprosy). He describes leprosy as a chronic, infectious disease, characterised by sores, scabs and white shiny spots beneath the skin.

A modern approach to the definition of true leprosy is to be found in the medical dictionary of Agnew 1967: From Greek *lepros* = scaly, scabby or rough. Leprosy

is a chronic communicable disease, caused by the *Mycobacterium leprae* microorganism. It produces various granulomatous lesions in the skin, the mucous membranes and the peripheral nervous system. Three main clinical types are recognized: (a) *cutaneous, lepromatous* or *nodular*; (b) *neural* or *macula-anaesthetic*; (c) a combination of (a) and (b) is called *mixed leprosy*. Manchester (1984:167) identifies the mixed types as 'borderline' types. Other forms of leprosy distinguishable are *cutaneous leprosy, Kabyle leprosy, murine leprosy*, and many more (Agnew 1967: s.v. Leprosy).

Macalister (1997: s.v. Leprosy) defines leprosy with a biblical background and a Hebraic touch: Leper: Greek *lepra* and Hebrew *šāra'at*. He regards the disease as a slow processing and intractable disease characterised by subcutaneous nodules: (Hebrew = *se'eth*, Greek [septuagint = *oule*] and in the King James Version, *rising*).

Scabs or cuticular crusts are also defined: (Hebrew *sappachath*, Septuagint = *semasia*), and white shiny spots under the skin: (Hebrew *bahereth*, Septuagint *telangema*). Other signs are (a) that the hair of the affected becomes white, (b) later a growth of quick raw flesh appears. This would cause the leper to be regarded as 'unclean'. While the cures of other diseases are called 'healing', that of leprosy is called 'cleansing', except in the case of Miriam (Nm 12:13) and that of the Samaritan (Lk 17:15) where the word 'heal' is used in reference to leprosy. The disease is called *tseht* in Coptic and Hippocrates calls it the '*Phoenician disease*', and Galen names it '*elephantiasis*' (Macalister 1997: s.v. Leprosy).

6.1.3.1 *Nature and locality of modern leprosy*

Macalister describes leprosy as a zymotic affection produced by a microbe discovered by Hansen in 1871. The microbe is known as the *bacillus mycobacterium leprae* and the disease has since been known as Hansen's disease worldwide. Leprosy is contagious although not readily communicated by casual contact (Macalister 1997: s.v. Leprosy). Brown (1970:640) describes

leprosy as the least contagious disease, sometimes taking up to 20 years for infected persons to show symptoms. It is now realized that *Mycobacterium leprae* is a highly infective bacterium but one that is of low pathogenicity, that is, its ability to induce clinical disease is low (Manchester 1984:167; Brown 1970:640).

6.1.3.2 *Biblical leprosy versus modern leprosy (Hansen's disease)*

The universal question that is posed: Is biblical leprosy the same disease as what we now know as Hansen's disease? Scholars in physical anthropology and paleopathology now concur that it is *not* the same disease (Gramberg 1959:127; Macalister 1997; Zias 1991:149; Yoeli 1955:331; Brown 1970:640). Even a dermatologist Verbov (1976:229) questions almost every single symptom described in every verse mentioning leprosy in the Bible. The best description of biblical symptoms are found in the book of Leviticus where we read: (Lv 13:2-4):

When a man has on the skin of his body a swelling, a scab, or a bright spot, and it becomes on the skin of his body *like* a leprous sore, then he shall be brought to Aaron the priest or to one of his sons the priests. The priest shall examine the sore on the skin of the body; and if the hair on the sore has turned white, and the sore appears *to be* deeper than the skin of his body, it *is* a leprous sore. Then the priest shall examine him, and pronounce him unclean. But if the bright spot *is* white on the skin of his body, and does not appear *to be* deeper than the skin, and its hair has not turned white, then the priest shall isolate *the one who has* the sore seven days.

Gramberg refutes this as modern leprosy. Firstly he puts it as unquestionable that depigmentation does occur in certain spots in modern leprosy, but by *no* means always. The hair in affected areas does *not turn white*, nor does the lesion at its centre lie deeper than the surrounding skin (Hebrew *se'et*); (Gramberg 1959:127). The term *scab* (Hebrew *sappachat*) may be applied to indicate vitiligo or other *hypomelanotic* conditions such as post-inflammatory depigmentation (Verbov 1976:229). Gramberg also mentions that the spots are thickened and if the centre lies slightly deeper this is only seemingly so. The spreading of the condition in Leviticus 13:5-8 describes, according to Verbov, localised psoriasis, and verse 8 as spreading of psoriasis.

⁵And the priest shall examine him on the seventh day; and indeed *if* the sore appears to be as it was, *and* the sore has not spread on the skin, then the priest shall isolate him another seven days. ⁶Then the priest shall examine him again on the seventh day; and indeed *if* the sore has faded, *and* the sore has not spread on the skin, then the priest shall pronounce him clean; it *is only* a scab, and he shall wash his clothes and be clean. ⁷But if the scab should at all spread over the skin, after he has been seen by the priest for his cleansing, he shall be seen by the priest again. ⁸And *if* the priest sees that the scab has indeed spread on the skin, then the priest shall pronounce him unclean. It *is* leprosy.

One of the most important signs of hair turning white in the disease of biblical leprosy does not occur in true leprosy (Verbov 1976:230). The hair that does turn white refers to *vitiligo*, says Verbov (1976:231). Gramberg (1959:127) believes that there is nothing in this description to remind us of present-day leprosy. Initially, he states, there are no white leprosy spots which cover the *whole* body, not to mention the white hair (see also Macalister 1997: s.v. Leprosy) also 'raw flesh in the risings' (Hebrew – *michjah bassar chaj*) of the skin which is not uncommon in other types of leprosy, but it is most uncommon in those *white* spots. The raw flesh, according to Verbov (1976:231), is excoriated psoriatic lesions or sore areas of vitiligo, perhaps due to sunburn. Both these authors think that the description in Leviticus 13:18-23 describes a bacterial infection:

¹⁸If the body develops a boil in the skin, and it is healed, ¹⁹and in the place of the boil there comes a white swelling or a bright spot, reddish-white, then it shall be shown to the priest; ²⁰and *if*, when the priest sees it, it indeed *appears* deeper than the skin, and its hair has turned white, the priest shall pronounce him unclean. It *is* a leprous sore which has broken out of the boil. ²¹But if the priest examines it, and indeed *there are* no white hairs in it, and it *is* not deeper than the skin, but has faded, then the priest shall isolate him seven days; ²²and if it should at all spread over the skin, then the priest shall pronounce him unclean. It *is* a leprous sore. ²³But if the bright spot stays in one place, *and* has not spread, it *is* the scar of the boil; and the priest shall pronounce him clean.

Leviticus 13:24-28 deals with burn lesions. The development of a bright spot in a burn lesion or scar in verse 24 is a natural phenomena and in verse 27 the description is of burns complicated by multiple septic spots, but this is never covered with white skin, white hair or a lower level of the skin, therefore not Hansen's disease (Gramberg 1959:128):

²⁴Or if the body receives a burn on its skin by fire, and the raw *flesh* of the burn becomes a bright spot, reddish-white or white, ²⁵then the priest shall examine it; and indeed *if* the hair of the bright spot has turned white, and it appears deeper than the skin, it *is* leprosy broken out in the burn. Therefore the priest shall pronounce him unclean. It *is* a leprous sore. ²⁶But if the priest examines it, and indeed *there are* no white hairs in the bright spot, and it *is* not deeper than the skin, but has faded, then the priest shall isolate him seven days. ²⁷And the priest shall examine him on the seventh day. If it has at all spread over the skin, then the priest shall pronounce him unclean. It *is* a leprous sore. ²⁸But if the bright spot stays in one place, *and* has not spread on the skin, but has faded, it *is* a swelling from the burn. The priest shall pronounce him clean, for it *is* the scar from the burn.

The plague of the 'scall', described up to verse 37, of the scalp and the beard and the appearance of black hair at the site of the spot is a sign that there is no leprosy. Gramberg (1959:128) thinks this points clearly to something like *favus* or *taenia capitis*. The corresponding verses are Leviticus 13:29-37:

²⁹If a man or woman has a sore on the head or the beard, ³⁰then the priest shall examine the sore; and indeed if it appears deeper than the skin, *and there is* in it thin yellow hair, then the priest shall pronounce him unclean. It *is* a scaly leprosy of the head or beard. ³¹But if the priest examines the scaly sore, and indeed it does not appear deeper than the skin, and *there is* no black hair in it, then the priest shall isolate *the one who has* the scale seven days. ³²And on the seventh day the priest shall examine the sore; and indeed *if* the scale has not spread, and there is no yellow hair in it, and the scale does not appear deeper than the skin, ³³he shall shave himself, but the scale he shall not shave. And the priest shall isolate *the one who has* the scale another seven days. ³⁴On the seventh day the priest shall examine the scale; and indeed *if* the scale has not spread over the skin, and does not appear deeper than the skin, then the priest shall pronounce him clean. He shall wash his clothes and be clean. ³⁵But if the scale should at all spread over the skin after his cleansing, ³⁶then the priest shall examine him; and indeed *if* the scale has spread over the skin, the priest need not seek for yellow hair. He *is* unclean. ³⁷But if the scale appears to be at a standstill, and there is black hair grown up in it, the scale has healed. He *is* clean, and the priest shall pronounce him clean.

The description of leprotic changes of the scalp are most uncommon in true leprosy, as described here in Leviticus 13:38-44:

³⁸If a man or a woman has bright spots on the skin of the body, *specifically* white bright spots, ³⁹then the priest shall look; and indeed *if* the bright spots on the skin of the body *are* dull white, it *is* a white spot *that* grows on the skin. He *is* clean. ⁴⁰As for the man whose hair has fallen from his head, he *is* bald, *but* he *is* clean. ⁴¹He whose hair has fallen from his forehead, he *is* bald on the forehead, *but* he *is* clean. ²⁴And if there is on the bald head or bald forehead a reddish-white sore, it *is* leprosy breaking out on his bald head or

his bald forehead. ⁴³Then the priest shall examine it; and indeed *if* the swelling of the sore *is* reddish-white on his bald head or on his bald forehead, as the appearance of leprosy on the skin of the body, ⁴⁴he is a leprous man. He *is* unclean. The priest shall surely pronounce him unclean; his sore *is* on his head.

The colour of these lepromas on the head is red to brown. The hair may fall out but it *never* turns white. True alopecia is never attended with visible changes of the skin (Gramberg 1959:38-44). Verbov (1976:232) says '*Karachat*' in Hebrew in verse 43 refers to the back of the head, and 'a white reddish sore' could have been used to describe *cutaneous lupus erythromatosis*, *lupus vulgaris*, *solar keratosis* or skin carcinoma.

The rest of the chapter describes leprosy of household vessels, clothes and house (walls) and uses the same terminology as for leprosy in humans, that is *•āra'at*. This in itself should raise eyebrows to the diagnostic capabilities of the priests. Of course, I might add, the observation and classification of diseases in ancient times were less perfect than today. On the other hand, it may also be a remarkable first in understanding bacteriological ability to form spores that may survive for many years outside biological matters. This fact is what the modern sterilization and infection control industry is built upon. McGee tries to put this in perspective by posing a rhetorical question: How did Moses know all that? 'Well, Moses wouldn't have known it, but God told him' (McGee 1997: s.v. Infectious diseases).

6.1.4 The puzzling biblical translations of *•āra'at* addressed

Regarding the description of the disease in Leviticus 13 and 14, Gramberg (1959:129) criticises the writer for the inadequate description rendered in these chapters. The description of the disease, or *plague* of *•āra'at*, offers no direct points of contact with leprosy as we know it. The question is also raised as to why did the author and/or lawmaker or priest, fail to mention the anaesthesia of the spots and of the extremities (the main characteristic in the diagnosis today) and why did he cite symptoms which are little in evidence and are difficult to

recognize, while forgetting or overlooking the marked swellings in the face, the hoarse voice, the mutilations, the pareses – any of the symptoms that would immediately strike even the less expert eye (Gramberg 1959:130).

The obvious answer to these questions is that the omissions of certainly the most important characteristics of the disease is proof enough that the leprosy of the Bible is not Hansen's disease. There were scholars in the beginning of the 20th century, amongst them Sitanala (1937) and Ketting (1922) as quoted in Gramberg (1961:13), who in spite of these objections, hold that the biblical leprosy and modern leprosy is one and the same. Their argument is based on the assertion that Moses and the rabbis who wrote the Levitical laws, only described the *initial* symptoms, because it was only necessary to recognize the symptoms as early as possible in order to expel these patients from the camp. It is evident that this explanation is wrong because verses 9 to 17 speak specifically of an old *•āra'at* whereas the earlier verses describe the onset and spread of the disease.

A comparative study to emphasize the difference in the various English translations of describing the diseased lesions. There is no consensus of opinion in the various translations of the following words: *•āra'at* as leprosy; *sappac +ath* as scab; *se'eth* as rising; *bahereth* as bright spot, *lāban* as whiteness and *michjah bassar chaj* as quick raw flesh (Hulse 1975:97). There are no explanations offered other than translation preferences (Gramberg 1959:128).

Table 1

Reference	New King James Bible - 1982	New Jerusalem Bible - 1986	Good News Bible - 1966	New International Version - 1973
Ex 4:6	Leprous as snow	Diseased -white as snow	Diseased/ white spots like snow	Infectious skin disease
Lv 13: 2, 8, 15, 45	leprous sore/ leprosy/leprous	contagious skin disease skin disease dormant	dreaded skin disease, sore	infectious skin disease, infectious disease
:12	mild leprosy	skin disease the disease	chronic skin disease skin disease	chronic skin disease the disease

:31	leprosy	the case of tinea spots dull white-rash	sore	kind of sore
:39	scaly sore dull white spot	dull white leprosy	spots – dull white	dull white spots contaminated with mildew
:47	leprous plague	stain of mould	mildew	mildew
Lv 14: 54	leper/leprous sore/scale	skin disease and tinea	dreaded skin disease spreading mildew	infectious skin disease spreading mildew
14:34	leprous plague	a disease		
Nm 5:2	lepers	contagious skin disease	dreaded skin disease dreaded skin disease	infectious skin disease <i>leprosy</i>
12:10	skin was leprous	virulent skin disease		
Dt 24:8	leprosy	virulent skin disease	dreaded skin disease	<i>leprous</i> disease
2 Sm 3:29	leper	virulent skin disease	dreaded skin disease	running sore of <i>leprosy</i>
2 Ki 5:1-27	leper, leprosy	virulent skin disease/ diseased	dreaded skin disease	<i>leprosy</i>
2 Ki 7:3	leprous men	virulent skin disease	dreaded skin disease	man with <i>leprosy</i>
2 Ki 15:5-7	leper	virulent skin disease	dreaded skindisease	king with <i>leprosy</i>
2 Chr 26:19-21	leprosy, leprous	virulent skin disease/ diseased	dreaded skin disease	leprosy

(It should be noted that the term *leprosy* used in the latter part of the New International Version above that are in italics, carries the message: ‘the Hebrew word that was used in these cases for various diseases affecting the skin, were not necessarily leprosy’.

The comparison of the different translations above amplifies the problematic situation that exists amongst translators which by no means helps to destigmatize the disease. In a final plea, Gramberg mentions that the article he wrote, *Leprosy in the Bible*, was not intended to be an historical study, but after he had witnessed the despair and misery of the leprosy patients in Indonesia, to give the true name of the disease. He states two reasons: the first was that every person has a right to treatment; the second is the fear factor that surrounds the disease, causing people to give up hope (Gramberg 1961:21).

6.1.5 Paleopathology

In paleopathology it is usually assumed that modern diagnostic criteria can be applied to infectious diseases of the past. However, as both the human species as well as the pathogenic microorganisms undergo evolutionary changes, this assumption is not always well-founded. Boldsen (2001:380) proposes that valid estimates of the frequency (the point prevalence at death) of leprosy in skeletal samples, sensitivity and specificity and lastly sample frequency must be estimated simultaneously. It is shown that more than three symptoms must be evaluated in at least three samples in order to reach estimates with well-described properties. Boldsen concludes that it is indeed possible to estimate disease frequencies without reference to modern standards, and that leprosy occurred with widely differing frequencies in different segments of the medieval population in Denmark. In studies anywhere in the world these evaluations will obviously be of great value to all paleopathological diagnoses. Leprosy is one of the diseases in which features identified in archaeological specimens have been of value in modern diagnosis (Müller-Christensen 1965:603).

The question being raised is whether there are any descriptions of ancient leprosy skeletons having been discovered in the Southern Levant or even anywhere in the Mediterranean Middle East. The answer is a shocking no, or a feeble yes maybe.

In an area so rich in paleographical descriptions of this feared disease it almost seems impossible to comprehend that there has never been any mention made of positive identification of leprosy signs in any. Arensburg et al. (1985:75) state that it should be noted that not a single case or symptom of syphilis in any of its forms was found in the Jewish remains (in Israel), nor was there any indication of leprosy or tuberculosis.

Zias (1991:147) concurs with Arensburg et al. Despite the ongoing concern for this issue (leprosy) in ancient Israel, no skeletal evidence for true leprosy had

ever been recovered. Zias also mentions the numerous references in literature, one of which is the Crusaders' Orders, known as the 'Knights of Saint Lazarus'. This Order was comprised largely of knights suffering from leprosy. Until recently there has been no physical evidence to substantiate this text. However, in 1980, several cases were reported from the Dakleh Oasis dating to the Hellenistic period, about 200 BCE. Therefore it appears that leprosy had made its entry into the Mediterranean basin at that time (Zias 1991:149). It must be noted that in another article Zias points out that he had mistakenly reported evidence of Hansen's disease or true leprosy (Zias 1985:2) due to a diagnostic error. He reveals that diagnosing infectious diseases in human skeletal remains, particularly leprosy, is difficult because many unrelated diseases may mimic one another. The mutilating skeletal changes often found in psoriatic arthritis are virtually indistinguishable from those found in certain forms of leprosy. Zias mistakenly made his diagnosis on a skull which seemed to have the typical facial changes that were known as *facies leprosa*. The typical signs are the atrophy of the anterior nasal spine, loss of anterior teeth of the maxilla and rounding of the nasal aperture. This sign or lesion together with partial resorption of the premaxillary alveolar process with or without loss of anterior incisors may also be found in tertiary syphilis and in *lupus vulgaris* (Ortner & Putschar 1981:177). It however proved to be a skull of a convicted criminal during the Byzantine era who was sentenced to have his ears and nose surgically removed (Zias 1991:151). The *facies leprosa* syndrome, in combination with atrophy and truncation of the fingers and toes, would appear to be almost pathognomonic for leprosy, according to Ortner and Putschar (1981:179). They however state that it is conceivable that in differential diagnosis, combinations of other diseases like syphilis and frostbite might cause the same symptoms.

A more complete list of osteological signs and symptoms are, according to Boldsen (2001:383) and others, the following:

- The alveolar process of the premaxilla and intravital destruction of the alveolar ridge (the prosthion has retreated above a straight line connecting the post prominent point on the alveolar process between the lateral

incisor and the canine bilaterally). M*ller-Christensen (1965:604) states that atrophy of the anterior spine and destruction of maxillary alveolar bone are pathognomic of leprosy.

- Atrophy occurs of the anterior nasal spine. Surface pitting and progressive resorption of the anterior nasal spine occur. Loss of cortical bone with exposure of cancellous bone occurs, also in M*ller-Christensen (1961:13).
- Margins of the nasal aperture – bilateral resorption and smooth remodelling of the margins of the nasal aperture occur.
- Two processes occur in the palatine process of the maxilla. Firstly: early pitting occurs. Later, plaques of subperiosteal new smooth bone occur. Secondly, larger erosive irregular lesions occur. In very advanced stages perforation of the palate may occur (resembling palatal damage of syphilis).
- Intranasal structures – the total destruction with remodelling of the margins of the nasal aperture that leaves a wide, empty cavity.
- Lesions of the cranial vault – due to lepromatous scalp lesions which lead to erosions of the cranial vault (Boldsen 2001:384); and M*ller-Christensen (1965:604) indicates that in leprosy, paleopathological changes are not to be found on the skull vault.
- Hands and feet: Diaphysial remodelling occurs. Diaphysial remodelling is a pathological process of the proximal phalanges, metacarpals and metatarsals which occurs in all established types of clinical leprosy. This is usually in response to sympathetic neuropathy (anaesthetised soft tissue). These changes are sometimes associated with the claw-hand deformity of leprous paralysis (M*ller-Christensen 1965:604). Manchester (1984:168) also mentions that the metatarsals develop concentric atrophy and become pencil-shaped with the loss of medullary cavity.
- In long bones – periostitis with subperiosteal new bone deposits forms. It often severely affects the tibia and fibula, producing pitting and fine longitudinal striated subperiosteal bone deposits. The tibia shows vascular grooves on the lateral surface (Manchester 1984:168).

- To this list Møller-Christensen added the presence of *usura orbitae* or *cribra orbitale*. That is the presence of bilateral cribriform changes in the orbital roof of the symmetric appearance and occurs mainly in the region of the *lacrima fossae*. Møller-Christensen found this phenomenon in not less than 67,9% of skulls from 100 skeletons with leprotic changes in hands and feet. To stress the point of his discovery, *usura orbita* is found 134 percent more frequently in leprotic than in nonleprotic skulls (Møller-Christensen 1965:610; 1961:29).

6.1.6 Conclusion to leprosy

Science has all but proven that *ḥāra'at*, the leprosy of the Bible, and leprosy as we know it today is not by any means the same disease. Perhaps the majority of modern scholars have shown their support that other diseases of ancient times were responsible for the symptoms described in the biblical text. It is however not possible with modern technology to determine that those differential diagnosed diseases mentioned above are indeed the diseases mentioned in the Bible, for two reasons:

- Firstly, like the poor symptomatic descriptions that are on offer in the Bible, the alternative diseases are likewise poorly described and no clear cut diagnosis can be made (Gramberg 1959:129).
- Secondly, the lack of paleopathological signs or markings in human remains from these nonleptous diseases. Not even *psoriasis arthropathica* which is a form of psoriasis associated with chronic arthritis leaves distinguishable bone lesions (Agnew 1967: s.v. Psoriasis).

With no physical paleopathological evidence of true leprosy in the Syro-Palestinian area, one would be tempted to accept the 'no leprosy in Israel' theory to be a fact. Paul A Janssens had perhaps a plausible countertheory: He points out that lepers and victims of syphilis have always been excluded from the community and would therefore not have received a proper burial, most probably just an ordinary interment into soft soil or even in desert sand (Janssens

1970:115). My own view on this matter is that the remains of their bones were therefore less protected against disturbing influences like for instance taphonomic processes, wild animals and weather conditions. Their graves would also not have been marked and seeing that they lived in the veld or just outside of the normal social areas, finding these graves may be virtually impossible. If nothing had disturbed their simple graves, their skeletons may for what we know, still be buried but have just not yet been discovered.

To summarise, the following:

- Biblical leprosy or Old Testament *⬢āra'at*, was not the disease now known as leprosy. Modern leprosy was known and recognized in New Testament times but was not called *lepra* but *elephantiasis graecorum*.
- The biblical evidence of the nature of *⬢āra'at* is more extensive than at first thought. The disease was compared to snow, not because the skin was white but because the most characteristic sign was the scales which rubbed off the surface of the skin resembling flakes of snow.
- The purpose of the long discussion of *⬢āra'at* in Leviticus 13 was not to provide a description of *⬢āra'at* but to guide the priest in his duty of distinguishing *⬢āra'at* from diseases which superficially resembled it.
- There is no evidence that patients with *⬢āra'at* were segregated for public health reasons. Aesthetic objections to the loose scales, which might have been thought akin to discharges, could have played a part in making *⬢āra'at* cultically unclean.
- *Psoriasis* could have been called *⬢āra'at* by the biblical writers. It is the disease which fulfills most of the characteristics of the condition. *Favus*, a severe variety of fungus infection of the skin, could produce those characteristics of *⬢āra'at* not shown by psoriasis (Hulse 1975:103). Hulse (1975:95) even mentions that *psoriasis* resorts under the *⬢āra'at* group of diseases.

It is a sad state of affairs that the theologians and the serious biblical students are left in the dark regarding the latest scientific discoveries on leprosy as well as the

feeling amongst world renowned scholars that the leprosy of the Bible is not the same disease as modern leprosy or Hansen's disease, and that the medical fact of the modern disease is that it can be successfully cured. Billions of people all over the world are spoonfed on relatively unimportant political doctrines and on the private lives of the rich and famous movie stars on a daily basis. Is the time not right to inform these peoples on the facts of leprosy?

The footnotes denoting changes on leprosy in certain verses and attended with the translator's personal doctrinaire in some Bibles may be of some help but may also confuse the reader for the lack of conformity amongst dissimilar translations. The answer may lie in educating the theologians and educators of the peoples and to work towards a universal translation code for this disease with a uniform system of advisory footnotes. These recommendations may seem trivial and success largely unobtainable and to some may even seem unnecessary, but in the bigger picture, how can we disregard the 12 to 15 million people who live with this disease at present? (Manchester 1984:173). The lay public continues to view true leprosy or Hansen's disease with horror. The biblical command that they (the lepers) should reside outside the camp of Israel (Lv 13:46) is still taken literally around the world despite the fact that the Bible is not referring to modern leprosy (Zias 1991:149).

6.2 TUBERCULOSIS

To read the poems of Pasternak is to get one's throat clear, to fortify one's breathing, to renovate one's lungs; such poems must be a *cure for tuberculosis*. At present we have no poetry healthier than this. This is kumys after tinned milk.

Quote by Osip Mandelstam (1891-1938);

[Kumys is a drink made from fermented mare's milk.]

Tuberculosis is an infectious disease with a much higher virulence than leprosy. Tuberculosis is also caused by a bacillus, in this instance by the *mycobacterium tuberculi*, discovered by Robert Koch in 1882. There are different but closely related types distinguishable:

- the cold blooded type causing disease in cold blooded animals;
- the avian type causing disease in birds and some mammals;
- the bovine and human type, causing disease in mammals including human beings (Roberts & Manchester 1995:136).

Roberts and Manchester see these types as probably representing an evolutionary chain in the development of *mycobacterium tuberculosis* (Roberts & Manchester 1995:136). This form or type that causes disease in bovines and humans is closely associated with the development of agriculture and later by the domestication of cattle. This is a feature of the Neolithic period. The spreading of the disease from bovines to humans is proven to be through the drinking of infected milk and eating infected beef. The centre for cattle domestication occurred in the north eastern basin of the Mediterranean in the seventh to sixth millennia BCE (Roberts & Manchester 1995:136). It is in the Egyptian mummies that Elliot Smith and Armand Ruffer found definite signs of tuberculosis, some mummies older than 4 000 years (Živanović 1982:226).

Zias mentions that in ancient Israel tuberculosis is extremely rare in the osteo-archaeological records of the Middle East skeletal paleopathological finds (Zias 1991:152). Arensburg et al. (1985:75) have found no evidence of tuberculosis in the caves of the Judaeen desert, however, Morse et al. (1964:531) describe the reviewing of some of the Nubian pathology by Rowling who examined four specimens with typical vertebral tuberculosis. The most probable date of these cases is believed to be of the Middle Kingdom (Morse et al. 1964:531). Generally speaking, according to Jones (1992:5,69), the critical application of modern medical knowledge together with the principles of epidemiology will often lead to a possible diagnosis, with an assessable probability of being correct.

The paucity of evidence for human tuberculosis in this region is puzzling because the disease has most probably originated in the north eastern Mediterranean basin. As milking of cows became popular by the fourth millennium BCE, the previous 2 000 years were marked by using cattle only for traction and for their hides, hence bovine tuberculosis remained confined within the cattle husbandry in agriculture (Zias 1991:152).

This startling lack of evidence for the disease amongst the population of ancient Israel finds confirmation in epidemiological studies that Jews (Israelites) have relatively low rates of morbidity and mortality from tuberculosis (Zias 1991:153), and in general they have a higher resistance against infectious diseases through their strict hygienic Mosaic rules and laws (McGee 1997: s.v. Infectious diseases). Btsh (1958:250) also confirms this fact; Israeli Jews appear to have a high resistance to the disease in spite of the relatively low infection rate, whilst the Arab population as a whole seems less resistant.

6.2.1 Tuberculosis in the Bible

In the Pentateuchal passages of admonition (Lv 26:14-41; Dt 28:15-68) a number of terms are used that appear to be associated with diseases. Leviticus 26:16 and Deuteronomy 28:22 mention **a~~t~~epet*. Thus, **a~~t~~epet*: masking disease, consumption, comes from the root *shp* which, by comparison with Arabic cognates, suggests that a disease is meant in which the body becomes extremely emaciated (Morse et al. 1964:524). These authors are *adamant* that without doubt, tuberculosis existed in the ancient Near East. However, **a~~t~~epet* must be taken as any disease in which there is a severe loss of weight. This could of course include a chronic wasting disease such as tuberculosis, but it could also include in the differential diagnosis a wide variety of other wasting diseases of an epidemic nature such as massive parasitic infestation and other acute and chronic diseases like intestinal infections such as typhoid and malaria. Therefore Freedman and Noel (1992:s.v. Tuberculosis) insist that **a~~t~~epet* should not be seen as the name of a given disease but rather as a sign of disease. Similarly,

qada +at (fever), from the verb *qādah* (be kindled) is a general term for fevers of any kind (Easton 1996: s.v. Fever).

The translation *consumption* referring to tuberculosis in the KJV is found in Deuteronomy 28:22; Leviticus 26:16; Isaiah 10:22,23; Isaiah 28:22. In the NKJV in Deuteronomy 28:22 Moses warns the rebellious Israelites:

The LORD will strike you with *consumption*, with fever, with inflammation, with severe burning fever, with the sword, with scorching, and with mildew; they shall pursue you until you perish. (Italics mine)

This terrifying declaration seems to refer to a *syndrome* rather than a single disease, including leprosy. Equally horrifying are the curses described in Leviticus 26:16 where consumption is substituted with wasting disease in the NKJV:

I also will do this to you: I will even appoint terror over you, *wasting disease* and fever which shall consume the eyes and cause sorrow of heart. And you shall sow your seed in vain, for your enemies shall eat it. (Italics mine)

Similarly horrifying is the section (Lv 26:14-39) of curses that follow a pattern of the ancient Near Eastern treaties, in that it was much larger in number than the enumerated blessings. The *terror* would consist of *consumption*, a general term that may have included dysentery, cholera, typhoid fever, malaria and tuberculosis. The burning ague *that shall consume the eyes, and cause sorrow of heart (causes life to wane)* may be a reference to gonorrhoeal blindness. ‘*Then I will punish you seven times more for your sins*’ indicates that these judgements are looked upon as God's discipline, alike to Deuteronomy 8:5; Psalm 38:1; Proverbs 3:11,12; Jeremiah 30:11, 31:18; Zephania 3:2; Hebrews 12:5-11 (Falwell et al.1994: s.v. Consumption).

Of all the translations of **a +epet*, The Living Bible seems to be one of the few translations that was bold to use the translation *tuberculosis* in Deuteronomy 28:22;

He will send tuberculosis, fever, infections, plague, and war. He will blight your crops, covering them with mildew. All these devastations shall pursue you until you perish.

And in Leviticus 26:16:

this is what I will do to you: I will punish you with sudden terrors and panic, and with tuberculosis and burning fever; your eyes shall be consumed and your life shall ebb away; you will sow your crops in vain, for your enemies will eat them.

6.2.2 Cross-immunity between leprosy and tuberculosis

It is almost universally an accepted fact that **⬥āra'at** (leprosy of the Bible) is not Hansen's disease of today as mentioned above. It is possible then that there is a possible natural cross-immunity between leprosy and tuberculosis.

Lietman et al. (1997:1923) have tested the hypothesis proposed by Manchester (1984:173), that individual-level immunity acquired from exposure to tuberculosis may have contributed to the disappearance of leprosy from Western Europe. The conclusion reached by these scholars is that if the degree of cross-immunity between two diseases is known within an individual, then the epidemiological consequences of this cross-immunity can be assessed with transmission modelling. There is convincing experimental and circumstantial evidence that exposure to one species of mycobacterium can produce an individual human host with some degree of protection against infection by another species of mycobacterium. Different strains or species of pathogens compete for hosts, and if cross-immunity is sufficiently pronounced then one species or strain of an organism may completely exclude another from a host population (Lietman et al. 1997:1923). Manchester explains that the reason may be because both diseases are caused by Mycobacterium, a single genus, and that the actual tissue response provoked by the two bacteria; Mycobacterium tuberculosis and Mycobacterium leprae is basically the same. However, it was shown by Manchester (1984:173), that leprosy does not produce any immunity to tuberculosis. This means that tuberculosis will develop in the leper but that mostly young children that have overcome the primary tubercle invasion, would recover completely, and would from there on be immune to leprosy. Dotinga (2005:1) reports that because tuberculosis kills more quickly than leprosy, and because the spread of tuberculosis is more rapid from person to person, he believes that

where a person is diagnosed with both diseases simultaneously, he will die of tuberculosis. The net effect will gradually lead to leprosy becoming eliminated in a community.

As both diseases in ancient times were in essence incurable (in the presumption that *•āra'at* was Hansen's disease), then the net effect would have little consequence other than that one may not have found individuals infected with both infectious diseases, or as Lietman et al. conclude, that tuberculosis may have contributed to the decline of leprosy if the basic reproductive rate of leprosy was low (Lietman et al. 1997:1027). In modern times where both diseases are curable, the net effect of cross-immunity may only be important in underdeveloped countries.

6.2.3 The pathogenesis of tuberculosis in bone

The paleopathological interest in tuberculosis lies mainly in the pathogenesis of the disease in bone tissue. Tuberculosis of the bones is most frequently caused by the *haematogenous dissemination* of the tuberculosis bacilli from some active focus of infection, usually in the lungs, kidneys, intestines or lymph nodes. A possibility even exists of direct spreading from infected tissue adjacent to the bone. Tuberculosis is far more frequently found in children (Živanović 1982:221). The disease at first mainly attacks the ends of the long bones, especially the upper and lower ends of the femur and tibia. It then spreads to the hip- and knee joints. It frequently attacks the spinal vertebrae where it is called *Pott's disease* (see 6.2.4.1). Soft tissues of Egyptian mummies have provided the most concrete evidence that tuberculosis affected early human populations. A classic example of tuberculosis infection of the spine was found in the mummified remains of the priest of Ammony where a large psoas abscess was found in the spine, associated with vertebral destruction (Brothwell 1981:129).

6.2.4 Paleopathological signs

Tuberculosis may attack any bone with no preferences. When examining a skull, *Erdhein's* warnings (a type of symptom) about the bones of the skull is that there are extensive erosive changes which far more attack the interior surface of the bone than the exterior. This must be borne in mind when examining the skull. This leads to the fact that the external opening in the bone is usually smaller than the interior one (this fact is important in the differential diagnosis between tuberculosis and syphilis). Sequestrae of small bony segments are also possible. In long bones characteristic changes tend to widen and lead to focal destruction. At the ends of the bone there are often extensive cavitation (Živanović 1982:227-228).

Janssens found that tubular bacilli are usually localised in the growth centres and more so in the spongy part of the compact bone of long bones. Tubular bacilli are particularly localised in the epiphysis and metaphysis in children, and in adults in the bone with red marrow such as vertebrae, phalanges, metacarpals and calcani (Janssens 1970:98). Differential diagnoses that must be kept in mind according to Janssens, are *syphilitic lymphogranulomatosis*, *gummata*, *Scheuerman's disease*, *osteitis fibrosa generalisata*, and *multiple myelosis* (Janssens 1970:99).

6.2.4.1 *Pott's disease*

Manchester (1984:162) states that the presence of Pott's tuberculous osteomyelitis of the spine is the osteoarchaeological evidence of tuberculosis. Putschar (1966:61) believed that the most characteristic gross bone lesion of tuberculosis is angular *kyphosis* (Pott's disease), which is due to destruction and fusion of several vertebral bodies and their intervertebral discs, accompanied by paravertebral abscesses in the active stage. In the case of tuberculosis of the spine, according to Brothwell (1981:132), the thoracic and lumbar regions are most commonly involved. At first the body of one vertebra softens and breaks down, then the disease spreads to the following vertebra until a humpbacked condition is produced. Some degree of repair sets in, resulting in the bony fusion or union. In the differential diagnosis of spinal osteitis, Brothwell states that one

should keep vertebral syphilis, mycotic infection and compression fractures in mind in differential diagnosis. Tuberculosis may penetrate bone tissue causing tuberculosis osteomyelitis which leads to necrosis and destruction of bone columns (Živanović 1982:228).

The vertebrae suffer exceptionally from tuberculosis and the form of hunchback affliction known as Pott's curvature then develops. Agnew (1967: s.v. Pott's curvature) describes Pott's disease or curvature as an abnormal curvature of the vertebral column caused by tuberculous caries. This disease symptom was first described in 1779 by Pott. In 1816, the French surgeon Delpech described this curvature as of tubercular origin (Janssens 1970:99). Janssens described a figurine found in Egypt with typical Pott's disease, one of a number of art forms that presented clear evidence that Pott's disease was common in Egypt in ancient times (Janssens 1970:99). Živanović (1982:229) concurs that the morphological changes in the vertebrae are very characteristic.

6.3 TREPONEMAL DISEASES

6.3.1 Treponemes in humankind

The treponemal diseases of which syphilis is the best known, are often thought to be a disease of the sixteenth century AD because of the assimilation with the well known history of Christopher Columbus who purportedly brought the disease from South America in 1492. Roberts and Manchester (1995:157) however mention that it may be possible that Columbus brought back from America only a more virulent strain of *T. pallidum*. This strain may have been responsible for converting a long-standing and comparatively mild disease in Europe into one of fulminating character. It has also been proposed by Hackett (1963:15) and Harrison (1959:1) that syphilis in Europe prior to the Columbian expeditions was not identified specifically from several other diseases, including leprosy.

Treponema, from Greek *trepein* = to turn + *nemā* = thread, is a genus of microorganisms of the family *Treponemataceae*, of the order *Spirochaetales*. There are at least nine different species of *treponema* of which seven are non-pathogenic to the human race and only three, namely *T. pallidum*, *T. carateum* and *T. pertenue* are pathologic to humans (Agnew 1967: s.v. *Treponema*).

The infectious human diseases caused by the bacteria of the genus *treponema* are *pinta*, *yaws*, *bejel* and syphilis. There is controversy as to whether these are different disease entities caused by different species of bacteria within the genus, or whether they are merely different clinical manifestations of infection by one species namely *treponema pallidum*. If they are truly different diseases, then collectively they may be referred to as *treponematoses*, but if they are just different clinical manifestations, the disease is known as *treponematosis* (Roberts & Manchester 1995:150; Hudson 1958:23). The international medical organisations are stressing research and treatment of *treponematosis* worldwide, while referring to its component parts as the *treponematoses*. The plural term is however still written as *treponematoses* (Hudson 1958:22). Ubelaker (1992:367) calls *treponematosis* diseases four clinical *syndromes* namely *pinta*, *bejel*, *yaws* and syphilis (with congenital syphilis as a variant). The word *syphilis* is *New Latin*, from *Syphilus*, the hero of the poem *Syphilis sive Morbus Gallicus* (then called 'syphilis' or the French disease) by Girolamo Fracastoro, an Italian poet, physician and astronomer (Mish & Morse 1993. s.v. *Treponema*; Steinbock 1976:89; Tulloch 1990 s.v. *Syphilis*). Mish and Morse explain syphilis thus: *treponematosis*, a contagious venereal disease progressing from infection of the genitals via the skin and mucous membrane to the bones, muscles, and brain. Mish and Morse (1993: s.v. *Treponematosis*) define the disease as a chronic contagious, usually venereal and often congenital disease caused through a *spirochete* (*treponema pallidum*); it is pathogenic in human and other warm-blooded animals. If left untreated it produces chancres, rashes and systemic lesions in a clinical courses (Agnew 1967: s.v. *Syphilis*).

Agnew (1967: s.v. Treponematoses) describes several other forms of *treponematoses*. These forms add to the list of Roberts and Manchester below. (1995:151). These other forms of treponemes, apart from pinta and yaws are mentioned only for the sake of completeness.

- *T. cuniculi* is the causative agent for rabbit syphilis which is non-pathogenic to human beings.
- *T. carateum* is the causative agent of a pinta (carate). This disease is pathogenic.
- *T. micro- and macrodentum* are nonpathogenic species found in normal human mouths.
- *T. pertunue* is the causative agent of yaws (*framboesia tropica*) in man. This disease is pathogenic.

6.3.2 Treponema as disease in the Bible

There is some evidence that venereal diseases were common in biblical times. In the Bible for example, Zachariah (11:17) warns the shepherd who leaves his flock, saying that his arm will be dried up and his right eye will go blind. These symptoms indicate a disease of the spinal cord, probably a venereal disease. Some believe that Leah, wife of Jacob, had an eye condition that could have been the result of hereditary syphilis (Gn 29:17); (Packer et al. 1997: s.v. Venereal diseases).

The Mosaic laws forbid the peoples of the covenant, Israel, to partake in any anomalous sexual behaviours that were forbidden in the laws laid down in Leviticus 18. In this chapter the Israelites are directed in general not to imitate the customs and practices of the Egyptians and Canaanites, but to keep the ordinances, statutes, and judgements of the Lord (Lv 18:1). They are instructed particularly to avoid incestuous marriages (Lv 18:6); carnal copulation with a menstruous woman (Lv 18:19); adultery (Lv 18:20); letting any of their seed pass through the fire to Molech (Lv 18:21); sodomy (Lv 18:22); and bestiality (Lv 18:23). The children of Israel are forbidden to partake in any of the sexual

transgressions practiced by their neighbours. They had to observe the pollution and destruction that these atrocities brought on the inhabitants of Canaan, and which would bring the same on them should they commit these atrocities. We find these warnings in Leviticus 18:24-25:

Do not defile yourselves with any of these things; for by all these the nations are defiled, which I am casting out before you. For the land is defiled; therefore I visit the punishment of its iniquity upon it, and the land vomits out its inhabitants.

The harsh punishment that awaits the transgressors is taken up in Leviticus 18:29-30:

For whoever commits any of these abominations, the persons who commit *them* shall be cut off from among their people. Therefore you shall keep My ordinance, so that *you* do not commit *any* of these abominable customs which were committed before you, and that you do not defile yourselves by them: I *am* the LORD your God.

The prohibition to take part in intermarriage with the heathen nations and thus protect their purity is spelled out in Nehemia 13:23-26:

In those days I also saw Jews *who* had married women of Ashdod, Ammon, *and* Moab. And half of their children spoke the language of Ashdod, and could not speak the language of Judah, but spoke according to the language of one or the other people. So I contended with them and cursed them, struck some of them and pulled out their hair, and made them swear by God, *saying*, "You shall not give your daughters as wives to their sons, nor take their daughters for your sons or yourselves. Did not Solomon king of Israel sin by these things? Yet among many nations there was no king like him, who was beloved of his God; and God made him king over all Israel. Nevertheless pagan women caused even him to sin".

The same proscription is found in Joshua 23:12-13:

"Or else, if indeed you do go back, and cling to the remnant of these nations—these that remain among you—and make marriages with them, and go in to them and they to you, know for certain that the LORD your God will no longer drive out these nations from before you. But they shall be snares and traps to you, and scourges on your sides and thorns in your eyes, until you perish from this good land which the LORD your God has given you".

Many of these proscriptions centred around adulteration of the 'holy' nation that Yahweh had chosen for Himself. Other biblical references can be found in Ezra 9:1-2 and 10:2-3. Altogether these prohibitions had perhaps one thing in mind; to

conserve the children of Israel from debilitating diseases. It is said that all these prohibition laws were necessary because these 'sins' did occur amongst the people of Israel. This is contrary to the belief that certain sins did not exist in Israel.

6.3.3 The geographical occurrence of Treponematoses

Hackett's (1963:8) views are that yaws, *bejel* or nonvenereal treponemal disease, syphilis and *pinta* are syndromes and epidemiological phases of one and the same disease caused by *treponema palidum*. His belief is contrary to what medical science at the time had known (see Agnew 1967 above). Hackett also believes that *treponematoses* in one form or another has been present on every continent for thousands of years. He suggests that Christopher Columbus (in the 15th century) was entirely irrelevant in the history of syphilis. Hackett claims that syphilis was present long before Columbus' travels but was not distinguished from a number of diseases, including epidemic diseases, all of which were referred to as 'leprosy' (Hansen's disease); (Hackett 1963;7) and in Goldstein (1969:287). Zias differs with these scholars and supports the theory which he believes is supported by osteo-archaeological evidence. Syphilis was unknown in Europe prior to 1492. He believes that osteoarchaeological evidence supports the theory that syphilis was probably the adaptive transmutation of a New World nonvenereal treponemal disease brought back to Europe by returning sailors in 1492 (Zias 1991:152; Cockburn 1961:223).

Nonvenereal treponemal disease or what is known as *bejel* was endemic in the Eastern Mediterranean. Like syphilis, *bejel* causes extensive skeletal involvement which is ultimately fatal. The transmission of *bejel* is by skin contact (Agnew 1967: s.v. *Bejel*).

A few cases of nonvenereal treponemal disease (*bejel*) in the Holy Land that were identified in paleoarchaeological records are believed all to belong to Bedouin and Arab populations (Goldstein et al. 1976:624).

On the origins of treponematoses Cockburn agrees with a theory of evolution of the bacteria. He offers the explanation that the ancestors of *treponeme* bacteria formed symbiosis with larger creatures which led to the development of parasitism with varying degrees of pathogenicity. He also states that man acquired *treponemes* from his primate ancestors and took it with him in his migrations over the globe after the Ice Age. Ecological isolations produced syphilis in colder climates and yaws in tropical or warm climates (Cockburn 1961:221).

6.3.4 The origin and spread of the *Treponemes*

The genus *Treponema* belongs to the family *Treponemataceae* which includes the genera *Borelia* and *Spirochaetales*, to which the family of *Spirochaetaceae* also belongs. Cockburn believes it is the free-living microbes that over millions of years formed symbiosis with large animals which spread horizontally to other animal species in the same ecology. Man inherited these parasites vertically from the primates. These parasites were not necessarily the pathogenic species of the *Treponemes*, but it nevertheless lived and spread with man for thousands of years (Cockburn 1961:223). The history of modern man, *Homo sapiens*, appeared about 38 000 years ago, most probably in Africa. *Homo sapiens* was not the only man, for another, the *Neanderthal* man, co-existed on earth until about 30 000 years ago. *Neanderthal* man then ceased to exist at that time. *Homo sapiens* started migrating all over the globe because of the fact that during the Ice Age man presumably took many of his parasites with him; among these would be the ancestor of the *treponemes* (Cockburn 1961:225). Zias (1981:321) believes that the *treponema* bacteria underwent mutation when migrants moved from the West to the Near East. The mutation rendered a nonsexually transmitted species into a sexually transmitted disease. Cockburn may not agree in full but mentions that the nature of the *treponemal* infections is influenced by the size of the population. In small populations the disease is chronic but becomes acute in larger populations (Cockburn 1961:225).

Cockburn concludes by saying that the promiscuous habits of people determines not only the spread of the disease but also the virulence of the infection. The decrease in morality will eventually lead to the selection of more acute and more highly infectious strains (Cockburn 1961:225).

6.3.5 Paleopathology of Treponemes in general

Yaws, *bejel*, and both forms of syphilis can affect the skeleton, unlike *pinta* that affects only soft tissue (Ortner & Putschar 1981:180). Although syphilis, *yaws* and *bejel* exhibit overlapping patterns of proliferative periostitis, *yaws* has an added skeletal manifestation not seen in syphilis and *bejel*. This expression of *treponematosi*s involves the erosive destruction of one or more joints, similar to the destruction of rheumatoid arthritis (Ubelaker 1992:367). There are other differences between *bejel* and *yaws*, but according to Hudson (1958:22) these can be explained by factors of climate and human customs. In general, *bejel* is found in colder climates where people wear more clothes, against *yaws* which can be found in hot and humid climates. In *bejel* the basic element in the epidemiology is the transfer of *treponemes* from mucous patches in the mouth of one person to the mouth of another.

That syphilis was known in the Near and Middle East in ancient times is perhaps seen in the many descriptions of leprosy in old texts. Some of these texts correspond more to a description of syphilis than leprosy. The fathers of paleopathology, namely Ruffer, Smith and Jones, found no trace of the disease amongst thousands of mummies in the Nubia excavations in 1910, according to Živanović (1982:234). He states that the inexpert would have found it an impossibility to distinguish between leprosy and syphilis in those days, but reckons that even today, with numerous technological advances, it still is difficult to distinguish between the two diseases when viewing skeletal remains.

Baker and Armelagos (1988:704) allege that, since skeletal lesions resulting from *yaws*, *bejel* and syphilis are very similar. Speculation regarding the modes of worldwide distribution and transmission of these *treponemes* are difficult to access. Reliable conclusions with regard to the prehistoric distribution of *treponemal* disease may, however, be drawn from skeletal evidence.

6.3.6 Differential diagnosis of Treponematosis

Harrison (1959:3) believes that the diagnosis of syphilitic diseases in ancient skeletal remains must always be regarded with suspicion. The apt name of syphilis as 'The Great Imitator' signifies the reality that differential diagnosis is not going to be easy, writes Harrison. Of the thousands of pre-1493 CE bones that have over years been studied, Harrison believes, scholars were unable to find any undoubtedly syphilitic changes. The lesions of syphilis often imitate other infectious and hereditary disorders. Skeletal tuberculosis often proves difficult to distinguish in a differential diagnosis of osseous syphilis. In the early stages tuberculosis tends to be progressive with bone destruction with little new bone production. The 'swelling' of the long bone diaphyses rarely occurs in tuberculosis but is general in syphilis. Pyogenic *osteomyelitis* may closely resemble the osseous lesions of syphilis in the initial stages of periostitis and osteitis. However, more bones are involved in advanced cases of syphilis (Harrison 1959:3).

Paget's disease may have postcranial lesions very similar to syphilis. However, the massive thickening of the skull vault is different from cranial syphilis (Steinbock 1976:137).

6.3.7 Comparisons between the major treponemal diseases

The following two tables of comparisons between the different treponeme diseases were drawn up from the information obtained from Edwardss (1995:140-142):

Table 2 Comparison of the major treponemal diseases

Disease	Organism	Source	Transmission	At risk
<i>Yaws</i>	<i>T. pertenue</i>	Skin	Contact	Children
<i>Pinta</i>	<i>T. carateum</i>	Skin	Contact	Family
<i>Bejel</i>	<i>T. pallidum</i>	Oral, utensils	Contact	Family
Syphilis	<i>T. pallidum</i>	Genital sores, oral	Sexual, placenta	Sexual partners, foetus

Table 3 Lesions left by Treponemal disease

Disease	Primary lesions	Secondary lesions	Tertiary lesions
<i>Yaws</i>	<i>Ulcerogenic</i> nodule	Skin, bones	Skin, bones, palms and soles
<i>Pinta</i>	<i>Papule</i>	Skin	Skin
<i>Bejel</i>	Rare	Skin, mucosae, bones	Skin, mucosae bones, handpalms and soles of the feet
Syphilis	Genital ulcer <i>Lymphadenopathy</i>	Skin Mucosae, bones, <i>meninges</i>	Cardiovascular, CNS, bones

6.3.8 Discussion of the different types of syphilis

6.3.8.1 Syphilis

Syphilis may be either congenital or acquired. Syphilis is transmitted through sexual contact. This type is called 'acquired syphilis'. However, the actively infected female can pass the organisms transplacentally to a foetus so that it is born with the disease (see below).

Venereal syphilis is acquired after puberty. After an incubation period of several weeks following infective contact the primary lesion (chancre) usually appears at the point of entry. Three stages of the disease are recognized;

- Primary syphilis. The first stage is marked by the development of a *chancre* and the spread of the *spirochete* in the body tissues. A *chancre* is a small papule which erodes into a reddish ulcer covered with a yellowish exudation (Agnew 1967: s.v. Chancre)
- Secondary syphilis. The second stage appears from 2 to 6 months after the primary infection and is marked by lesions in the skin but also internal organs. Fever is also experienced. The skin eruptions are without etching. Severe headaches and pains in the joints are typical.
- Tertiary syphilis. The third stage is marked by skin ulcers and *gummas* under the skin. Skeletal involvement is common as well as the internal viscera that may become extensively diseased (Mish & Morse 1993: s.v. Syphilis; Agnew 1967: s.v. Syphilis).

The soft tissue lesions have already been mentioned above. It is however the skeletal changes that are of importance to the paleopathologist. Changes in the skeleton appear between 8 and 25 years after the primary infection and are seen in the third or tertiary stage of syphilis. Destruction may be massive and it is then that the so-called *gummata* are found. A *gumma* (singular) is a soft tumour made of tissue resembling granulation tissue, similar to the tuberculosis gumma (Agnew 1967: s.v. Tuberculosis). These *gummata* appear anywhere and lead to a variety of symptoms. In the event of it attacking the skeleton, then the vomer, tibia and skull would be the preferred areas. Ortner and Putschar (1981:188), however report that the most common location of tertiary syphilitic lesion is in the skull,

particularly in the paranasal area and in the cranial vault. The calvarial lesions represent the most specific diagnostic features. *Gummata* in the bones may lead to fracture, deformity or collapse of bone structures. When the vomer collapses, then the support for the soft tissue of the nose disappears and the result is the 'saddle-nose' characteristic of syphilis. *Gummateous* periostitis can be found in any bone (Živanović 1982:236).

6.3.8.2 Congenital syphilis

Congenital syphilis is transmitted *in utero* by treponemes invading the foetus from the placenta of an infected mother. The disease is easily transmitted as shown by an attack rate of 84% in offspring of an infected mother (Steinbock 1976:98). The treponemes cross the placenta after the third month of foetal development and spread via the bloodstream to virtually every bone in the foetus (Steinbock 1976:98; Ortner & Putschar 1981:198).

- The dental image: The dental stigmata of late congenital syphilis are important but are not pathognomonic signs of this disease. The dental stigmata are associated with characteristic bone lesions in about 50% of all cases, and in such instances the diagnosis of congenital syphilis is very reliable (Steinbock 1976:106).
- The permanent dentition, and in rare cases, the primary molars, are affected. This phenomenon is plausible in hereditary or congenital syphilis because these teeth develop after the foetus has been invaded by the *treponemes in utero*. The exact pathogenesis of the dental stigmata remains uncertain. The major teeth involved are the maxillary incisors and all first molars. The mandibular incisors are less frequently affected. The tooth malformations were described by Hutchinson in 1863 and bears his name since (Steinbock 1976:106).
- Classic Hutchinson's maxillary incisors are barrel-shaped with convergence of both lateral margins towards the incisal edge. Notching of

the incisal edge is a general phenomenon but the amount of notches varies widely. In some teeth a distinct crescentic notch at the incisal edge is present; in some incisors there are pit-like depressions on the buccal surface, and sometimes both phenomena are present. Sometimes the notchings are not apparent but then the shape of the tooth may be characteristically 'screwdriver' shaped or almost 'peg-shaped' (Steinbock 1976:108)..

- The affected molar teeth, be it the primary molars or the first permanent molars, are known as 'mulberry' molars, also bud molars, domeshaped molars, Moon's molars or Fournier's teeth. The occlusal surface resembles a mulberry in that it is rough and irregular with several small knobs representing atrophic cusps. Enamel hypoplasia similar to rickets may also be present. Again it must be stressed that the Hutchinson teeth are not pathognomonic of congenital syphilis unless it is associated with other characteristic syphilitic bone lesions such as the sabre-shin tibia (Steinbock 1976:108).

6.3.8.3 Yaws (*framboesia, pian or bubas*)

According to the 'Unitarian' theory, yaws is one of the four syndromes of *Treponematoses* caused by *Treponema pallidum*. The four syndromes include syphilis, *bejel*, *pinta* and yaws, according to Steinbock (1976:142). Others believe that yaws is a separate disease caused by *Treponema pertenue*, like Edwards (1995:140).

Bosch (2000:1248) mentions that the oldest discovery of yaws in a skeleton was 8 000 years ago in Florida in the United States. Goldstein (1969:288) states that yaws often manifested itself in ancient times with 'boomerang leg' and swelling of the forearm with ankylosis of the elbow joint. The symptoms have changed very little in time as Edwards (1995:141) describes modern times symptoms, suggesting that anthropologically the characteristics have not changed

significantly. Ubelaker states that the distribution of the disease within the skeleton is variable but shows predilection for the bones with minimal overlying soft tissue, like the tibia and the *calvarium* (skull). The most common skeletal manifestation is abnormal bone enlargement resulting from proliferative periostitis with most of the new bone formation being added to the anterior and medial surfaces, thereby giving the false appearance of a curvature (Ubelaker 1992:368).

A proliferative granuloma containing numerous treponemes develops at site of initial infection. This is followed by secondary eruptions and perhaps hypertrophic *periostial* lesions of many bones with underlying rarefaction. Lesions of late *yaws* are characterised by destructive changes which closely resemble the osteitis and gummas of tertiary syphilis and which heal with much scarring and deformity. The incubation period is 3 to 4 weeks (Agnew 1967: s.v. Yaws).

- Early *yaws*: The primary soft tissue lesion is usually on the leg or buttocks. The secondary eruption follows a few weeks later as papillomas covered with whitish yellow exudate in the flexures and around the mouth. *Phalanges* nasal bones and tibiae swell and become distorted. Most lesions will eventually subside, even if untreated.
- Latent *yaws*: Recurrence of early *yaws* symptoms and after an interval of 5 to 10 years, late *yaws* follows.
- Late *yaws*: Solitary or multiple lesions appear as nodules or ulcers in the skin, *hyperkeratosis* lesions of palms and soles and *gummatous* lesions of bone take place. They heal with scarring. Lesions of facial and palatal bones cause terrible disfigurement (*gangosa*); (Edwardss 1995:141).

6.3.8.4 *Pinta*

Pinta is Spanish for 'painted', also the name of one of Christopher Columbus' three ships that took him to discover the new world and in the process the Spanish *conquistadores* arguably brought back syphilis to the New World (Živanović 1982:233). Hackett however mentions that Pinta is considered the ancient endemic treponematosi s of the Americas (Hackett 1963:24). Agnew defines pinta as a chronic *dyschromic dermatosis* disease. The skin lesions are characterised by spots ranging in colour from white to red or violet. Pinta is also called *mal del pinto*, *carate*, *azul*, *boussarole*, *tina*, *lota*, *empeines* or *spotted sickness* (Agnew 1967: s.v. Pinta). For the paleopathologist it is important to know that there are no bony impairments. The skin lesions may be important in various differential diagnoses (Edwardss 1995:142).

6.3.8.5 *Bejel*

Bejel is a nonvenereal form of treponematosi s (*T. pallidum*) occurring mostly amongst children in the Middle East. It is strongly related to the nomadic groups of the Southern Levant, in the region of the Negev. In modern times the incidence amongst the Bedouin nomads reached 65 percent of the total population. In Israel, *Bejel* had been found in tombs in Syro-Palestine dated 200-100 BCE, all of the tombs belonging to the Bedouin tribes (Arensburg 1985:29). As mentioned earlier, *bejel* leaves skeletal lesions very similar to the venereal strain.

Steinbock (1976:138) believes that nonvenereal treponemal disease is a form of Treponematosi s with clinical manifestations intermediate between those of syphilis and *yaws*. Nonvenereal treponemal disease is usually acquired in childhood under unhygienic conditions through bodily contact. The disease is found in underdeveloped countries, in warm and arid climates, typical of the Eastern Mediterranean region (Arensburg 1985:28).

Described by Steinbock (1976:140), the *naso-palatal* destruction and *osteoperiostiti s* are some of the most common lesions. Unlike syphilis, the cranial vault is rarely affected. Of the long bones, the *tibia* and *fibula* are mostly affected,

followed by the *radius*, *clavicle*, *phalanges* and *calcaneus*. Nonvenereal treponemal disease closely resembles late congenital syphilis as well, apart from the *osteochondritis* and dental involvement which only occur when the *treponemes* invade the foetus *in utero*. Other bone reactions are the typical sabre-shin *tibiae*, the narrow medullary cavity and the irregularly thickened *subperiosteal* bone, giving the typical swollen-bone appearance (Steinbock 1976:140).

6.3.9 CONCLUSION

A brief review of the causal *treponema* organisms, the clinical course, epidemiology, estimated geographical distribution and several other aspects of the four human *treponematoses* show that much more knowledge is needed before final decisions on the presence of these diseases in Syro-Palestine can be made. Ortner and Putschar (1981:177) indicate that the paleopathologist can never not have *treponematoses* as a possible differential diagnosis when viewing any form of facial lesion that closely resembles syphilitical or tuberculosis' facial lesions. Too often the paleopathologist is confronted only with a cranium with clear pathological lesions and nothing else, as Risdon (1939:100) was confronted with in many of the human skulls removed from the rest of the skeletons at Lachish.

Hackett (1963:38) has mapped the incidence of the various *treponeme* forms globally and was able to show that the occurrence of *bejel* may have been the only form prevalent in the region of Syro-Palestine during the period of 3 000 BCE and the first century CE.

However, any disease not found and described by paleopathologists is still no proof of its nonexistence. I believe that with the advent of the science of DNA technology, the future of macromorphological and microscopical studies of human remains may have to take a backseat to DNA research.

CHAPTER 7

METABOLIC DISEASES

Diseases of paleopathological significance that are noninfectious may at times be more important to the paleopathologist because of the more dependable array of lesions than those found in infectious disease cases as has been mentioned before. These noninfectious diseases may be considered as the abnormalities of deficiencies or excess, mostly of dietary constituents (Zias 1991:149). Carlson et al. (1974:405), however, remind us that there is a strong relationship between cultural, environmental and biological variables effecting the incidence of pathology in a population. Palestine, and in particular the ancient land of Israel is known as a mostly arid land. The Negeb desert comprises roughly two thirds of the 1948 Israel, even more in certain ancient periods (Bimson et al. 1985:22). In early times, especially in lands dependent on their own productions, famines were not infrequent. Since the line between famine and plenty in Palestine depends mainly on the rains coming at the right time and in the proper supply, famine was an ever-present threat (Youngblood et al. 1997: s.v. Famine). Famines were generally caused by local irregularities of the rainfall, by destructive hail storms (Ex 9:23, 11, 32), by ravages of insects (Ex 10:15; Joel 1:4) and by enemies (Dt 28:51). A famine in a city might be caused by a siege as described in 2 Kings 6:25. Pestilence often followed in the wake of a famine, and the suffering due to hunger was usually great. The common Old Testament word for 'famine' is *ra`abh*; *re`abhon* also occurs in Genesis 42:19, 33 and in Psalm 37:19, and *kaphan* is the word used in Job 5:22 and 30:3, all translated as 'hunger' and 'famine'. In the New Testament the word is *limos*, meaning primarily 'failure' or 'want of food' (Orr 1997: s.v. Famine). Past societies lived on the proverbial knife-edge between subsistence and starvation. Improved techniques of hunting and agricultural methods improved the situation and shifted groups away from starvation. It is unfortunately not just the lack of food but also the quality in respect of the essential vitamins and chemical trace elements that are important. Evidence of chronic food shortages may be deduced from the study of skeletal and dental remains. Many factors may be involved in the production of such skeletal and dental abnormalities, and a direct causal relationship with poor

diet cannot be inferred as it is likely that multifactorial causes may be implicated (Roberts & Manchester 1985:163).

The metabolic diseases can also be described as 'markers' or 'indicators of stress'. Dorland defines stress as the sum of all nonspecific biological phenomena elicited by adverse external influences, including damage and defence. It may be localized or be systemic (Agnew 1967: s.v. Stress). The abnormalities observed in skeletal and dental remains represent the individual's adaptive response to stressors working on the body during the growing years (Roberts & Manchester 1995:163). These authors present the following factors which determine stress responses:

- It can be determined by the individual's immune status and genetic predisposition.
- Age: During the formative years the response of the bone tissue and teeth is much greater than during any other phase of life.
- Environmental factors may buffer or enhance the impact of stress.
- Stress factors may be cultural sensitive – certain cultures or populations may overcome stressors better than others would.
- Psychological stress may be predispositional to diseases that cause physical signs of stress.
- Where an abnormal infant mortality exists in a population it would suggest acute disease that may have precipitated deaths at that age-group. Although there may be few or no skeletons to confirm the stress causing fatal disease, it can be deduced from palaeodemographic statistics.
- Decreased stature may indicate poor nutrition during growth (Roberts & Manchester 1995:164)

For the purpose of this chapter certain 'indicators' that show a clear relationship with nutritional inadequacy will be considered. These signs include anaemia, osteoporosis, Harris lines and dental enamel hypoplasia.

7.1 EVIDENCE FOR DIET

Evidence for the type of diet that people in ancient times enjoyed are to be found in various aspects.

- Physical evidences used in compiling information about diets in ancient populations are textual, pictorial and archaeological (Hilson 1997:153).
- Scientific evidence may come from detailed chemical analysis of bone and teeth. The level of trace elements in these tissues has been used as an indicator for the dietary status in ancient societies (Burton & Price 1992:547).
- Evidence of dietary type may come from an analysis of the proportion of carbon isotopes present in human bone. Analysis of stable isotopes in bone collagen has been able to show when maize was introduced in new agricultural societies (Schwartz & Schoeninger 1991:285).
- Coprolite studies can reveal not only specific dietary components but also reveal to a certain extent the ecology of the surroundings of the finds.

7.2 PATHOGENESIS OF ANAEMIA

The study of paleopathological changes caused by different types of anaemia found in skeletal remains has been able to reveal not only the relative health or disease of an individual and a community but also when they started agriculture (Roberts & Manchester 1995:166).

Agnew 1967 Medical Dictionary defines anaemia as follows: *Derived from Greek: an = negative + heama = blood + ia.* A reduction below the normal in the number of erythrocytes per cubic millimeter, the quantity of haemoglobin, or the volume of packed red cells per 100 milliliter of blood. Anaemia occurs when the equilibrium between blood loss and blood production is disturbed (Agnew 1967: s.v. Anaemia).

Edwards' medical text book defines anaemia as a state in which the blood haemoglobin level is below the normal range for the individual's age and sex (Edwards 1995:785).

Iron is needed for the development of haemoglobin in newly formed erythrocytes in bone marrow. In anaemic individuals the erythrocytes are pale and small and they have a marginally shorter life span. The normal life span of erythrocytes is 120 days but in anaemic patients it may be as low as 60 days (Roberts & Manchester 1995:166). Iron is needed for haemoglobin formation in red blood cells and hence necessary for transportation and transfer of oxygen to the body cells. Iron is also necessary for the transmission of nerve impulses for collagen (protein) synthesis and contributes to the strength of the immune system (Roberts & Manchester 1995:166; Edwards 1995:787).

Iron is found in high quantities in red meat, legumes and shellfish and is absorbed in the intestines. Iron from plants is harder to absorb. Compounds found in staple foods like cereals and maize, called *phytates*, actually inhibit the absorption of iron. Vitamin C *per se* enhances uptake (Roberts & Manchester 1995:167). It is because of the phytates that the transition from a hunter-gathering to an agriculturally based economy proved to be detrimental for health reasons to mankind, causing iron deficiencies and anaemia (Roberts & Manchester 1995:169).

The causes of anaemia that lead to a decreased or ineffective marrow production are, according to Edwards (1995:787), the following:

- lack of iron, vitamin B₁₂ or folic acid;
- hypoplasia;
- invasion of malignant cells into the bone marrow.

Peripheral causes:

- blood loss;
- haemolysis;
- hypersplenism.

7.3 AETIOLOGY OF IRON DEFICIENCY

Iron deficiency may be caused by active bleeding, inadequate diet or malabsorption. Iron loss may be through menstruation or gastrointestinal bleeding. In tropical areas iron loss may also be due to infestation of hookworm or schistosomiasis (bilharzia) (Edwards 1995:788). The impact that these infections have on a population is seen in the nutritional deficiencies that develop. Møller-Christensen has shown that a large percentage of the remains that have revealed bone changes of leprosy had skeletal indications of anaemia (Møller-Christensen 1953 in Roberts & Manchester 1995:166). At the time Møller-Christensen believed the lesions in the orbits to be the result of leprosy. Years later this was confirmed by Møller-Christensen (1965:610) and the condition was known as *leprous cribra orbitales* or *usura orbitae*. Carlson et al. (1974:408) explained the role of parasitic infections in the occurrence of cribra orbitalia in skeletons from prehistoric Nubia as well as Stuart-Macadam (1992:152), who summarizes the evidence for infectious diseases as a major aetiological factor in the development of iron deficiency anaemia. De Gruchy (1970:200) states that infection does cause a *relative* inability of iron to contribute towards erythropoiesis. The reason is that the process of infection leads the body to withhold iron from the pathogens which need the iron to reproduce. In other words, it is a built-in protection mechanism of the body against infections, unfortunately detrimental to itself in other ways, because of the anaemia that follows. Stuart-Macadam (1992:159) however suggests that the aetiology of infection and anaemia is multifactorial, thus including climate, geography, hygiene, diet, time period and economy. See also under 'Iron deficiency as antimicrobial mechanism later.

The changes that occur in the skeleton are a direct result of anaemia. The body attempts to produce more erythrocytes in the marrow to compensate for the lack of iron. The bone lesions that occur are thinning the outer table of the skull due to vertically orientated trabeculae in the diploid bone, causing pressure on the table (hair-on-end appearance radiographically) and thickening of the diploid cells between the two skull tables. Apart from the external skull lesions, seen mostly in the occipital and parietal bones, the orbital roofs are affected in the form of holes

or pits in the bone surface. These changes are what is known as *cribra orbitalia*, always affecting the orbitae symmetrical (bilaterally) (Roberts & Manchester 1995:167). Vault lesions occur far less than orbital lesions.

7.3.1 Haemopoietic tissue

Blood cell formation is referred to as *haemopoiesis* (Greek: *poiesis* = to make). To understand anaemia and the resultant changes in the skeleton one has to understand the process of erythrocyte production. The production areas or the haemopoiesis tissue are found in the bone marrow or myeloid tissue of flat bones (sternum, skull and ribs) and certain long bones. Edwards (1995: s.v. Anaemia) describes the process as follows: Haemopoietic tissue is one of a number of rapidly proliferating tissues in which DNA synthesis is intense. Vitamin B₁₂ and folate are essential in this process. Deficiency of vitamin B₁₂ and folate will result in failure of DNA synthesis and disordered cell proliferation, called *megaloblastic anaemia*. Haemopoiesis is susceptible to this deficiency and division of cells is delayed and eventually halted. Morphological changes appear in the marrow cells. In the erythrocyte series these changes are described as a megaloblastic process (production of abnormally large cells). Erythrocyte cell division then starts occurring rapidly and that eventually leads to cell reduction. If however DNA synthesis is impaired, the time between divisions is increased, leaving larger cells (Edwards 1995:787). In the iron deficiency anaemia due to blood loss, the erythrocytes produced are small and pale, called microcytes (Marieb 1992:586).

It has been empirically shown that there is a correlation between lower iron levels and anaemia (Fornaciari et al. 1981 in Roberts & Manchester 1995:169). Although iron deficiency anaemia is thought to be the most commonly observed anaemia in ancient and modern times, as mentioned before, it may be necessary to discuss two genetic anaemias characterised by abnormal haemoglobin. These two, as will be shown later, produce the same skull changes as other anaemias, but also produce changes in the rest of the skeleton. These two conditions are *Thalassaemia* and *Sickle-cell anaemia*.

7.3.2 The hereditary anaemias

7.3.2.1 *Thalassaemia*

The term is derived from the Greek: *Thalassa* = sea, *haema* = blood. This condition was originally observed in persons of Mediterranean stock, hence the name *Thalassaemia* or *Mediterranean anaemia* or *familial erythroblastic anaemia*. The disease is a hereditary, genetically determined *haemolytic* anaemia with familial and racial incidence. The most severe form of this disease is known as *thalassaemia* major and the milder form as *thalassaemia* minor (Agnew 1967: s.v. *Thalassaemia*). Edwards (1995:796) describes this form of anaemia as an inherited impairment of haemoglobin production in which there is partial or complete failure to synthesize a specific type of the globin chain. This may be because of a genetic information problem. The gene itself may be deleted, like in *thalassaemia* major. *Thalassaemia* major results in a very high mortality rate in childhood and a limited adult life span in the few survivors. Only the major strain leaves bone changes (Steinbock 1976:220).

7.3.2.2 *Sickle-cell anaemia*

It is a genetic disease where abnormal elongation of erythrocytes occurs. This condition is also of a genetical origin: the inheritance of the *sickling* gene ('s') which causes a substitution of *one* amino-acid in the chain of haemoglobin. Haemoglobin molecules containing the abnormality become sharp when the oxygen tension in the blood is low, causing this erythrocyte to assume a sickle shape. This condition is not treatable apart from blood transfusions. Sickle-cell anaemia is widespread amongst black people in Africa, India and the eastern Mediterranean (Marieb 1992:1008).

According to Steinbock (1976:216) the sickling gene 's' is found exclusively in Negroes, whereas the other mutant genes occur in various racial groups. A large

proportion of individuals who are homozygous for the abnormal haemoglobin 's', 'c' and 'e', will die during the first years of life. Many of those living on into childhood will die before the age of ten.

7.3.3 Malaria and hereditary anaemia

The mutant genes that cause the hereditary haemolytic anaemias are geographically widespread over large areas of Northern Africa, the Mediterranean and South Eastern European countries, stretching in a band across Asia including India and the Indonesian Islands (Edwards 1995:785). It was found that people who are heterozygous for thalassaemia or sickling trait have a higher resistance to malaria. This resistance is mainly due to the short life span of the red blood cells in these individuals which prevent the malarial parasites from establishing an infection in the bloodstream (Allison 1954:1187-1188). Angel (1966:720) mentions that thalassaemas and sickle cell anaemias are balanced polymorphisms which are apparently maintained by *falciparum* malaria. Angel (1972:307) believes that during migrations, population increases and the decline in health at the time of the farming revolution between the eighth and the sixth century BCE, the spread of the new mutant *falciparum* malaria crossed the flow of genes from Africa northwards. This he believes is indicated by an increase in incidences of porotic hyperostosis. The coincidence between malaria and the anaemias is seen as a possible cause of porotic hyperostosis. In Anatolia and Greece (part of the anophelic belt of the Old World) from the seventh to the second millennia BCE, porotic hyperostosis occurred frequently in farmers in the marshy areas but rarely in inhabitants of dry or rocky areas. The logical explanation may lie in the abundance of water in which the *anophelic* mosquitos breed in marshy areas (Angel 1966:761). He also mentions that the frequency of the disease decreased as farming methods improved in marshy fields because of making better use of available water. The prevalence of porotic hyperostosis again increased together with the increased incidence of malaria and poorer farming methods which caused malnutrition in Hellenistic and Roman times. This

may reflect on an aetiology of poor nutrition as a cause of porotic hyperostosis that Carlson et al. (1974:405) also proposed at a later date.

7.4 PALEOPATHOLOGY OF THE DIFFERENT ANAEMIAS

Lesions of anaemic and related diseases must be seen as signs of diseases and not diseases *per se*. The bone lesions in most cases are pathognomonic of a specific anaemic disease and are amply exemplified in the literature, and are referred to as symmetrical or porotic hyperostosis osteoporosis. The term 'osteoporosis' has a general connotation with many bone conditions which show rarefactions. More definite terms have been suggested by Carlson et al.(1974:405; Lallo et al. 1977:471) in the place of symmetrical osteoporosis: osteoporotic pitting; spongy hyperostosis; and cribra orbitalia.

Lallo et al. (1977:471) mention that cribra orbitalia is the initial osseous manifestation of porotic hyperostosis with osteoporotic pitting and spongy hyperostosis occurring secondarily.

- Osteoporotic pitting refers to lesions of small pits on the external surface of the cranium. This corresponds with the 'porotic' type of Nathan and Haas (1966:171). There is thickening of the diploic space associated with osteoporotic pitting.
- Spongy hyperostosis (*hyperostosis spongiosa*) is characterised by the appearance of osteophytes forming a network of trabecula-like bone on the external surface of the cranium plus thinning of the external table and expansion of the diploids.
- Cribra orbitalia refers to lesions on the superior surface, of the orbits. Cribra orbitalia also shows pitting and thickening of the diploids as shown above, but only inside the orbit. In later stages the pitting expands into a honeycomb-like effect.

Angel (1966:171) had no answer to the aetiology of this bone condition. Few textbooks in anatomy and no osteology books in his time had mentioned these

signs. Welcker (1888: as quoted in Nathan & Haas 1966:174), who first described cribra orbitalia in 1885 and named it thus, considered it to be a racial feature. Others suggested irritation and inflammation of the periosteum a cause (Nathan & Haas 1966:173). M*ller-Christensen (1965:610) regarded leprosy as the only causative factor and found that 67% of confirmed leprosy skulls had indications of the presence of cribra orbitalia out of a 100 assessment cases. Angel (1964:369) considered *thalassaemia* and *avitaminosis* as a possible factor in the aetiology of cribra orbitalia.

Of the 718 skulls that were examined by Nathan and Haas (1966:175) some degree of cribra orbitalia (25,3%) was found in 182 of the cases. The condition was most common in the group from Israel amongst adults and children alike. In table 4 only the skulls from Israel from the Judaeen Desert Caves will be shown (Nathan & Haas 1966:172).

Table 4 shows the different locations in Israel, all three being caves where remains seem to be better preserved on average (Nathan & Haas 1966:185).

Table 4

Origin	Number of skulls examined			Number of affected skulls				
	Children	Adults		Total	Children	Adults		Total
		M	F			M	F	
Caves: Nahal Mishmar (Chalcolithic period)	6	8	2	16	6	3	1	10
Caves: Nahal Hever and Nahal Seelim (Jewish Bar Kochba period 2nd century AD)	15	8	12	35	14	1	9	24
Caves: Ein Gedi (Jewish 1st or 2nd century BC)	15	46	33	94	10	6	6	22

Statistical values for the chalcolithic period is included merely to show a broader field of investigation. Nathan and Haas are of the few archaeologists in the sixties

to have made an effort to investigate the remains of human skeletons found for pathology.

Whereas the average positive identification of affected skulls is 25,3% of the whole study of 718 skulls (not shown in table 4), the incidence amongst the Israelites from the above mentioned caves is an average of 38,6% categorized as:

Children:	83,3%
Adult, male:	16,1%
Adult, female:	34,0%

The extremely high frequency of cribra orbitales amongst children in the Israeli caves seems to reflect not only the harsh conditions to which the inhabitants of Israel were subjected, but also the fact that we may have to do here with a troglodyte population where more children's skeletons are normally recovered in comparison to rural and metropolitan burials. It is only in North America that more children's skeletons were comparably recovered. Cribra orbitalia in the study field of Northern America affected 63% of the skulls (Nathan & Haas 1966:186).

Even within the adult group the percentage of cribrae lesions in Israel is the highest of this study group. In ethnic geographical groups that were included in this study, the following were recorded: Negroes – 48%; Mongols – 37%; Caucasian – 55,5%; and Israelites – 65,7% (Nathan & Haas 1966:187).

Sub-adult crania were examined for the presence of porotic hyperostotic lesions by Lallo et al. (1977:471) to determine the effects that their social lifestyle within their ecological surrounding may have had on their health. The study included groups from hunter-gatherers, transitional and agricultural societies. The result shows the frequency of porotic hyperostosis is significantly higher and more severe in the agricultural populations. There is also a significant association between porotic hyperostosis and infectious disease.

The possible aetiologies of the three cranial lesions that are localised on the superior border of the orbits or on the external surface of the cranium include:

- a discrete trait (Brothwell and Sandison 1967:viii);
- pressure from surrounding bones or intra-ocular infection (Nathan & Haas 1966:180);
- a hereditary haemolytic anaemia (thalassaemia or sickle-cell anaemia) (Angel 1966:762);
- some form of nutritional disorder (Nathan & Haas 1966:189);
- an iron deficiency anaemia as the primary factor (Lallo et al. 1977:479);
- periosteal inflammation of the orbit due to local infections of the eye such as trachoma or acute or chronic conjunctivitis (Nathan & Haas 1966:188);
- leprosy. Nathan and Haas however suggested that the higher frequency of cribra orbitalia in leprosy patients was due to the poor nutritional conditions under which they lived, together with the effect of nutritional disturbances produced by the disease itself (Nathan & Haas 1966:179).

Some of the proposed aetiologies may be mere guesswork, as in local inflammatory conditions, it is hard to explain why specially the roof and not the floor, medial and lateral walls of the orbit are affected (Nathan & Haas 1966:188). The most popular aetiologies that have stood the test of time are anaemic conditions and in particular iron deficiency due to haemorrhage, infections and poor nutrition (Strauss 1978:660).

Carlson et al. discuss the interaction of diet, cultural tradition and population ecology in the development of iron deficiency anaemia and the aetiology of the three cranial lesions. The diet of milled cereal grains (millet and wheat) contains critically little iron (Carlson et al. 1974:408). Prolonged suckling and weaning-diarrhoea are both sources of respectively low iron intake and iron loss (Carlson et al. 1974:408; Angel 1966:760). Lallo et al. explain why iron deficiency develops

from a diet of maize. Not only is maize low in iron, but it contains phytate which binds iron, thus causes reduction in iron (Lallo et al. 1977:474).

Unusual high incidences of hyperostosis are mentioned by Angel (1966:762). With the changes in farming cultures or rather in presumably the transitional period, from hunter-gatherer to agricultural farming, low iron consumption due to a diet of wheat as well as increased malarial frequency were reported and the incidence of porotic hyperostosis reached the 50% mark in the Middle Bronze period.

The question may arise whether vault lesions and orbital lesions have the same aetiology. Most authors agree that it does (Stuart-Macadam 1982, 1985; Angel 1966; Carlson et al. 1974), but all see the process starting in the frontal bones and orbitae and then spreading to the vault (Stuart-Macadam 1989a:187). Each type can however occur separately as well. It was found that whenever vault lesions occurred there were always orbital lesions (cribra orbitalis) (Stuart-Macadam 1989a:188). Keita (2003:213) concurs with Stuart-Macadam in his results of a study of porous lesions of the skull vault in Upper Egyptian samples. He believes the iron deficiency anaemia of hypoferraemic states produces cranial vault and orbital roof lesions in childhood. He remarks that it has been shown that chronic blood loss stimulates marrow hyperplasia but that dietary insufficiency alone causes notably less of a response. Stuart-Macadam (1987a:525) is of the opinion that skulls with porotic hyperostosis can show the same pattern of pitting of the compact bone as well as thickening of the diploids in both the orbit and skull vault. On the evidence of bone changes in anaemia he insists that the two lesions of orbital and vault, of porotic hyperostosis have the same aetiology.

Porotic hyperostosis is described with characteristic bone lesions of the skull, whether the aetiology be hereditary or acquired anaemias. To confirm the diagnosis of these lesions radiographically Stuart-Macadam (1987a 511-513) has compiled seven radiographic criteria to facilitate comparison:

- 'Hair-on-end' radiographic pattern of trabeculation – this appearance is more likely to occur in thalassaemia. This appearance has been noted in many disorders in which hyperplastic bone marrow is a feature. This appearance has been found in 5 – 10% of radiographs of patients with various anaemias.
- Outer table thinning or even total disappearance of the outer table – this feature is common and it occurs in most forms of anaemias.
- Texture changes – the normal homogeneous appearance of skull vault trabeculae is replaced with coarse, granular patterns and shows an increase in radiolucency. Appears in 25 – 50% of suspected cases.
- Diploic thickening – found in many haematological disorders, particularly in anaemias. Diploic space – a great change in the ratio of diploic bone to compact bone is a sign of pathologic change. The ratio is 1:1,4 for normal skulls but pathological bone reaches ratios from 1:2,3 to 1:73. This feature is noted in 22% of suspected skulls.
- Orbital thickening – this is evident on lateral radiographs of the skull. The roof of the orbit greatly increases in thickness in children under the age of four with sickle-cell anaemia, also observed to a lesser extent in other haemolytic disorders.
- Orbital rim disorders – an altered appearance of the orbital rim on a posterior-anterior view of the skull radiographically. The altered appearance includes thinning, flattening, loss of definition and obscuring of the normal rim outline.
- Frontal sinus development – haemolytic anaemia can cause the air spaces in the temporal bones and paranasal sinuses to become encroached and sometimes obliterated by marrow hyperplasia and internal swelling of the bones, even in children where sinus cavities may normally be only pea-sized.

Although the radiographic tests were done on live patients, most or all of these radiographs can be taken of human remains of any historical age, for this procedure is totally noninvasive and will ensure no destruction of bone matter.

7.5 IRON DEFICIENCY AS AN ANTIMICROBAL MECHANISM

The mechanism of iron deficiency is also aptly summarised by Stuart-Macadam (1992:41). Many microorganisms require iron for their replication. Without having their own stores they have to rely on supplies of iron that they can obtain from their hosts with their own iron-chelates. The human body can counteract this need by withholding iron and so fight the infection. It has also been suggested that iron deficient patients are less at the risk of infections because bacteria cannot replicate. This process is similar in effect to that of the auto-withholding system. The child deficient in iron should fare better than one who is iron-replete, unless the deficiency interferes with other aspects of host response according to Lukens (1975:161). Stuart-Macadam (1989b:215) explains the microorganism's requirements as follows: apparently the assimilation of iron is a requirement for microbial growth. Microbes synthesize substances that bind iron. It is to the advantage of the host to be hypoferraemic in the situation of a microbial invasion. For an infant who has lost the immunity conferred by the mother and is exposed to certain pathogens a definite advantage then is to be iron deficient. De Gruchy (1970:95) does not agree with the above mentioned authors, he states that on the contrary, infants with iron deficiency are more prone to repeated infections.

Iron deficiency is not an easily obtainable 'disease' condition. Arthur and Isbister (1987 – as quoted by Stuart-Macadam 1992:41) state that even when iron intake is reduced to nil – which in itself is hardly possible – then it would still take at least two to three years to develop anaemia. They also add that as iron levels in the diet decrease, the proportional absorbance of iron increases. Hyperferraemia, or iron-overload would then lead to a decrease in absorbance of iron from the diet. De Gruchy (1970:83-85) regards this as a purely theoretical supposition, and does not happen in practice. Stuart-Macadam (1992:41) concludes that diet is of little importance in the development of iron deficiency anaemia and that iron deficiency is an adaptive response to stress. For the sake of comprehensiveness it may be necessary to include the physical symptoms of patients with iron deficiency anaemia. Stuart-Macadam (1989b:214) gives the more frequently

reported symptoms: fatigue, weakness, light-headedness, dyspnoea, palpitations and paresthesias and gastrointestinal disturbances such as loss of appetite, flatulence, diarrhoea, constipation, nausea and vomiting are not uncommon. In severe and chronic cases *koilonchia* (spoon-shaped nails), *cheilitis angularis* (cracks in corners of the mouth), *glossitis* (sore tongue), atrophy of tongue papillae and atrophic gastritis occur. Bone changes may develop parallel with these symptoms during the later stages. An Egyptian manual of therapeutics as early as 1500 BCE has apparently described iron deficiency anaemia. The *Papyrus Ebers* describes a disease that is characterised by pallor, dyspnoea and edema (Stuart-Macadam 1989b:216).

7.6 NONSPECIFIC STRESS INDICATORS

7.6.1 History

Nonspecific indicators of stress has since the nineteen sixties become increasingly popular among paleopathologists.

Stress is described in Buikstra and Cook (1980:444) as any extrinsic variable or combination of variables which cause an organism to react. Reaction is mediated by the physiological state of an organism and can be completely buffered, leaving no osseous record. However, disease states lasting as little as 72–96 hours can interrupt growth, producing markers such as lines of growth-arrest in long bones and in the dentition. Chronic stress can permanently affect growth and development and can alter adult skeletal dimensions, leaving no markers within the bone or teeth, but may produce gross malformations of bone and teeth (Buikstra & Cook 1980:444).

Transverse lines were first studied by Asada in 1924 and by Harris in 1933 (Steinbock 1976:48). The term 'Harris lines' was first used by Wells in 1961, first quoted by Brothwell and Sandison (1967:xi-xiv) in their editorial prolegomenon. It was only after this date that scientists sat up and took notice. Harris lines are one

of the nonspecific indicators of stress. Harris lines are skeletal markers of growth arrest and recovery.

Other nonspecific indicators such as dental hypoplasias, bone material densities, growth attainment, sexual dimorphism and developmental asymmetry can provide population measures of chronic and acute stress without reference to differential diagnoses (Buikstra & Cook 1980:436).

7.6.2 Harris lines

A less specific condition in terms of aetiology seen in skeletal material is Harris lines. They are seen as dense, opaque transverse lines (particularly on radiographs) in long bones such as mainly the tibia but also in the femur and radius. These lines represent periods of stress caused primarily by nutritional deficiencies and childhood diseases (Roberts & Manchester 1995:176). These lines can only form when bones are growing. For a line to occur in a bone, the individual has to recover from a stress episode. It may be in order to compare this phenomenon to growth rings of a tree, but only in a spacially different dimension. More than one Harris line follows when episodes of stress are followed by recovery and new stress episodes follow. It stands to reason that when a person is continually malnourished and diseased there will not be any Harris lines. Harris lines are in effect 'recovery lines' (Roberts & Manchester 1995:175). Wells (1967:390) explains that in the event of malnutrition or a childhood disease, the orderly process of bone development may be interrupted for an indefinite time. With recovery, development continues and when it does so, a transverse line of calcification is left in the bone as a record of what has happened. These lines resemble 'hunger bars' found on the tail feathers of hawks and other captive birds (Wells 1967:391).

Buikstra and Cook (1980:445) agree that most line formation occurs during infancy and early childhood. Lines that form later in life tend to resorb more readily than those formed early in life. It was also found that a greater tendency

toward line formation is in association with stress in the female population. Buikstra and Cook also found that lines resorb less readily in malnourished populations and it was also found that the lines appear in individuals only after dietary supplements.

7.6.2.1 *General appearance*

Transverse lines must be visualized roentgenographically or by sectioning of bone. The term 'transverse' applies to the long and short tubular bones that have transverse growth plates. The transverse lines are most common in the distal tibia, proximal tibia, distal femur, distal radius and metacarpals (Steinbock 1976:43). The thickness of the lines range from a millimeter to more than a centimeter. They are thickest in the end of bones because of more rapid growing (Buikstra & Cook 1980:446).

Harris lines are three dimensionally seen within the medullary cavity as a latticework of bone trabeculae that corresponds to the transverse line seen on the anteroposterior roentgenogram (Steinbock 1976:45).

7.6.2.2 *Mechanism of formation*

Intensive studies have been conducted by Ginhart (1969:19-20) and Wells (1967:392) resulting in determining specific sex and age related peaks of formation in children. In his conclusion Ginhart mentions that almost every person has transverse lines. The frequency is considerably higher in boys at young ages. The lines follow periods of diseases such as measles, mumps and chicken pox. Steinbock (1976:46) adds dietary deficiencies to these diseases and others. Following longitudinal growth arrest new osteoblast begins to lay down new bone in the interior surface of the medullary cavity, forming trabulae which are arranged horizontally rather than vertically, forming the transverse lines seen on a roentgenogram. Lines appear to endure longer in females but almost all lines disappear within 10 years (Ginhart 1969:19), due to remodelling. The lines that

do persist into adulthood are those that were laid down very early in life (Steinbock 1976:49).

7.6.2.3 *Transverse lines in paleopathology*

The sequence and incidence of disease processes in one individual or the comparison of morbidity rates between different populations can be done by calculating the average number of lines occurring in a selected bone from a sample of each population. The differences may explain data on genetic background, environment, diet, habitation and mode of life (Wells 1967:392). Steinbock (1976:49) adds the information obtainable on the amount of morbidity suffered by individuals during the growing years. The recovery aspect, as mentioned above, is most important in the interpretation of the results of transverse line studies seeing that the line will not form unless the individual recovers from the illness or obtain adequate nutrition (see also Gill 1968:215). The number of lines can provide a rough guide to the frequency of difficult periods during growth. Where lines are found in groups of skeletons of the same period and place and age group, they can indicate a crisis of subsistence or, in other cases, some social inequality of the sexes (Renfrew & Bahn 1996:425). Thus a population chronically malnourished will not exhibit as many transverse lines as a population with seasonable periods of starvation and good nutrition.

Studies of these lines in skeletons may provide valuable information in comparable studies of health conditions among various populations from the same locality but from different time periods, according to Steinbock (1976:80).

Schwager (1968:130) dispells the notion that Harris lines are 'growth arrest' lines since no significant difference in finally attained adult stature was noted between heavily and lightly lined subjects.

7.7 DENTAL HYPOPLASIA

Dental enamel hypoplasia is a deficiency in enamel thickness (even total absence) resulting from a disruption in the matrix formation phase of amelogenesis. These enamel defects may be the result of local trauma, hereditary conditions or systemic metabolic disruption, in other words, metabolic stress conditions (Goodman & Armelagos 1985:479).

It is necessary that the paleopathologist can distinguish between the aetiologies of the above mentioned. Hillson and Bond (1997:89) state that hypoplasia due to trauma or localised factors will result in a defect occurring in only one tooth with the possibility of an adjacent tooth being affected. Hereditary defects begin *intra uterine* or shortly after birth and will be noticed with the first appearance of the primary teeth or newly formed and erupted permanent teeth whose crowns were formed before birth, *intra uterine*. Systemic disruptions are likely to affect more than one tooth and the location of the defect on those teeth will reflect the relative completeness of crown development at the time of the stress. By far the majority of defects are caused by growth disruptions (see also Roberts & Manchester 1995:60).

The distribution of frequency of defects in different teeth is given by Goodman and Armelagos (1985:481), ranging from most affected to least affected: maxilla, central incisor, lateral incisor, first molar, second primary molar, first primary molar, canine, second molar. Mandible: first molar, central incisor, first primary molar, second primary molar, lateral incisor, second molar, canine. The distribution of hypoplasias by morphological tooth thirds are: occlusal/incisal, middle, cervical.

Roberts and Manchester (1995:59) define hypoplasia as defects observed as grooves, lines or pits on the enamel surfaces, mostly on the buccal surfaces of the incisor and canine teeth. Defects can only occur while teeth are developing and will remain as a permanent record into adulthood.

7.7.1 Causative factors

Many factors are relevant to enamel defect aetiology and it can be broadly categorized into two groups;

- Nutritional deficiency
- Childhood illnesses such as measles but also infectious diseases like malaria.

7.7.1.1 *Nutritional deficiencies*

Famine coupled with nutritional deficiency, is probably the main cause of dental hypoplasia especially in Syro-Palestine. Changes in subsistence economy and the influence that diet has in states of famine are part of the archaeological investigation. Very little has been done in this regard in the Southern Levant (Roberts & Manchester 1995:60).

7.7.1.2 *Illnesses in childhood*

Hypoplasia lesions represent defects which can be termed as indicators of episodic stress (linear hypoplasia) or stress associated with specific diseases (vault porosities), according to Keita and Boyce (2001:735). They also state that linear hypoplasias are nonremodelling defects of the enamel that indicate the arrest or slowing down of ameloblast activities. Similar to nutritional deficiencies, childhood illnesses coupled with periods of sometimes extreme bouts of fever will leave hypoplastic lesions. The raised temperature inhibits normal amelogenesis leaving the telltale signs (Janse van Rensburg 1981:192). Hillson and Bond (1997:89) remind us that during illnesses there are usually a decline in appetite, resulting in a nutritional deficiency.

7.7.2 Hypoplasia and the relation to other stress indicators

Kolaridon (1991) as quoted in Roberts and Manchester (1995:60) found no correlation between Harris line formation and other stress indicators, including enamel defects in medieval times. Mittler et al. (1992) as quoted by Roberts and Manchester (1995:60) however, found a strong association between enamel hypoplasia and cribra orbitalia in an ancient Nubian population.

7.7.3 Methodology

Recording of defects is usually undertaken macroscopically or using a binocular microscope technique with a good light source or using models from casted impressions of the dentition and even solitary teeth. Recording defects on casts rather than on teeth themselves is easier, more productive and more accurate (bar discolouration marks) according to Roberts and Manchester (1995:60). These authors describe a classification system for defects on enamel, developed by the Federation Dentale Internationale (FDI).

The classification rests on recording the number of teeth affected, appearance and severity of defects as standard data to be recorded. Tooth development is shown below in table 5 after Wilkens (1999:280). If babies are weaned later (between 12 months and 18 months) then defects would appear between two and three and a half years of age, suggesting that these individuals were suffering following weaning (Roberts & Manchester 1995:61).

Differential diagnosis that should be considered are amylogenesis imperfecta, Hutchinson's incisors and other syphilitic teeth markings, bite relationship discrepancies, dental attrition and trauma. It is essential that the investigator be educated in the chronology of tooth eruption.

Table 5 Tooth Development and Eruption: Primary Teeth				
		Hard Tissue Formation Begins (weeks in utero)	Enamel Completed (months after birth)	Eruption (months)
Maxillary	Central incisor	14	1,5	10 (8-12)
	Lateral incisor	16	2,5	11 (9-13)
	Canine	17	9	19 (16-22)
	First molar	15,5	6	16 (13-19)*
	Second molar	19	11	29 (25-33)
Mandibulary	Central incisor	14	2.5	8 (6-10)
	Lateral incisor	16	3	13 (10-16)
	Canine	17	9	20 (17-23)
	First molar	15,5	5.5	16 (14-18)
	Second molar	18	10	27 (23-31)*

There is a difference of about 1 month between the sexes. That of boys being quoted.

Table 6 describes the formation of primary teeth that already begins *in utero*, when each primary tooth begins to mineralize, and the average months after birth when the enamel is completely formed before the date of eruption (Wilkins 1999:280). The mixed dentition may not pose a problem in determining the age of an individual; it may probably make age determination more accurate.

Table 6: Tooth Development and Eruption: Permanent Teeth				
		Hard Tissue Formation Begins	Enamel Completed (years)	Eruption (years)
Maxillary	Central incisor	3-4 mo	4-5	7-8
	Lateral incisor	10 mo	4-5	8-9
	Canine	4-5 mo	6-7	11-12
	First premolar	1,5-1,75 yr	5-6	10-11
	Second premolar	2-2,25 yr	6-7	10-12
	First molar	At birth	2,5-3	6-7
	Second molar	2,5-3 yr	7-8	12-13
	Third molar	7-9 yr	12-16	17-21

The mixed dentition comes about when primary teeth are being exfoliated and permanent teeth move in to take their places. This occurs between the ages of 6 and 12 years, as shown in table 6.

7.8 CONCLUSION

Rather than to state categorically that cribra orbitalia is always the result of iron deficiency anaemia, or that hypoplasia of dental enamel is always the result of metabolic deficiency, this chapter sought to demonstrate that total environmental, cultural and biological factors must be considered at all times if we are to understand the occurrence of pathological conditions in ancient populations. The ecological and social conditions of the population of the Southern Levant was conducive to many or most of these metabolic diseases in ancient times. The conditions varied from (ab)normal diets, low in proteins and high in starches containing phytates that caused iron deficiencies (Roberts & Manchester 1995:167), to famines of which there were many over the historical periods of the Bible:

- Famines are mentioned as occurring in the days of Abraham (Gn. 12:10), of Isaac (26:1), of Joseph (41:53–56), of the Judges (Ruth 1:1), of David (2 Sm. 21:1), of Ahab (1 Ki 17:1; 18:2), of Elisha (2 Ki 4:38), during the siege of Samaria (6:25), in the time of Jeremiah (Jr. 14:1–6), during the siege of Jerusalem (2 Ki 25:3), after the captivity (Neh. 5:3), in the reign of Claudius Caesar (Ac 11:28), before the destruction of Jerusalem (Mt. 24:7); (Unger 1988: s.v. Famine).

Other conditions were the constant periods of war that ravished the countryside. Epi- and endemic diseases that followed in the wake of famines were usually blamed on the wrath of God. God used famines throughout history as indications of his displeasure, and as warnings to repent (e.g. 1 Ki 17:1; 18:17-18; Hg 1:6, 9-11; 2:16-17). This view persists in Revelation (e.g. 6:5-8), where famine is a direct visitation on human sin. Obedience and prosperity (Ps1:1-3; Pr 3:7-10; Is.1:19), disobedience and want (Lv 26:14-16) are biblical inseparables. This law

is given classic expression in Deuteronomy 28, and poetic illustration in Jeremiah 14 (Douglas 1996: s. v. Famine).

Skeletal stress indicators in all its various appearances are reminiscences of not only the health of ancient populations but also the ecology at the time that the paleopathological investigation dates the remains. It follows then that periods of famine or abundance, socioeconomic depression or prosperity, war or peace can be 'read' into the skeletal remains' condition. This information can then be used in cross-reference with biblical and extra-biblical sources, trying to match with other documentations and descriptions of conditions of the past, particularly in the said periods.

CHAPTER 8

DNA, GENES AND ANCIENT BIOMOLECULES

Genetical studies find its place in this dissertation by virtue of the use of DNA technology in the verification of the diagnosis of certain diseases that paleopathologists are encountered with. Because of the difficulty in obtaining suitable diseased skeletal specimens for diagnostic purposes it may be important to optimise the material at hand by selective DNA analysis. Biomolecular science is bound to become extremely important to the discipline of paleopathology and therefore it will be almost essential for scholars to understand the basics of DNA technology in the same sense that it is important for the paleopathologist to have a basic knowledge of bone tissue.

The science of DNA studies occupies the centre stage in modern biology by virtue of its role as the permanent and heritable store of biological information (Brown & Brown 1992:11). DNA research may have changed the face of anthropology and paleopathology forever. The future of biological research lies not only in DNA research, but it may soon depend entirely on this new field of study. I believe that the medicine world is on the threshold of one of the biggest discoveries in its history. This 'controlled explosion' of this new knowledge and the understanding of the biomolecular world is difficult to fully comprehend, for few know what the real potential and future of this new science holds for mankind. Religious groups anticipate this science to be the ultimate of sin; the possibility to clone the human species is deemed to be as taking over the creation function of God.

However enigmatic the future of this science is, the fact is that if controlled, humankind can only stand to benefit from it. Anthropology through archaeology and more specific through paleopathology, stands to receive answers to long time outstanding questions: as few diseases leave signs in or on skeletal remains and even diseases which are known to leave skeletal lesions but do so in only a small

percentage of cases, more specifically the aetiology of diseases, age, sex and ethnic group. Ancient DNA (aDNA) is a relatively new field in which the tools of molecular biology are being applied to archaeological materials. The discovery of the polymerase chain reaction (PCR) is one of such tools. It allows the retrieval of infinitesimal amounts of DNA and its amplification from biological samples; even when molecules are damaged and degraded, it may still provide enough strands of PCR (Greenblatt & Spigelman 2003: v).

8.1 ANTHROPOLOGICAL PERSPECTIVES IN THE STUDY OF ANCIENT DISEASES

Our interpretations of past human diseases depend not only on identifying the organisms (when infectious) involved, but also our understanding of conditions that influenced the pathogenesis of the organism. Wilson (1996), as quoted in Ubelaker (2003:93) describes the factors that may be involved in the disease process: migration due to famine factors, environmental shifts, changes in land use, socioeconomic factors, technological aspects, medical treatment, demographic factors, population vulnerability, formation of new habits and microbial evolution.

Paleopathology has come a long way since multidisciplinary methods were introduced. Ubelaker (2003:102) outlines the breakthroughs in understanding the past emergence of new diseases will flow when:

- objective terminology in describing lesions enables detailed, accurate comparison of data;
- specific diseases can be diagnosed with increased accuracy, through their effect on tissue or through molecular analysis;
- disease recognition can be coupled with population analysis of general morbidity and mortality and anthropological interpretation of relevant environmental and cultural factors;
- research becomes truly multidisciplinary to avoid problems in interpretation in isolation;

- new emerging technology is fully utilised and incorporated into sophisticated problem-orientated research.

Added to this list may be the recognizing of the importance of differential diagnosis and the processes of taphonomy as well as the use of incorporating other disciplines such as the study of coprolites. If all these preconditions stated above are implemented, the newly found science of aDNA technology may prove to make a remarkable impact on the disciplines of anthropology, archaeology and particularly paleopathology.

8.1.1 Identifying disease elements through DNA analysis

That ancient DNA (aDNA) analysis may provide more information about endemic infection rates of ancient populations than morphognostic inspection, is a claim made by Hermann and Hummel (2003:143). Firstly, they believe, aDNA analysis may provide insight into the genomic coevolution of hosts by tracing inherited diseases beneficial for heterozygotes, and more importantly, the evidence for infections that has always been unclear and problematic, may be solved with aDNA analysis. The absence of evidence of a pathogen in any given human remains is not evidence of its absence, they believe. It is true that the vast majority of infectious diseases in ancient populations cannot be diagnosed directly because they are undetectable. As has been stated before, most infectious diseases do not leave bone lesions, and even those that do, only do so after a long-term chronic infection (Hermann & Hummel 2003:145).

It is thus the analysis of the aDNA of the pathogens on and within the bone in skeletal remains that gives the edge to DNA science especially in cases where there is no obvious signs of disease in the source. Furthermore, aDNA analysis requires no more than a few molecules of DNA or RNA of the causative microorganism's remains, thus almost totally noninvasive. Of the more serious problems encountered in obtaining DNA samples are contamination with unwanted DNA. Contamination takes place when for instance in drilling into bone

tissue to produce aDNA, unwanted and modern microbial DNA are the most likely contaminants. Taphonomic processes may cause the infestation with fungi, algae and bacteria (Brown & Brown 1992:12).

As for the rest of the process of extraction of ancient DNA, Brown and Brown (1992:12) as far back as 1992 believed the technique posed no problem. They saw the cumulative effects of damage caused by environmental agents such as heat, radiation and microbial attack on the DNA samples, less severe than might be expected (Brown & Brown 1992:13).

8.1.2 History and the molecular genetic science of aDNA

The existence of ancient DNA was first demonstrated convincingly in 1984 when DNA molecules were extracted and cloned from dried muscle taken from the salt preserved skin of a quagga, an extinct zebra which had died approximately 140 years ago (Brown & Brown 1992:10). Paäbo (1985:644) reported the extraction of clonable DNA from the 2 400 year old mummy of an Egyptian child.

In 1988 a new procedure, the polymerase chain reaction (PCR) was first applied to archaeological material. The importance of PCR is that it enables nucleotide sequences to be obtained from extremely small quantities of DNA. PCR can function efficiently even if the DNA has undergone a certain amount of chemical modification. It is clear that through PCR, aDNA can now be obtained from all types of biological material relevant to archaeology (Brown & Brown 1992:10).

8.2 aDNA AND INFECTIOUS DISEASES

Dutour et al. (2003:151) believe the paleopathological studies done on remains of plague victims of the Baroque period were found to be of great importance in the search for a data bank of techniques to develop an archaeological approach to infectious diseases that could effectively resolve some historical outbreaks as well as explore the past history of re-emerging human pathogens. The re-

emergence of past diseases is presenting new challenges to microbiologists who are studying and examining the history of human infections in order to understand their present-day evolutionary possibilities.

The biological molecular approach offers the chance to confirm both the cause of massive death and the diagnoses of the specific infections by studying the amplification of specific sequences of aDNA. These studies were done by Dutour et al. (2003:160) in order to identify *Yersinia pestis* and mycobacterium tuberculosis in ancient human skeletal remains and comparing it with known plague epidemics that were identified by polymerase chain reaction (PCR).

Tuberculosis was the first ancient disease to be diagnosed using DNA analysis (Dixon & Roberts 2001:190). The method has been proved to be able to collect DNA specimens in the form of PCR products from skeletal and on mummified tissue to detect the *M. tuberculosis* genome. The majority of the initial aDNA studies of tuberculosis in antiquity have so far only attempted to diagnose individual skeletons with clear osteological changes indicative of the tuberculosis disease. A few have identified mycobacterial aDNA in the tissue, bone and teeth of skeletons where no bone changes associated with tuberculosis were apparent. By accomplishing this it may also explain why in some periods of time skeletal evidence of tuberculosis is just not apparent despite the historical documentation of high frequencies (Dixon & Roberts 2001:191).

The aim for future studies may be to concentrate on establishing whether the biomolecules exist and to develop extant methods of analysing a whole population to show the frequency of infection to establish a statistical data bank for the infectious diseases of tuberculosis and leprosy.

Dutour et al. (2003:163) state that molecular biological techniques have largely broadened the diagnostic horizon in paleopathology, not only by confirming the macroscopical diagnosis of tuberculosis but also by helping to identify new criteria for differential diagnoses. Morphological techniques often do not allow the

recognition of tuberculosis lesions. However, the biomolecular analysis of archaeological human remains for tuberculosis proved to be efficient using two biomarkers that persist in ancient bone material and can be diagnostic of tuberculosis infection and the pathogen. Matheson and Brian (2003:140) describe the survival rate of mycobacterial DNA might long survive due to a tough cell wall, and this can provide direct evidence for tuberculosis infection.

8.2.1 Contamination and taphony

Baron et al. (1996:668) anticipated contamination of soil-inhabiting mycobacterial species not belonging to the *M. tuberculosis* complex which consists of *M. tuberculosis*, *M. bovis BCG*, *M. africanum* and *M. micriti*. It is known, Baron et al. state, that bacteria from the soil can populate skeletons. No contamination should be ensured by restriction enzyme analysis and by a system of control reactions. On this subject Cooper and Poinar (2000:1139) have laid down certain criteria to be routinely applied to ensure scientific replicable test results: physical isolation of work area, controlled amplifications, reproductibility and independent replication that will enhance the authenticity of the experiment.

Microbial contamination is not a real danger to Brown and Brown (1992:19). The primers used in PCR amplification are specific for the species being studied. The problem is however the possibility that ancient human DNA can be contaminated by modern human DNA. Four potential sources of contamination with extraneous human DNA are identified (Brown & Brown 1992:20):

- Between death and inhumation: if the burial involves any practices which expose the remains to other human blood, urine or faeces, contamination is certain.
- Between inhumation and excavation: When more than one body (specimen) is interred together, leaching of DNA from biological material into the soil takes place. If a number of specimens are interred together, then wholesale exchange of DNA is to be expected.

- During excavation: Due to handling of specimens, modern DNA is deposited on the specimen. Ideally an excavation should be done under sterile conditions.
- Post excavational: during analysis in the laboratory. In practice, contamination at this stage can be tested by carrying out suitable control experiments.

8.2.2 Taphonomy and DNA samples

Dutour et al. (2003:156) describe the processes on a macrophysical level; gross taphonomic processes must first be identified, then the sample will reduce its interest for biomolecular DNA studies. If the taphonomic agent proves to be nonbiological, then the effect of this agent on the biological specimen sample does not in any way have detrimental effects on the sample. It cannot then be assumed that no contamination took place.

At a molecular level, taphonomical processes slow down DNA extraction (Dutour et al. 2003:158). Two common processes affecting DNA in archaeological material are:

- hydrolytic damage of the specimen leads to deamination of bases (depurination, depyrimidation);
- oxidative damage caused by ionizing radiation results in modification of basis.

In what Matheson and Brian (2003:129) describe as first order taphonomy, they start with the moment of death. The loss of information begins at this point. Biodecay of organs of the host begins immediately. The biomolecules are bombarded with lytic and degradatory enzymes and chemicals which will destroy the cells and tissues. This process provides a nourishing aqueous environment for microorganisms already present in the body. The process of deposition commences and the end result will depend on the burial environment. Incorporation of biological remains into the depositional environment is focused

on complete equilibrium (moisture, microorganisms and pH) with the surrounding environment achieved through taphonomy.

Trace remains are evidence of an organism's interaction with its surroundings such as gall stones, kidney stones and coprolite. When 'low heat' is administered, fire as a depositional process may create a carbon cast which destroys the outer surface area of the remains while the uncharred internal biological remains are preserved by drying and flame sterilization. Matheson and Brian's (2003:136) second order taphonomy concurs with that of Dutour et al. mentioned above, to which they add poor storage conditions which increase degradation by exposure to air borne microorganisms and moisture.

8.3 DNA, GENES AND BIOLOGICAL INFORMATION

DNA is the permanent and heritable store of biological information. Each unit of biological information is contained within a unit called a gene, of which 50 000 is needed to make a human being, specifying the biochemical functions that constitute life and also the development and differentiation processes that convert a fertilized egg into a mature human being.

Brown and Brown (1992:11; Marieb 1992:47) explain that DNA molecules are extremely long polymers comprising linear sequences of subunits called nucleotides. Each human cell with a few exceptions such as erythrocytes, possesses a full complement of the 50 000 human genes; the vast majority contained in the DNA molecules located within the chromosomes of the cell's nucleus. Reproduction cells possess 23 chromosomes that comprise 22 autosomes (chromosomes that are common to males and females) and one sex chromosome (X or Y). Each of these 23 chromosomes contains a single, different DNA molecule between 5.5×10^8 and 2.5×10^9 base pairs in length. Nonproductive cells have 46 chromosomes: two pairs of each autosome plus two sex chromosomes (XX in females and XY in males).

In addition to nuclear DNA, each human cell also contains about a thousand identical copies of a much shorter DNA molecule (16 569 base pairs, 37 genes) located in the energy-generating organelles, called *mitochondria*.

A gene is simply a segment of a DNA molecule (75 to over 2.3×10^6 base pairs in length, depending on the complexity of the biological information it contains). The biological information is designated by the nucleotide sequence of the gene. Four chemically distinct nucleotides are known as adenine, cytosine, guanine and thymine, universally known as A, C, G and T. These nucleotides can be linked together in any order. Each gene is in essence a linear sentence written in a code that utilises just these four letters. The genetic code was deciphered in 1966 but did at first not explain the actual meaning of the biological information that the gene carries (Brown & Brown 1992:12).

8.3.1 Deoxyribonucleic acid

DNA is a nucleic acid originally isolated from fish sperm and thymus gland, but later found in all living cells. On hydrolysis it yields adenine, guanine, cytosine, thymine, deoxyribose and phosphoric acid. Ribonucleic acid is originally isolated from yeast. On hydrolysis it yields adenine, guanine, cytosine, uracil, ribose and phosphoric acid. Transfer RNA is sometimes used in aDNA analysis because of the short strands available (Agnew 1967: s.v. DNA).

Zink et al. (2004:32) have shown that they can successfully identify *M. tuberculosis* complex DNA in bone tissue. Experiments were performed on a series of vertebral samples from an Egyptian population of the necropolis of Thebes West (dating to 1450 – 500 BCE). Some samples that were investigated had typical macromorphological signs for *tuberculosis spondylitis*; the result was 3 of 5 cases revealed a specific amplicon of the *M. tuberculosis* complex. Two out of nineteen cases without any macroscopic pathology revealed the same amplicon.

The amplification of molecular techniques for the identification of infectious diseases is growing, according to Zink et al. (2004:32). The analysis of certain bacterial DNA (aDNA) is part of history now, for instance information on acute and chronic diseases such as tuberculosis (Spigelman & Lemma in 1993), leprosy (Haas et al. in 2000) and syphilis (Kolman & Tuross in 2000), has successfully identified the causative microorganism through DNA analysis (Zink et al. 2004:33). This, Zink believes, opens the door for identification of further microbes in various population groups.

By far the most DNA information is available for tuberculosis because it may be more easily accessible to DNA research due to the natural resistance to taphonomical processes of the mycobacteria and therefore would render more adequately preserved aDNA.

The pathogens of DNA in the case of tuberculosis, although highly resistant, still need to be extracted in the most highly sophisticated technical manner to prevent contamination (Baron et al. 1996:667). They were able to detect the pathogens' DNA in affected bone and in bone tissue without any tuberculosis lesion, by the simple deduction theory that any infectious agent which is carried into bone with the bloodstream, should be detected by the use of PCR.

8.4 CONCLUSION

Paleopathology as a discipline is still a baby amongst the multitude of scientific disciplines in the modern world. Breakthroughs in understanding ancient diseases and the past emergence of new diseases will be achieved when, according to Ubelaker (2003:93):

- objective terminology in describing lesions enables accurate and detailed description and comparison of data;
- specific diseases can be diagnosed through their effect on tissue or through molecular genetical analysis;
- research becomes truly interdisciplinary;

- new emerging technology is fully utilized.

Biomolecular science using DNA analysis has come to enhance paleopathological research in finding ancient diseases that were known to humanity through ancient art or ancient writings in biblical and extra-biblical sources to the extent that soon DNA analysis may be necessary to be the final authority to accept proof of all proposed diseases. Compare this new scientific 'tool' to what radiography and microscopy meant to researchers only a century or more ago in their investigations and explorations into diseased material of their time.

It is the opinion of Ewald (2003:124) that molecular genetics are used to better understand the role of microbacterial diseases. The new science of DNA is integrating evolutionary principles with the health sciences to produce total biological insights, according to Ewald (2003:125). This new science, he says, is emphasizing how environments and human activities influence the characteristics of microorganisms and the role of infection as the cause of chronic diseases. Ewald believes that in this way we can better understand the health problems we face today, but also understand how past populations have probably faced the same diseases.

Molecular paleopathology is now used to confirm the presence of disease of the past (Matheson & Brian 2003:142). In the initial phases of this science the presence of microorganisms were only confirmed in skeletal remains that were known to have been infected by a specific microorganism, for instance; tuberculosis by Spigelmann and Lemma (1993), leprosy by Rafi et al. (1994) and *Yersinia pestis* by Drancourt (1998) (Matheson & Brian 2003:142).

The technology and methodology of DNA science have improved to the point where morphological previously undiagnosed specimens are examined and DNA tests are done. According to the results, first hand diagnosis can be made of a number of different diseases like tuberculosis, leprosy, *Yersinia pestis*, syphilis,

malaria, Chagas' disease, retrovirus (RNA), *escherichia coli*, *influenza orthomyxovirus*, *ascariasis*, *schistosomiasis* and *corynebacterium* (Hermann & Hummel 2003:147).

The time may be close at hand when every skeleton or part thereof could be scanned to determine not only the cause of death but also what other underlying diseases the individual was suffering from.

To understand the aspiration of this science, the aim is most probably for a 100% success rate. To attest to this unprecedented aspiration we must simply look at the genetical studies of Pill and Kramer's work to determine the sex of an individual. Pill and Kramer (1997:673) have shown that it is possible to determine the sex of an individual by using the PCR and amplify the region of ZFX and ZFY gene from DNA in human tissue. They chose to extract pulp tissue from freshly extracted teeth in this experiment. The result was a remarkable 100% accuracy in numerous trials. Pill and Kramer (1997:674) have demonstrated that the same results could be expected when DNA was extracted from crushed dentine substance from ancient teeth.

CHAPTER 9

CONCLUSION

It was pointed out in Chapter 2 that far too little paleopathological material has been found and described in the region of biblical Syro-Palestine. In a nosographical study (the description of diseases and the detailed classification of known diseases) the principal predicament is the scarcity of human remains with diseased material in the archaeological records (Hermann & Hummel 2003:144). It therefore follows that the dilemma to find and demonstrate certain biblical diseases depends on the availability of skeletal material to a large degree.

Only a small percentage of human remains has been studied by biological anthropologists. That American archaeologists do not appreciate the full potential of osteological research as a source of information on biocultural behaviour and human adaptation, is the view of Larsen (1999:1). Larsen seems shocked by the disregard some archaeologists have concerning human remains, some openly stating that 'burials on historical sites are much more trouble than they are worth'. This attitude seems to be the same in certain circles of archaeologists in many countries, judging statistics of publications in this regard. On a more positive note, Larsen believes that there is growing evidence that archaeologists are incorporating skeletal studies into their research designs. This is the case where many of these scientists are drawing inferences about diet, nutrition, health, disease, demography, physical behaviour and lifestyle of the past (Larsen 1999:2). It may be the case in North America, but the question posed is: what is happening in Syro-Palestine? Roberts and Manchester (1995: 201) also propose that perhaps education of archaeologists about where and what to look for will empower them to be able to recognize and interpret abnormalities in skeletal material with reference to the cultural derivation of the material. The aims of paleopathology are to trace the history of disease over long periods of time, assess the predisposing cultural factors for disease occurrence and determine for instance the effects of disease on past societies.

My own observation regarding this matter was made after viewing numerous books and articles on the subject of paleopathology that have been noted in hundreds of bibliographies in the process of acquiring paleopathological material for the research of this dissertation. The principal dilemma was finding suitable paleopathological material explicitly for the geographical region of Syro-Palestine, and more specifically within the time frame of the biblical period (circa 1800 BCE–150 CE). There seems to be countless data and information available in most other parts of the world on this subject, mainly from North and South Americas, Britain, Scandinavia, North Africa, in particular Egypt and some Far Eastern countries. In the greater picture of worldwide paleopathological research I do believe that I have only just reached out to touch the tip of the iceberg of available researched documents, although I am sure that I have covered the greater percentage of literature on paleopathology of the Palestine region, especially for the period set out to cover. But sadly very little data is available. The object remains the same: the relevance of skeletal remains to the study of the human condition and human behaviour in general. The study of human skeletal and dental remains will reveal life history at both the individual and the population levels (Larsen 1999:3).

The theme, period and geographical region ultimately chosen for this dissertation was with a biblical premise in mind. The data from the studies of the sciences of archaeology, anthropology and even the subdivision of paleopathology in this area and period may only ultimately enhance the understanding of the biblical Scriptures. As Dever puts it: 'to see the realia of archaeology that can help illuminate ancient Israel' (Dever 2002:16). He mentions that a biblical text is a product of a particular time, place, culture, language, and it must be placed back in that context to be understood at all. A text is also written with a certain intent by the author usually for a specific audience. This is exactly what this study has in mind: to supply the relevant information and social background to understand the biblical Scriptures.

9.1 Archaeological records

The problem still remains in Syro-Palestine that there is too little information available. To demonstrate this point I have tabulated archaeological excavations in this region. I have used arguably the most comprehensive collection of archaeological reports on excavations of this region known: Ephraim Stern's edited version of *The New Encyclopaedia of Archaeological Excavations on the Holy Land* (NEAEHL), the 1993 edition, as well as other independent reports on the subject. The aim was to research archaeological sites in the hope to find reports on human remains that were discovered, but more importantly, to discover to what extent, if at all, these archaeologists have noted their finds and whether any annotations were made of manifestations of disease or pathological signs.

Table 7, first column, shows the identification of the site by name and where possible description of the geographical position of the site and name of excavator/archaeologist. The next column will show the extent of notice of paleopathological signs. Lastly the author and reference is noted. Only excavation sites that mention skeletal finds are tabulated irrespective whether any paleopathological examination was made or not. The object of this exercise is to point out how little was done in the respect of taking notice of human remains and noting paleopathological changes.

Table 7

Identification of excavation site Archaeologist	Period, burial and skeletal remains Paleopathology	Author and page
<p><u>Jericho.</u> 10 km north of Dead Sea. E Sellin & C Watzinger 1907-9 K M Kenyon 1952-58.</p>	<p>Middle Bronze Age – skeletal finds; disintegrated and incomplete. Iron Age 2. Ossuaries found of Greek and Aramic origin – no mention is made of bones. <i>No paleopathology.</i></p>	<p>Kathleen M Kenyon p679</p>

<p><u>Jerusalem</u></p> <p>Various archaeologists</p>	<p>Tombs on the western slope of Mt Zion, First Temple period: 8th – 7th century BCE. Many skeletons found; disarticulated <i>No paleopathology.</i></p> <p>Second Temple period – many tombs studied and described in 1950's and 1960's by LT Rakmani et al. In 1967 many more were found after the Six Day War which led to a building boom in the city. About 800 tombs are now known around the city in a 5 km radius. <i>No mention is made of any paleopathology.</i></p>	<p>Hilel Geva</p> <p>p714</p> <p>Hilel Geva</p> <p>p747</p>
<p><u>Tel Ridan.</u></p> <p>Situated on the Mediterranean coast, 18 km south of Gaza.</p> <p>F Vitto & G Edelstein.</p>	<p>Late Bronze Age cemetery with eight cist graves; number of corpses vary in each. Four described in tomb 6, the largest. No paleopathology.</p> <p>Middle Bronze Age 2 remains; Number of skeletons. <i>No paleopathology.</i></p>	<p>Fanny Vitto & Gershon Edelstein</p> <p>p 1283</p>
<p><u>Nahal Hever Cave number 8</u></p>	<p>Possibly Roman period. Remains of Jews of the Bar Kokhba revolt 133 – 135 CE. Description of bones: 21 individuals, mostly skulls; 17 adults – <i>only lesions mentioned were mostly of dental origin.</i> No other paleopathology mentioned. Rest of skeletons underwent biometrics .</p>	<p>H Nathan</p> <p>p167</p>
<p><u>French Hill in Jerusalem</u></p>	<p>Limestone ossuaries of Jewish origin 1st century BCE to 1st century CE. Distributed in ossuaries single or in some cases up to 3 individuals in one ossuary. 70% adults; 30% children. <i>Number of arthritic diseases and osteoporosis found. Dental pathology like tooth loss, few cases of caries and hypoplasia.</i></p>	<p>Arensburg & Rak</p> <p>p70</p>

<p><u>Giv'at ha-Mivtar.</u> <u>Jerusalem</u></p>	<p>Roman period, ± 100 CE. Three burial caves with 35 individual skeletons in 15 limestone ossuaries: 7 children, 1 foetus, 2 adolescents, 23 adults, of which 11 were male and 12 female. Craniometric measure -ments were comprehensively done – dental condition noted, mostly periodontal diseases, caries, attrition and abscesses found.</p> <p><i>Two children were found with cribra orbitalia lesions. NB: The skeleton of the crucified man was described with nails through the calcaniae.</i></p>	<p>N Haas 1970:41-55</p>
<p><u>The Persian Garden</u> <u>(el-Bahja)</u></p> <p>North of Acco on coast – description of a cemetery. G Edelstein 1971</p>	<p>Late Bronze Age. Five undisturbed graves – intact bodies. Distinguished as B3, A2, C1, C2.</p> <p>B3 – 3 skeletons, 2 males, 1 female. A2 – 1 skeleton, not sexed. C2 – fragments of 2 skulls, 1 male, 1 female. A3 – Remains of child skeleton.</p> <p><i>No paleopathology.</i></p>	<p>S Ben-Arieh p29</p>
<p><u>Achzib</u></p> <p>14 km north of Acco on the Mediterranean coast. M W Prausnitz 1963 – 1964</p>	<p>Cemetery on the Mound. Iron Age 1. Cist tombs. Individual and couples burial.</p> <p>Northern cemetery. Iron Age 7th to 6th century BCE. Craters filled with charred bones. Cremated bones from late Iron Age found in jars.</p> <p>Eastern cemetery. Shaft tombs. Early I.A. In one burial chamber, remains of 200 – 300 skeletons.</p> <p>Southern cemetery (Menet-Ez-zib). Single burials of 9th to 7th Century BCE.</p> <p>10th to 7th century BCE tombs with dozens of skeletons in primary and secondary burial. Burial probably Canaanite. <i>No paleopathology.</i></p>	<p>E Prausnitz E Mazar p34 – 36</p>

<p><u>Tell el Wawiyat.</u> Lower Galilee B A Nakhal et al. and W Dever 1986-1987</p>	<p>Middle Bronze Age II Skeleton of infant and two children aged 3 and 5, found in separate jars. <i>No paleopathology reported</i></p>	<p>B A Nakhal et al. P1501</p>
<p><u>Ashkelon</u> 63 km south of modern Tel Aviv and 16 km north of Gaza on the Mediterranean coast. Excavations conducted by J Garstang 1921 – 1922. Latest by L E Stager, 1985.</p>	<p>Late Bronze Age to Iron Age. Burial cave, served for human and equine burials. Skeletons found in several layers, men and horses side by side. Iron Age 1, 12th to 10th century BCE. Single burials in pits dug into the ground. Burials in large pottery jars; 11th to 10th century BCE. Burials in brick coffins, 11th century BCE. Cephalometric analysis done – brachycephalic skulls found. Cremation: 2 skeletons found in jar, charred. Communal burials, 10th to 9th century BCE. <i>No paleopathological investigations.</i></p>	<p>M Dothan p128 – 129</p>
<p><u>Tel Bira</u> (<u>Tel Bir-el-Gharbi</u>) 9 km south east of Acco. M Prausnitz 1957 – 1980.</p>	<p>Cemeteries, Middle Bronze Age. Tombs with skeletons in pits. Early Iron Age. Skeletons in benchlike rock cuttings. Iron Age II. Tomb for double burials found. <i>No paleopathological investigations.</i></p>	<p>M W Prausnitz p263</p>
<p><u>Dan,</u> Situated at the foot of Mount Hermon, northern border of Ancient Israel. A Biran, 1966 – 1967</p>	<p>Late Bronze Age. The so-called Mycenaean tomb. 381 found dug into the natural hamra soil. 40 skeletons of men, women and children found in disarray. <i>No paleopathological investigations.</i></p>	<p>A Biran p326</p>

<p><u>Dothan</u> Situating in a broad valley, 22 km north of Schechem. J P Free, 1953 – 1965</p>	<p>Late Bronze age to Early Iron Age. A cistern/tomb quarried in soft limestone. Skeletal remains found in disarray. <i>No paleopathological investigations.</i></p>	<p>RE Cooley & GD Pratico p374</p>
<p><u>Tell Mazar</u> Located in the Jordan Valley. 3 km north west of Tell Deir 'Alla. Yassine 1977 – 1981</p>	<p>Iron Age 1, 10th century BCE. 84 tombs discovered in a cemetery. Men buried in supine position and women in a flexed position. In one burial a skeleton was found buried with animals. <i>No paleopathological investigations.</i></p>	<p>A de Groot p990</p>
<p><u>Tel Nami</u> 15 km south of Haifa. Dothan, Raban and Fleming 1975; M Artzi 1985</p>	<p>Late Bronze Age 2b. Numerous burials, some in box graves, others stone lined. Infant burials in storage jars, some adults in collared rim jars. <i>No paleopathological investigations done.</i></p>	<p>M Artzi p1096</p>
<p><u>Tel el Far'ah</u> (North) North western Negev Desert Gilead, I in 1976-78</p>	<p>Middle Bronz Age II B 1550 BCE Burials in the ground, alone or mother and child combination. Newborns buried under floors in jars. <i>No paleopathological investigations done.</i></p>	<p>A Chambon P438</p>
<p><u>Tel el Far'ah</u> (South) 24 km South of Gaza W Petrie 1928-1929 E MacDonald 1932</p>	<p>Late Bronz Age; 19 skeletons in tomb. Iron Age II; 116 soil burials, pottery vessels. Iron Age I and Persian Period; large burial chambers found, not elaborated upon. <i>No paleopathology described.</i></p>	<p>Y Yisraeli p443, 444</p>

<p style="text-align: center;"><u>Gezer</u></p> <p>Situated in the last foothills of the Jordan Mountain range, near Shephelah.</p> <p>R Macalister 1902-1909. G E Wright 1964-1966. W Dever 1966-1970 1984-1990</p>	<p>Late Bronz Age I ; several dozen burials, most of the bones show signs of advanced arthritis, probably from stooped labour.</p> <p><i>Shows a certain interest in paleopathology by this examination and reports.</i></p>	<p>William G Dever</p> <p>P 501</p>
<p><u>Tell es-Sa'idiyeh</u></p> <p>Halfway between Tiberias and Dead Sea, 1,8 km East of R. Jordan. J N Tubb</p> <p>1985-1987 1989-1990</p>	<p>Late Bronze Age/ Early Iron Age. Double Pithos (jar) burials with skeletons. Children's skeletons found in smaller jars.</p> <p><i>No paleopathology reported.</i></p>	<p>J N Tubb</p> <p>P 1294</p>
<p><u>Haruba Cluster</u></p> <p>In North Sinai North Sinai Coastal Plain between Suez Canal and Gaza. Oren 1972-1982.</p>	<p>Late Bronze Age skeletal discoveries at fort at Haruba.</p> <p>Children burials under floors in various parts of the fort. Complete adult male skeleton and child uncovered.</p> <p><i>No paleopathology.</i></p>	<p>Eliezer, D</p> <p>P1390</p>
<p><u>Timna</u></p> <p>30 km North of Gulf of Elath-'Aqaba B Rottenberg 1964-1990</p>	<p>Late Bronze Age II & Iron Age I and II</p> <p>Two skeletons of African origin discovered.</p> <p><i>No paleopathology reported</i></p>	<p>B Rottenberg</p> <p>P 1481</p>

<p><u>Jokneam (Tel Yoqne'am)</u> Near Mount Carmel and Jezreel Valley. A Raban 1970 Ben-Tor 1977</p>	<p>Late Bronze Age 1 in Stratum XXI. Several child burials in jars under the floors of a room. <i>No paleopathological investigations.</i></p>	<p>A Ben-Tor p810</p>
<p><u>Lachish</u> <u>(Arabic Tell ed-Duweir)</u> J L Starkey 1952 Y Aharoni 1965 and 1966 D Ussishkin 1973</p>	<p>Iron Age II – probably pinpointed as 701 BCE – during the Assyrian conquest. Starkey uncovered mass burials in caves. Skeletons and skulls piled in disorder; in secondary burial. 1 500 skeletons. 695 skulls were sent to London to be examined by D C Risdon. Detailed cranometric was performed. <i>Three cases of trepanned skulls were found. Dental pathology described of numerous individuals.</i></p>	<p>D Ussishkin p907 Risdon, D L (1939:117-120)</p>
<p><u>Masada</u> Situated on top rock cliff on the border between the Judean desert and the Dead Sea Y Yadin 1963 – 1965</p>	<p>Roman period. Zealot remains. 3 skeletons in lower terrace. Large heap of skeletons found in a small cave: 25 skeletons; 14 men, 6 women, 4 children, 1 embryo. <i>No mention of any paleopathological investigations.</i></p>	<p>E Netzer p981</p>
<p><u>Tel Malhata</u> (small) Located in the Negev desert, south of Beersheba. R Amiran 1979</p>	<p>Middle Bronze Age II (Stratum 3) Several burial sites were uncovered, one of which is an infant in a storage jar. <i>No paleopathology reported.</i></p>	<p>R Amiran O Ilan p939</p>

<p><u>Megiddo</u> Jezreel Valley A Hrdlicka 1938</p>	<p>Middle Bronze Age; 2 skull fragments Late Bronze Age; 16 skulls, damaged. Iron Age; 13 skulls, imperfect. All skulls were sexed. All skulls were craniometrically evaluated. <i>No paleopathology reports.</i></p>	<p>P L O Guy (1938:132)</p>
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9.2 SUMMARY OF PALEOPATHOLOGICAL FINDINGS IN SYRO-PALESTINE

In addition to the data acquired in the NEAEHL, a number of other excavation reports that were relevant to this study were integrated if there were no overlapping characteristics.

The number of sites described in Stern's NEAEHL and the individual reports are approximately 320. However the number that has been worked from is 290. Of these there are 224 sites that describe strata that falls within the timeframe of the biblical period originally selected. Of these 224 sites only 25 had reportedly found human remains. Of these 25 sites that had reported skeletal remains, only 5 had reportedly done any paleopathological research. Statistically then, of the 225 sites the yield of reports with confirmed skeletal pathological data is only 2,23%, this is much lower than the 4% that is claimed by Larsen (1999:2) in his research field in Northern America. It is thus clear that the lack of archaeological skeletal material that was initially presented as a problem area, seems to be a poor state of reality in Syro-Palestine. There had been insufficient human skeletal material made available for over a century. It is thus difficult for the disciplines of paleopathology and anthropology to make a meaningful contribution to their scientific interests. Modern techniques present an excellent opportunity for multidisciplinary research to gain insight into the social, cultural and medical realities of yesteryear – but there seems to be no short term solution to the relative lack of paleopathological material, caused at least partially by the Israeli Halakah Laws.

The aim of this study was an attempt to demonstrate amongst others the conformity between ancient diseases and modern diseases and also between ancient disease causing microorganisms and their modern peers. Medical science may then be able to determine evolutionary changes in both disease and microorganism and put the results to good use for the benefit of the entire human race. Certain aspects of the social, cultural and demographical lifestyles of the ancient populations that were subjected to the various biblical diseases may be

used amongst others to elucidate the abstruseness of scriptural texts. But the dilemma is still the unavailability of adequate material to work from.

Larsen (1999:1) reported that in the entire southern half of Texas (United States of America), over 300 mortuary sites have been reported by archaeologists, but skeletons from only 50 sites were described. Human remains from only eight sites were described and interpreted in detail. Statistically, the results are a mere 2,67% but in relevant terms of importance to the masses of people, the result of Syro-Palestine may be more shocking and needs urged attention.

The view of an archaeologist in a statement to a reporter at an excavation site in Colorado was: 'Human bones don't provide that much information. After all, we know that they are Indians.' And another archaeologist's view was that burials on historical sites are much more trouble than they are worth, and that unless the circumstances are special, he would advise that the remains be quickly covered over and forget you ever saw them. This attitude is apparently shared in other regions of the globe, is Larsen's conclusion, and mine. And something needs to be done about it.

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