PALAEOPATHOLOGY AND ARCHAEOLOGY: THE CURRENT STATE OF PLAY

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INTRODUCTION

'*...practically all behavior patterns will affect disease incidence in some way*' (Alland, 1966: 47).

To place this paper within the context of the book title, a few definitions are worth considering. This paper considers palaeopathology, whilst the rest of the book is devoted to the archaeology of medicine. In essence, this chapter sets the scene for what is to come, and introduces disease as something that humans in the past had to develop coping mechanisms to deal with. In effect, medicine (and surgery) developed to enable populations to cope with disease and injury. With this in mind the true definition of medicine is 'the science or practice of the diagnosis, treatment and prevention of disease, especially as distinct from surgical methods', whilst pathology is 'the science of bodily diseases', and disease is 'an unhealthy (i.e. state of being unwell) condition of the body or mind, illness, sickness' (Thompson, 1995).

Palaeopathology (the history of disease), classified as a subdiscipline of biological/ physical anthropology, has been studied in many parts of the world since the nineteenth century. Whilst non-human remains provided most of the focus initially, by the early twentieth century the study of human remains for evidence of disease became more popular (Aufderheide and Rodriguez-Martin, 1998). Disease is very much part of our lives today, as it potentially may result in death, and health problems affect how human and non-human populations function within their environment, whether they can adapt to changing circumstances or whether they succumb to illness and die. Everybody, past and present, has suffered, is suffering from, or will suffer from ill health. Therefore, the study of disease today, and in the past, has implications for social, political and economic systems which all may be changed as a result of the impact of disease. For example, the Black Death in Britain in the fourteenth century AD had such an impact on mortality that the reduction in population numbers meant that social/economic and political systems had to change (McNeil, 1976). Paradoxically, and taking a view from a modern context, as a result of global warming major changes in our environment and climate are occurring, and these are, in turn, affecting our health. Bhasin *et al.* (1994: 65) have eloquently reminded us that '...health is not a component but an expression of development; so that the health of a community at a given moment is the very situation of the whole social system seen from a health point of view...', and Brown *et al.* (1996: 183) indicate that '...the nature of interaction between disease and culture can be a productive way of understanding humanity'. Disease, or a deviation from normal health (whatever normal is), will also affect populations both geographically and through time, with specific patterning which will be determined by many factors intrinsic and extrinsic to the people affected. By implication, disease must be seen ultimately as a key part of the study of past human populations (and archaeology as a whole) because, without information on their health status, the rest of the archaeological evidence may be less well understood.

This chapter has a number of goals:

1. To introduce the subject of palaeopathology;
2. To highlight how health and disease is studied in the past;
3. To explore how we might recognise the care of the sick;
4. To consider how palaeopathology as a discipline has developed and contributed to our knowledge of the past;
5. To suggest recommendations for future work.

In effect, this chapter concentrates on the scientific study of unhealthy conditions of the body or mind in the past. However, bound up with disease is how people in the past perceived it, and whether any attempt was made to treat, or indeed care for, people who got sick. The focus, however, of this paper is on palaeopathology whilst most of the rest of this book concentrates on the evidence for medical treatment in the past.

Despite its importance, palaeopathology (and palaeobiological anthropology generally) has received little recognition as a major contributor to archaeological site interpretations, particularly in Britain, until recent years. Firstly, this is probably because palaeopathology has had a clinical emphasis (Bush and Zvelebil, 1991: 3) which did not allow the non-specialist reader to access the information in an understandable manner. Perhaps also, the people working in the area, especially in the 1960s and 1970s, discouraged non-medically trained personnel to work in palaeopathlogy. As Wells (1964a: 20) has stated, 'It is most unwise for anthropologists who lack clinical training to venture into the infinitely subtle field of ancient disease'. Wells was always quick to point out that anybody lacking medical training should steer well clear of studying palaeopathology, succinctly stating in the following, '...only a clinician or clinical pathologist who has spent his life studying disease as a living and ongoing process can assess the significance of the final etchings on dead bone... the great majority of physical anthropologists have enough scientific humility to recognise their limitations and incompetence in the interpretation of disease' (Chadwick Hawkes and Wells, 1983: 6–7). This is hardly encouragement for people trying to work in the field or for archaeologists to consider it worth doing! Fortunately, over the last 10 years, certainly in Britain, some undergraduate students of archaeology, anthropology and other related disciplines such as biology, genetics and anatomy, have been trained at graduate level in how to recognise, record and interpret evidence of disease in skeletal remains; this is now influencing how palaeopathological study in Britain has developed. Whilst graduates in archaeology and other subjects do not have medical backgrounds, doctors and dentists, more often than not, do not have the archaeological training to put the skeletal material into context for interpretation which also puts them at a disadvantage. However, let us emphasise that each person developing our knowledge on the history of disease has something to contribute, and each has their limitations. As Farmer (1996: 267) has said '...our approach must be dynamic, systematic and critical. In addition to historians, then, anthropologists and sociologists accountable to history and political economy have much to add, as do critical epidemiologists'.

Secondly, and associated with this barrier raised to persuade non-medically trained personnel not to become involved with studying palaeopathology, has been the lack of awareness by archaeologists to recognise the potential of the study of human skeletal remains. Again, Bush and Zvelebil (1991: 3) concisely describe this particular problem: 'Unaware of the potential of human skeletal remains, many archaeologists view them, as at best, an irrelevance, and when encountered *in situ* as objects whose excavation is time consuming and which somehow does not constitute 'real' archaeology'. Two points need to be made here. In Britain, it is likely that the reason most archaeologists do not find human skeletal remains useful is because many graduated from Universities with no awareness of the value of human remains in the final archaeological interpretation of a site, or how to excavate them properly. Put such an archaeologist on a cemetery site and there are inevitably going to be problems. In recent years, however, many University archaeology departments have seen fit to employ a (palaeo) biological anthropologist on their teaching staff, and it is gratifying to see so many students genuinely interested in courses devoted to the study and interpretation of human remains from archaeological sites. This can only be good for archaeology as a whole. However, a recent survey of the 32 universities teaching archaeology (UCAS, 1998), suggests that only ten have archaeology departments with significant teaching in biological anthropology (with some palaeopathology). By contrast, in North American universities Anthropology Departments more often than not teach biological/physical anthropology (including palaeopathology), and most graduates of anthropology have some grasp of knowledge of biological anthropology. However, in Britain at least, as many more people are being trained at Masters level in the analysis and interpretation of archaeologically derived human remains, increasing numbers of graduates are being employed to excavate cemetery sites, thus often combining an archaeological and biological anthropological background and providing a unique and broad expertise.

The second point relates to publication of data on human skeletal material. Although the situation has improved a little over the last five years, publications rarely integrate the biological information with the rest of the archaeological (cultural) evidence to ultimately say something meaningful about the population under consideration. This partly is reflected in the backgrounds of many people working in the area, partly the fault of the archaeologist responsible for the excavation of the site (and publication) not recognising the value of integrating the data, and partly the result of the formatting of publications keen to relegate 'specialist' reports to the back of the final work, thus making them isolated. Of course, cost will also affect the final format and structure of the report. Furthermore, the palaeopathological findings often tend to be placed in 'specialist' journals such as the *International Journal of Osteoarchaeology*, *Journal of Paleopathology*, *Journal of Archaeological Science*, and the *American Journal of Physical Anthropology* which many archaeologists, especially those doing fieldwork, do not have access to. However, even if archaeologists do read publications devoted to palaeopathology, they are often bombarded with medical jargon and are usually faced with isolated case studies with no archaeological context. We must make our work more accessible to all. In recent years there has been a small change and publications of human skeletal remains in archaeological journals have started to appear (e.g. Farley and Manchester, 1989; Mays, 1993; McKinley and Roberts, 1993; Roberts, 1996).

Furthermore, biocultural (linking biological and cultural evidence) population based approaches to palaeopathology are rare in Britain (e.g. Grauer and Roberts, 1996; Mays *et al.*, 1998), whilst in North America they have become the more normal approach (e.g. Jurmain, 1990; Walker, 1986). Consideration of disease in this way allows humans to be viewed as biological, social and cultural beings (McElroy, 1990). Logically, linking biology and culture, and looking at populations not individuals, is the most profitable way of approaching palaeopathology, but not everybody agrees. In 1991 Bush and Zvelebil (1991: 5) lamented that, '...in contrast to North America, the biocultural approach is yet to become established in Europe...'; unfortunately this is still the case. To support some of these findings Mays' (1997) study of publications in palaeobiological anthropology from 1991–95 illustrates the differences between UK and US work in palaeopathology. In both countries palaeopathology was the area where most publications lay but, when the numbers of 'case' versus 'population' studies were compared, more of the former were seen in the UK and more of the latter in the US (55% versus 27% in the UK and 29% versus 44% in the US). Mays clearly states (1997: 604) that, '...we need to progress towards a more population-based approach, in which osteological findings are combined with other archaeological data in order to produce a more complete picture of the human past'. Archaeologists are, after all, excavating the lives of people, '...not just their buildings, animals and pottery...' (Roberts, 1986: 111). Clearly, the UK is in a position now to address the deficiencies seen in palaeopathological work but there has to be the motivation to do it.

PALAEOPATHOLOGY: SOURCES OF EVIDENCE, METHODS OF STUDY AND LIMITATIONS

'Palaeopathological studies, in Britain at least, are uncoordinated and desperately understaffed (and therefore) there is little possibility of constructive exchange of views between archaeologists and palaeopathologists' (Cramp, 1983: 11?).

Palaeopathology has a number of advantages over clinical medicine. It is a way of studying disease over long periods of prehistory and history, over many thousands of years. Through human remains it gives direct evidence of the expression of disease uninfluenced by modern drug therapy, it provides a window on how humans adapted to their environment (or did not), and what epidemiological factors were operating at the time to allow specific diseases to appear. It may even generate information on the evolution of disease-causing organisms, and diagnostic criteria not described in the clinical literature.

Sources of evidence

Many sources of evidence may be used to reconstruct the history of disease (Table 1). The primary source of evidence for palaeopathology is human remains from archaeological sites. These may be inhumed, exposed or cremated, and disposed of in a variety of funerary contexts. Some work on the palaeopathology of preserved bodies, as opposed to bones and teeth, has been done (Aufderheide and Rodriguez-Martin, 1998), although most work concentrates on the latter. However, having only the skeleton to study precludes the potential identification of diseases that only affect the soft tissues such as the plague, cholera or chickenpox. Fragmentary and poorly preserved skeletons, the lack of non-adult remains in a cemetery, and the fact that the individuals being investigated are a small sample of the original living population are some of the problems inherent in palaeopathological recording, analysis and interpretation. These, amongst other limitations, are outlined in Wood *et al.*'s (1992) important paper, and highlight that the information ultimately derived from a skeletal assemblage has many biases.

Table 1. Sources of evidence used in palaeopathology.

Primary	Skeletal remains (cremated/ inhumed/ exposed) Mummified remains (frozen, dessicated, deliberate, bog) (Clinical approach)
Secondary	Iconographic (drawings, paintings, sculpture) Documentary (written works) Archaeological (artefacts, ecofacts, structures) Ethnographic (traditional living populations)

Other evidence which may be utilised in the reconstruction of past human population health includes historical (written) data, and iconographic representations (paintings, drawings and sculptures). Whilst this body of evidence is classified as secondary, it has one particular advantage over human remains and that is that it records and describes disease processes affecting the soft tissues. However, it is also accepted that authors and artists, more often than not, depict the more dramatic and horrifying diseases rather than those of more minor significance, which did not necessarily look frightening. As Roberts (1971: 41) has reminded us, and many since, literary works must be studied critically '...within the traditional framework in which their facts are presented...when medical writers of Tudor times...describe rats, moles and snakes leaving their holes before plague struck, it must be remembered that in fact they are repeating Avicenna, almost verbatim'. The study of traditional living populations' health and disease (medical anthropology), where they are inhabiting parts of the world where the nature of their lifestyle and environment can be likened to past populations, has also provided some useful data with which to interpret past population health (see Sargent and Johnson, 1996; and McElroy and Townsend, 1996). Of course, there are limitations to using living population data to interpret the past, not least their distance in both space and time from archaeological groups. However, these populations are probably more similar to ancient groups than modern populations from which most of our knowledge of disease comes; their disease patterns, and coping mechanisms, are also likely to be very similar (Polunin, 1967). Nevertheless, as archaeological evidence in all its forms is fragmentary, teasing out particular factors responsible for disease occurrence and patterning in a population may be possible using medical anthropological work as a base. Archaeological evidence (artefacts, ecofacts and structures) obviously provides a wealth of information about living conditions, diet, economy, trade and contact, occupation, hygiene, climate and much more, all aspects of a society which will influence the appearance, maintenance and transmission of disease. For example, trade with other groups will allow new diseases to be introduced to a population which has never experienced them before and thus can lead to increased and rapid mortality. Furthermore, quality and quantity of diet will also affect the development and strength of the immune system and its ability to fight off disease. Without integrating archaeological evidence with palaeopathology, the final interpretation is almost useless.

Whilst there are many sources of evidence for the reconstruction of palaeopathology, human remains form the primary evidence on which the rest of this chapter is based.

Methods of study

Although there are a number of methods available for studying the palaeopathology of human remains (Roberts, 1991 and see Table 2) and, despite them providing much more detailed information normally possible with more common approaches, many are expensive, time consuming and need specific expertise. Most people worldwide use the less expensive 'macroscopic' approach for identifying and recording pathological lesions in skeletal remains; it is argued that this will always remain the case unless funding for archaeological work increases substantially in the future. It is pleasing to know that technical support and expertise exist should isotope or aDNA analysis, for example, become desirable and affordable, but most of the time people working in this discipline do not have the financial support to use these techniques.

Table 2. Methods of study for the analysis and interpretation of palaeopathology.

Macroscopic	visual examination
Radiographic	e.g. macroscopic, microscopic, computed tomography
Microscopic	low and high power, e.g. scanning electron microscopy
Biomolecular	e.g. aDNA, mycolic acids
Trace elements and isotopes	e.g. carbon, nitrogen, oxygen, lead, strontium

The Macroscopic Approach

This approach relies on the accurate identification of pathologically induced changes in the bones and teeth of the skel-

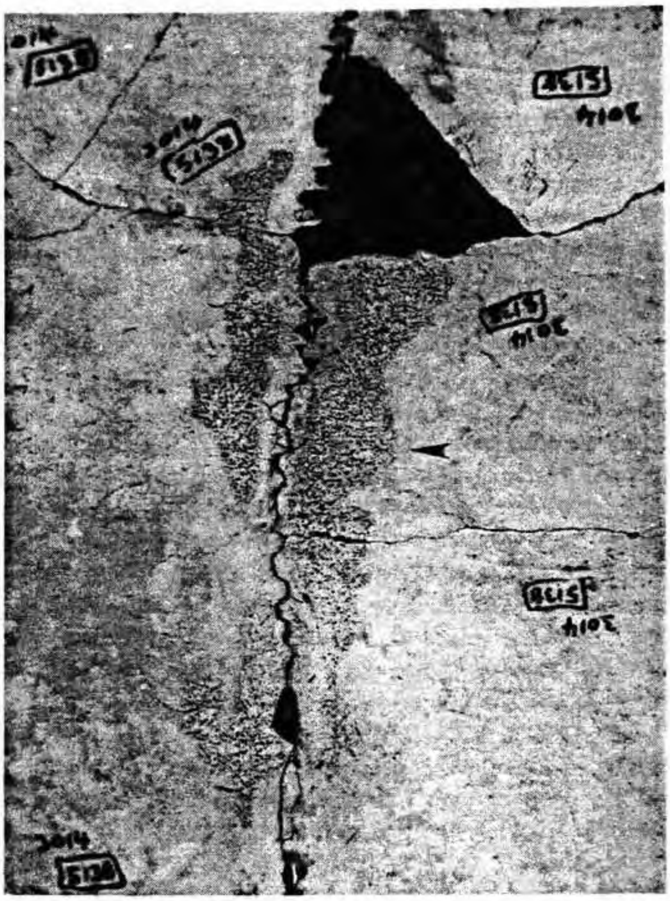

Fig. 1. New bone formation on the endocranial surface of the skull in a juvenile skeleton. Note the porous nature of the bone formed indicating that it is relatively recent in occurrence.

Fig. 2. Head of femur showing extensive destruction as a result of infection, possibly tuberculosis. Note that the remaining bone is remodelled or healed, suggesting that the person had the condition for a long period of time.

eton. In the bone these changes are manifest as areas of new bone formation (Fig. 1) and/or destruction (Fig. 2), with the new bone being formed being woven (porous and disorganised) or lamellar (smooth and more organised) in appearance. The former represents rapidly formed bone which illustrates that the condition was active at the time of death, whilst lamellar bone indicates a longstanding chronic (and healed) problem. In effect, any new bone formation indicates chronicity i.e. that the person has survived the acute stages of a disease to develop the chronic changes in bone; they are, in effect, the healthy ones with strong immune systems. However, it should be remembered that the absence of pathologically-induced change could indicate three scenarios: that the person was healthy, that the person died from a disease that did not leave bone damage (because they died in the acute stages or before the skeleton had chance to respond, or that it was a disease that affected only the soft tissues), or that the person's immune response was such that they had a mild form of the disease. In fact, the ultimate response of humans to a disease can result in four possible scenarios: death, acute disease and recovery, chronic illness, or the person could become a carrier of the disease with no signs or symptoms (Blumberg and Hesser, 1976: 260).

The aim of recording lesions in the skeleton is to identify abnormal areas, describe the characteristics of the bone formed or destroyed, whether the lesions are healed or not (Figs. 3 and 4), and then record their distribution pattern. Some researchers have developed sophisticated tools for recording distribution patterns (Ortner, 1991) which are extremely powerful, but most researchers at present do not have access to such hard and software. By comparing distribution pattern data with data from known clinical cases of disease affecting the skeleton, it is potentially possible to generate a number of possible differential diagnoses. Unfortunately, disease can only affect the skeleton in a limited number of ways and the changes observed may suggest a number of possible diseases. A complete skeleton is a prerequisite for successfully attempting a diagnosis, although even then it is not that easy. Research has shown that people working in palaeopathology are much more comfortable in diagnosing into a 'general' category (such as joint disease) rather than making a specific diagnosis (e.g. rheumatoid arthritis) — Miller *et al.* (1996). In addition, research has also shown that interobserver error and non-agreement on diagnosis are particular problems in palaeopathology (Waldron and Rogers, 1991). Clearly, diagnosis is not easy even in living people (Waldron, 1994).

To add to these problems, fragmentary skeletal material provides a major hurdle to diagnosis because the distribution pattern of lesions are not possible to record if skeletal elements are missing. For example, gout (a metabolically based joint disease) affects the joints of the big toe (usually on one side) in most cases (Resnick, 1995), and therefore if that joint is not

Fig. 3. Cranium with perimortem wound with no evidence of healing, although pitting of the bone surface around the wound indicates that the person may have lived a little time following the injury.

preserved for examination it is not possible to be sure the person did or did not have gout. However, problems in diagnosis may not only be related to those previously discussed. Palaeopathology takes its diagnostic criteria from clinical sources and these sources do not necessarily describe all changes observed in the skeleton, particularly the subtle bone formation not even seen radiographically (for example, see Roberts *et al.*, 1998a and Fig. 5). Sometimes, palaeopathology can provide additional data that might help in the diagnosis of skeletal disease. Another example is that of the work of Moller-Christensen (1961) who identified skeletal changes of leprosy in a Medieval Danish context which had not been described clinically before. Fragmentary skeletal material also has implications for recording actual prevalence rates for disease and how people working in palaeopathology record frequency data. It is essential to record the actual number of bones or teeth present for examination so that percentage prevalence rates for disease can be given. If rates are given on an individual basis, for example ten of twenty individuals had a specific infection, this assumes all bones for all skeletons were available for examination whereas it is more than likely that many bone elements and teeth will be absent, incomplete or damaged in archaeological contexts.

Furthermore, deposition, burial and excavation can damage a skeleton and mimic pathological processes (Henderson, 1987); even to the trained eye it can present problems. In addition, the representative nature of the sample needs attention. Does the sample represent the original living population (Waldron, 1994)? Was only part of the cemetery site excavated, and could there be burials still lying inhumed in the ground? Were people from that population buried elsewhere, or just particular groups, e.g. children or the diseased? Is the funerary context biasing the sample? For example, is it associated with a nunnery or a monastery, which would affect the sex profile of the population? A multitude of funerary contextual factors could affect the eventual interpretation of the site even before the burial environment, excavation and processing of skeletal material gets underway (for an example of a potentially biased sample see fig. 5 in Dawes and Magilton, 1980: 8).

The development of methods of macroscopic recording of palaeopathology has received particular attention recently, especially in North America where the need to rebury human remains has become pressing, partly as a result of the Native American Graves Protection Act passed in 1990 (Rose *et al.*, 1996). Rose *et al.* had already noted the problems of palaeopathology recording in the 1980s and was horrified at the non-comparative nature of a lot of extant data (1988). It was realised that standardisation of skeletal recording was essential if comparative population studies were to be attempted and, indeed, if useful data were to be collected. This resulted in the publication of a manual which provides methods and suggestions for the recording of human skeletal remains, including a chapter on palaeopathology (Buikstra and Ubelaker, 1994). The manual emphasises the need to use a standard terminology with no jargon (even a problem in clinical contexts), with definitions of terms used, and to describe in detail the abnormal pathologically induced changes in the skeleton before even thinking about a diagnosis. The manual also contains a coding system and photographs to illustrate abnormalities. Other recommendations were to study sex and age distribution for diseases observed and, when talking about 'severity' of lesions, to use definitions, and preferably photographs, to illustrate stages in disease manifestation. Some work on classifying the appearance of some lesions has been done, although there is generally no clear idea what the appearances actually mean (for examples see Lukacs, 1989; Sager, 1969; Stuart-Macadam, 1991). In addition, diagnostic criteria must be specified in any palaeopathological report so that readers know on what criteria diagnoses have been based. Without these basic data this information cannot be evaluated scientifically, or indeed re-evaluated in the future especially if the remains have been reburied.

The Radiographic Approach

The second most common method of analysis of human skeletal remains is through radiography, often to confirm a diagnosis or visualise the internal structure of a suspected pathological bone or tooth (Barber *et al.*, 1997; Elvery *et al.*, 1998; Fig. 6). Whilst selected bones are usually radiographed, research has shown that more pathological evidence could be identified if all bones were subject to radiography (Rothschild and Rothschild, 1995). Some disease processes just do not reveal

Fig. 4. Injury to occipital bone which has healed. Note the rounded remodelled edges.

Fig. 5. New bone formation on the visceral (lung side) of the ribs.

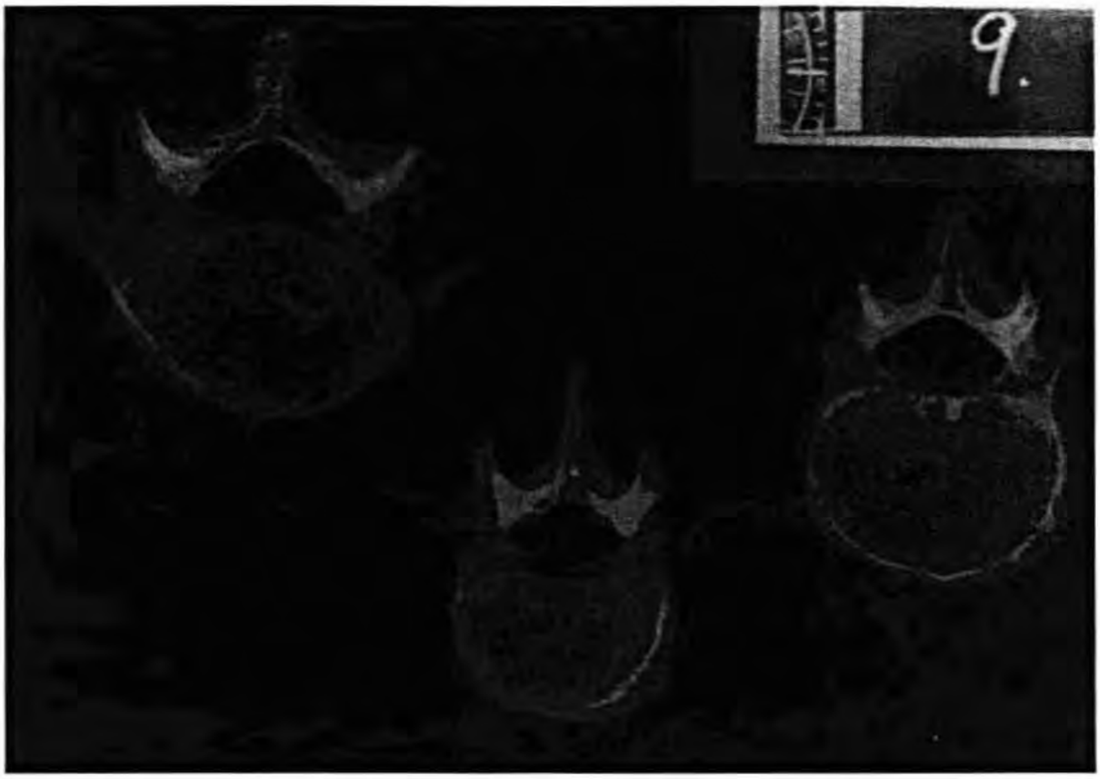

Fig. 6. Superior view of vertebrae showing circular lesions in the bodies with an opaque (sclerotic) border around them, suggesting healing has (and was) taking place at the time of death.

themselves unless radiographed and this may be because the disease is just developing (for example, in some cancers and the early stages of infections such as osteomyelitis commencing on the interior, medullary cavity, of a long bone). Plain film radiography is the most common method used, mainly because it is relatively quick and cheap, and most people working in the discipline have access to this facility. More sophisticated methods are utilised less often because of lack of availability of resources but include microradiography (Blondiaux *et al.*, 1994) and computed tomography (Melcher *et al.*, 1997), which are able to investigate more detailed structural changes within bone. Plain film radiography records areas of opacity and lucency which reflect bone formation and destruction, respectively; it may also provide an indication of the quality, i.e. state of healing, of bone formation. For most categories of disease it provides hidden information. For example, the overlap, apposition and angulation of fracture fragments (see Roberts, 1988 for more detail), Harris lines of arrested growth (Hughes *et al.*,1996; Fig. 7), the 'mosaic' patterning of Paget's disease, essential for diagnosis (Wells and Woodhouse, 1975), and the subchondral (beneath the cartilage of a joint) cysts of osteoarthritis (Rogers and Waldron, 1995; Fig. 8) are all features of health problems seen in the skeleton which would not be visible without a radiograph. There are problems with this method, however, for example the appearance of pseudopathological features which are difficult to interpret, the expense of the procedure, and getting exposure and time settings correct to bring out the best image.

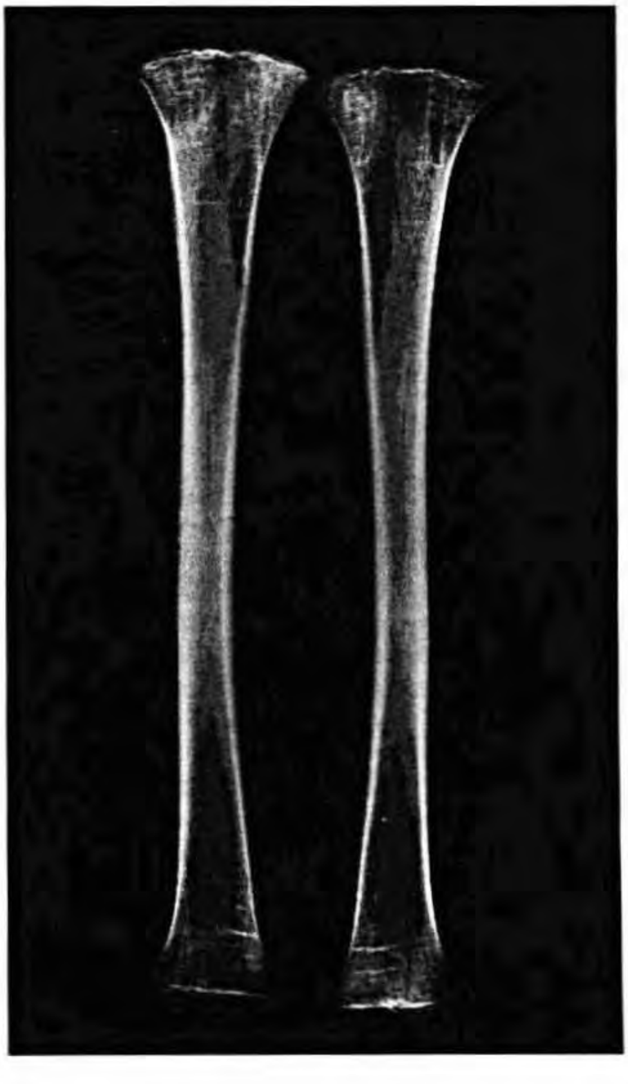

Fig. 7 (*right*). Horizontal opaque lines across the tibiae at their proximal and distal ends, suggesting stress during growth

Fig. 8. Subchondral cysts in femur, a feature associated with osteoarthritis.

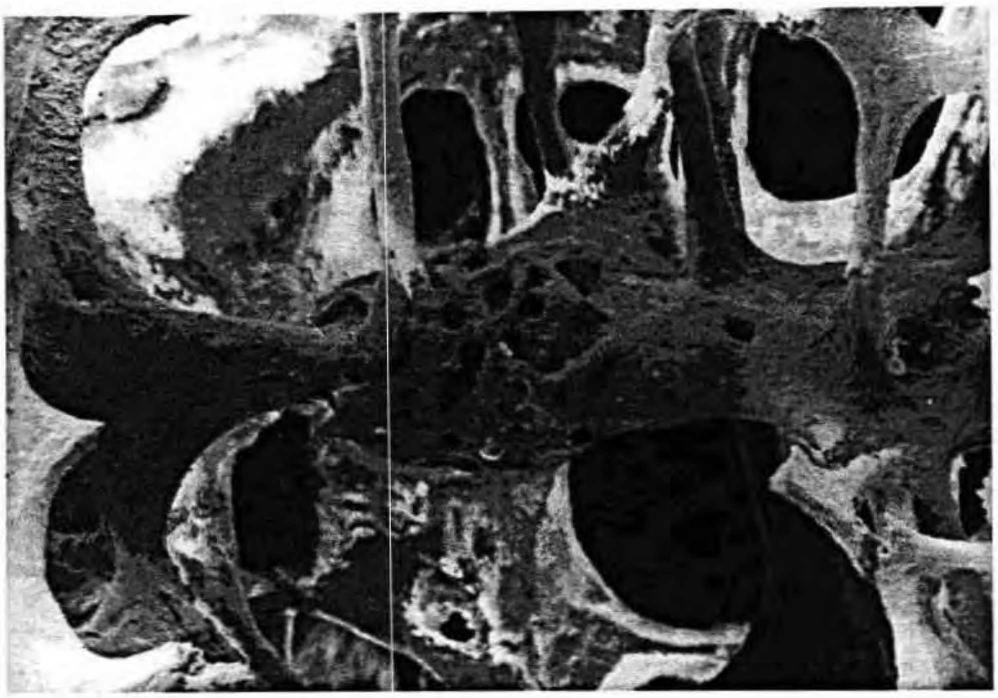

Fig. 9. A microfracture with callus (immature new bone formation) in a vertebral body (cancellous bone).

However, it remains an extremely useful tool for the interpretation of palaeopathology.

The Histological Approach

The use of histological analysis in palaeopathology, again, has seen less frequent use than macroscopic methods due the expertise, finance and time needed to pursue these methods. However, some useful research has been carried out confirming diagnoses of disease (e.g. Aaron *et al.*, 1992), looking at detailed morphological appearances using the scanning electron microscope to identify areas of bone formation and destruction at the microscopic level (Roberts and Wakely, 1992; Fig. 9), for assessing the content of calculus on the teeth (Dobney and Brothwell, 1988), and dental microwear patterns to look at quality of diet (Teaford, 1991), and also using histology to address differential diagnoses for skeletal lesions, and establishing the effect of postmortem damage on palaeopathological manifestations of bone (Bell, 1990). Whilst the histological preservation of skeletal material determines the ultimate information derived, it can be a powerful method of information generation (Pfeiffer, 2000; Bell and Piper, 2000).

The Biomolecular Approach

In recent years, biomolecular approaches to diagnosis of disease have seen increasing use particularly using aDNA (Drancourt *et al.*, 1998; Fricker *et al.*, 1997; Salo *et al.*, 1994) and mycolic acids (Gernaey *et al.*, 1999; Gernaey and Minnikin, 2000). Although most work has concentrated on tuberculosis to date, increasing emphasis is being placed on other mycobacterial diseases such as leprosy (Spigelman *et al.*, 1999). The biomolecular approach has much to offer palaeopathology (Brown, 2000), particularly in identifying diseases that only affect the soft tissues, for people whose immune system resistance was so good that skeletal changes did not present themselves, or in tracing the evolution of particular organisms. Again, this method at the moment is expensive, time consuming and unpredictable, with a potential problem of contamination. Before more useful work can proceed, there is a great need to identify when these ancient biomolecules survive, i.e. in what environmental circumstances, so that time and money are not wasted trying to extract what is not there. In addition, education of those working in archaeology on the merits and problems of ancient biomolecule analysis is an overdue necessity so that assumptions of its value are not overstated. Because of the application of biomolecular methods of analysis to palaeopathology, the discipline is certainly at an exciting stage in its development where its potential has not yet been recognised.

Trace element and isotope analysis

Work in the analysis of elemental content of bones and teeth has been undertaken since the 1970s and has concentrated mainly on trying to reconstruct the palaeodiet of individuals (usually) and populations (Sandford, 1992; 1993; Sandford and Weaver, 2000). Since that time questions of whether levels of elements really do reflect life levels have made many cautious but, with care, this type of analysis has great potential. Of course, diet has a significant effect on the development of the immune system which, in turn, will affect whether a person contracts a disease or not (and how chronic that disease becomes) and therefore looking at quality of diet is highly relevant to palaeopathological studies. In addition, researchers have tried to assess the effects of pollution in the body by measuring, for example, lead (Rogers and Waldron, 1985), and measured levels of particular elements to correlate them with other (pathological) features in the skeleton (e.g. Glen-Haduch *et al.*, 1997). More recent work (but also starting in the 1970s — Katzenberg, 1992) has concentrated on assessing the levels of isotopes of carbon and nitrogen to determine the quality and constituents of the diet and, even more recently, to answer questions about weaning (Katzenberg *et al.*, 1996). People have also now begun to look at migration using stable lead isotopes (Carlson, 1996) and also strontium isotopes to consider changes in diet with movement of people (Sealy *et al.*, 1995; Katzenberg, 2000; Mays, 2000). Clearly more work in these areas will continue and these methodologies provide potentially exciting information.

Nowithstanding the many methods available to evaluate palaeopathological evidence in skeletal and mummified remains, in order for many of those described to be used it is necessary to sample and destroy bone or teeth. Along with expense, time and necessary expertise, it is essential that people working in these methodological areas do not destroy valuable skeletal material with no particular aims, questions or problems in mind. Skeletal collections are a non-renewable resource and, in some parts of the world, a resource that is diminishing fast. To reiterate, the author believes that the macroscopic and radiographic approaches (i.e. non-destructive) will remain the predominant methods used in palaeopathology for as long as palaeopathology is studied.

HUMAN PALAEOPATHOLOGY AS A DISCIPLINE

'The progress of paleopathology, as a specific subject of research, parallels the development of many scholarly and scientific disciplines' (Ortner, 1991: 5).

There are a number of aims in palaeopathological study which workers try to address. Palaeopathology considers the occurrence of disease in human and non-human remains, its prevalence and the impact of disease load on 'population' groups. To interpret palaeopathological observations, other key parameters of the population also need to be known, which include age at death, sex and stature. How long you live will determine what organisms you will become exposed to, bearing in mind that the young and old (today and in the past) are more vulnerable to health problems, and the older you are the more severe a disease can potentially become. Biological sex will also determine diseases experienced; for example, osteoporosis (loss of bone quantity) and rheumatoid arthritis (an immune joint disease) are more common in females, while ankylosing spondylitis and Forestier's disease (both conditions affecting the spine) are more common in males. It is only in recent years that palaeopathology has begun to try to understand sex differences in disease occurrence, culminating in a recent book (Grauer and Stuart-Macadam, 1998). Thus, the palaeodemographic profile (age and sex distribution) is key to understanding palaeopathology because it indicates when and who died in that sample population. This, in turn, indicates health problems (because people are dead) which could range from cancer to infection, and even decapitation which, of course, severs important body life supporting systems.

Stature (or height) too is a very useful parameter for understanding health and disease. For example, people who are shorter than normal for their sex, age, population and period of time may have had health problems during development of the long bones which affected their normal growth. Although it would be hard to suggest exactly what caused the reduction in stature, it provides a possible indicator of health. Finally, ethnic affiliation of the individual will have an impact on what diseases the person suffers from (Polednak, 1989; Reichs, 1986). For example, the Mediterranean and south-cast Asia see a high frequency of thalassaemia amongst its inhabitants, and sickle cell anaemia is more common in African countries (Aufderheide and Rodriguez-Martin, 1998).

Whilst all these parameters need attention and correlation with evidence of disease in an individual skeleton, the emphasis in recent years has been on the need to consider 'populations' of skeletons rather than 'individuals'. The original 'diagnostic/clinical' model approach to palaeopathology (i.e. individual case studies) does still have some value because it highlights cases of certain diseases in geographic, period and funerary context (and collation of these data can contribute to a fuller picture of past health on a global scale). However, more recent years have seen a concentration on hypothesis/question driven/ problem based population studies. For example, an hypothesis to be tested might be: people living in urban Medieval environments were less healthy than those in rural environments. This indicates a 'hunch' or expectation of the data that can be tested using appropriate skeletal material. An example of a question might be: what happens to people's health when they start practising agriculture? Here, one should be thinking of investigating the living environment of the population, their diet, living conditions, hygiene, water supply etc. which may answer the question. Even more recently the physical, chemical and biological bases for pathological change in the skeleton have been a focus in palaeopathology (the integrated and process driven model — Sandford and Weaver, 1998). Why do those holes appear in the orbits in somebody suspected of having anaemia? Why do the different treponemal syndromes produce differential patterning of new bone formation on the skeleton? There is now a clear move towards questioning why rather than accepting at face value that specific pathological lesions are linked to certain diseases.

Palaeopathology, for all its problems, has always been a dynamic, progressive and changing discipline, probably because of the membership of the Paleopathology Association (founded in the US in 1973) being so varied in its expertise — archaeology, anthropology, medicine, dentistry, anatomy, genetics, history etc. To reiterate, everybody has something to offer palaeopathology and each person sees it from a different perspective. Despite this there are standards and levels to which people working in it should strive to achieve (as discussed above).

EXAMPLES OF SOME WORK IN PALAEOPATHOLOGY

'The value of the biocultural approach lies in its comprehensive view of humans as biological, social and cultural beings' (McElroy and Townsend, 1996: 244).

There has been excellent work in palaeopathology but also mediocre and very poor studies. Of course, most people have tended to concentrate on the commoner (and perhaps easier to recognise and interpret?) conditions such as infectious and joint disease, trauma and dental disease, whereas other less common conditions have seen little attention, such as neoplastic and congenital diseases. Much work, however, has consisted of individual case studies (as discussed previously). However, as numerous authors have pointed out, focusing on the individual and the disease seen in that person lets the role of the pathogen in that condition take over (Armelagos *et al.*, 1992). In a modern sense, but just as applicable to palaeopathology, a population approach enables workers to move beyond this clinical perspective and concentrate more on the complex myriad of factors in the environment which contribute to the appearance of ill health. McElroy and Townsend (1996: xxi) are quite clear in describing the limitations inherent in the clinical perspective when they say that Western medicine, '...usually considers disease as a clinical entity that can be diagnosed, and treated independently of cultural context'. In the context of treatment too, drug therapy and surgery are all well and good but a person or population's recovery depends on their environment, their diet, their hygiene and even how their psyche deals with the illness and/or operation. They go on to say (*ibid.*, 1996: 32) that '...we see neither the social context in which the disease occurs nor how the individual or family members and community perceive and experience the illness'. Wood *et al.* back in 1992, however, did note that in palaeopathology, at least, they saw a move towards the population based perspective rather than individual case studies, the latter of which they saw telling us '...little about the disease experience of ancient populations' (*ibid.*, 345). Larsen (1997) also notes that because of this it was becoming possible to create a more meaningful understanding of past human adaptation, or how people have changed and adapted to new and changing situations.

Concepts of how and why a disease enters a population, maintains itself and possibly leads to death will naturally influence how a society copes with that illness. If they think a disease is transmitted by eating a specific food then that food may be omitted from the diet, or if a pain in the head is believed to be caused by a 'demon' within then the obvious solution may be to let the demon out by creating a hole in the skull (in this case referred to as trepanation — see Backay, 1985 for more details). But what disease or illness is to one person or population may not be perceived the same in another. Work on living societies suggests that, for example, mild forms of diarrhoea may be regarded as normal, requiring no treatment (Findley, 1990). Many minor illnesses in any society today and in the past may be accepted as normal. Of course, there will be variations on this theme whereby one person may appear very ill with a minor illness, whilst another with the same illness may appear in relatively good health. Positive and negative attitudes to illness play a large part in expression of them and the ability to function and behave normally, and many factors may determine these attitudes (Roberts, 1985).

Working from a population rather than an individual perspective enables the biocultural approach to palaeopathology to be used and ultimately have an impact on the reasons behind the evolution and history of disease we understand today. Medical anthropologists have been using the biocultural approach for years to assess health problems in traditional living populations. They claim, quite rightly, that to understand the health problem you cannot isolate disease from culture because it 'manufactures' disease (Inhorn and Brown, 1990: 110). Thus, studying leprosy in populations today devoid of cultural contextual information makes the final interpretation very limited. Health reflects an individual's ability to adapt to his or her environment by biological or behavioural means and disease reflects failure to adapt (Wiley, 1992: 222). Of course, 'One can adapt to as well as adapt something to meet their (one's) own needs (*ibid.*, 229)', and 'adaptation is a useful and powerful explanatory concept and provides a model for decision making, a perspective on history and prehistory, and a way of generating and testing hypotheses about reality' (*ibid.*, 233). Whilst these ideas relate to living populations today, they are equally applicable to the past even though the evidence used is much more problematic. Perhaps because of the fragmentary nature of archaeological data this makes it even more imperative to view palaeopathology from a biocultural perspective in a very holistic way. In doing this the impact of disease on a cultural group or society living in a specific environment may be better understood, especially with respect to coping mechanisms. Whatever area of study a researcher can claim to have expertise in, he or she, '...can only claim to have one small piece of a very complex puzzle, the pieces of which are complementary, not contradictory. To discourage investigation in one domain is to deny a fundamental aspect of the human condition in health and sickness' (*ibid.*, 232). Even the Hippocratic School in fifth century BC Greece recognised the value of considering a disease in its cultural, social and geographic context when Hippocrates in '*Airs, Waters and Places*' described a successful physician as one who relates disease to environment (Furness, 1970).

In effect, the biocultural approach can be classified as an epidemiological study or, '...the study of the distribution of disease in populations and of the factors that explain disease and its distribution: the population rather than the individual is the unit of study' (McElroy and Townsend, 1996: 43). It relates disease to age, sex, ethnicity, occupation, marital status, and social class amongst other variables, and compares rates between geographic areas and time. However, it should be remembered too that some of these variables may change over the lifespan of the individual and can therefore have different effects with respect to disease, and they may vary regionally. In archaeological contexts these changes prove problematic to identify because what is examined is the state of the skeleton of an individual (and population) at their time of death. It is a static observation and usually cannot take into account the detailed life history of that person or population, especially if the evidence seen for disease is chronic and healed in nature. It also presents a major question that cannot be answered. When did this person contract the disease seen in the skeleton, and did he or she have more than one episode of the disease? One of many scenarios could be that the person was very healthy through into early adulthood and then had a period of ten years when he or she contracted a number of diseases, some not affecting the skeleton. Recovery occurred and then the person lived another 20 years. Detailed examination of the characteristics of the pathologically induced lesions may help solve some of this problem but will not give all the answers. With respect to changes in environment, diet, climate and occupation, and their effects on health through an individual's lifetime, it may be possible to see the results of these changes reflected in disease patterning in a population, and by linking the biological evidence with evidence for these variables, direct cause and effect for disease may be seen. However, a timescale for these changes would not be evident. Another example explains this concept. If a person had a malaligned healed fracture to a leg bone and the adjacent joints displayed osteoarthritis, it is often assumed (but cannot be proved) that the osteoarthritis came after the fracture (because of changed stresses through the joint) but that may not necessarily be the case. What needs emphasising is that, despite trying to take a biocultural approach to palaeopathology, it will never be possible to pick up the nuances, detailed facets and changes that a population may experience through its lifetime — but this does not mean that it should not be attempted!

There has been some extremely beneficial work in palaeopathology that has taken this biocultural approach into account when trying to understand the aetiology (cause) of le-

Fig. 10. Cribra orbitalia ('holes') in the left orbit of a skull.

sions in the skeleton. Three examples will illustrate the point. Firstly, a condition termed cribra orbitalia (or 'holes' in the eye sockets) has attracted much attention in palaeopathology (Fig. 10), probably because in some populations it has been seen in high frequencies, and is relatively easy to recognise and record. Stuart-Macadam (1985) has studied it both from a clinical and palaeopathological perspective, and it has been documented in agriculturally based populations in higher frequencies than for hunter-gatherers (Cohen and Armelagos, 1984). Despite much work on the condition having been done, its aetiology is not yet fully understood. A number of possible factors have been implicated for its appearance which is believed to be associated with anaemia. A diet low in iron, low birth-weight in children, a reliance on cereal in the diet, an overall high infectious disease load in the population, excessive blood loss, and intestinal problems are some of the causative factors suggested (Holland and O'Brien, 1997; Stuart-Macadam and Kent, 1992). By considering the condition from a biocultural perspective, all these factors could be considered as possible causes of the lesions. Was the population practising agriculture? Did they rely on cereals for much of their diet? Is there any evidence of infection in the population, and what factors appear to have induced it? What was the meat component of their diet? Of course, cribra orbitalia may have been caused by all these factors if these were identified in the cultural contextual data for the archaeological site, but at least this way of approaching disease causation may answer the question. If cribra orbitalia is recorded with no reference to the person's environment there is little more than can be said except that the person or population had the condition.

A second example illustrates a similar situation. New bone formation in the maxillary sinuses, the largest of the sinuses in the facial bones, has been noted in skeletal material from archaeological sites (Fig. 11). It is accepted as representing sinusitis in life (inflammation of the sinuses) — Roberts *et al.* (1998b), but there could be many potential causes. Smoking, environmental pollution, dental disease and allergies are some of the many aetiological factors involved in the appearance of the condition. Again, however, by considering later Medieval skeletal populations living in rural and urban environments it was possible to suggest causes for the sinusitis seen. Looking at cultural data indicating the quality of environment in which each group were living in, their occupations and housing, clear differences (but also similarities) were noted. Documentary and archaeological evidence in the urban centres indicated the presence of polluting industries, perhaps contributing to the rates seen there (especially for the males, who had the most severe and chronic changes in their sinuses), whilst in the less industrially (but agriculturally) polluted rural environment, other factors were identified as possibly contributing to the lower rates (for example, pollen, animal hair, etc.). Again, without the cultural contextual data the sinusitis frequencies would have remained clinical entities devoid of context.

The final example relates to lesions seen on ribs (Fig. 5) which many have suggested relate to lung infection (Kelley and Micozzi, 1984; Pfeiffer, 1992). Originally this work attempted to understand the mechanisms of the new bone formed in the ribs and its specific cause (Roberts *et al.*, 1994), suggesting that pulmonary tuberculosis was a likely candidate although it was accepted that other chronic lung diseases could have lead to the same changes. More recent work, as yet unpublished, has tried to focus on the specific environmental conditions that might lead to the rib changes. By considering populations from hunt-

Fig. 11. Floor of maxillary sinus with extensive new bone formation, suggesting inflammation of the sinus during life.

ing and gathering and agricultural communities, desert and industrialised groups, the aim has been to try and explain more specifically what is causing the pathological lesions. If it is a respiratory disease, were the population living in close contact with each other? Did social status, sex or age have any influence on the appearance of the lesions? Are the rib changes necessarily from a lung infection or are the changes a result of irritation of the respiratory system from an external cause such as a dusty environment, or high levels of pollen in the atmosphere? Although the data is currently being worked on, the final results should make interesting reading and develop the rib lesion-lung condition theory (and probably make it even more complex!).

The inferences that are potentially possible from a bioculturally based population approach to palaeopathology are extensive and exciting and there are many questions that need approaching with respect to health in the past. For example, what were the effects of migration on health and disease in societies? Can we identify where people originated and moved to during their life? Recent work has suggested that this is possible (Carlson, 1996; Sealy *et al.*, 1995). But what are the real implications for disease when a person moves to a new area? By moving to a new place people expose themselves to new pathogens that their immune system cannot deal with, and they also take with them new diseases which the population they encounter has not experienced before which often leads to increased and rapid mortality (Swedlund and Armelagos, 1990). Trade caravans, religious pilgrimages and military manoeuvres have, in the past (and today), been responsible for mass movement of people (Wilson, 1995). In addition, acute disasters (e.g. drought), voyages of discovery and even stigma associated with a disease may lead to migration. What is important to note as was so clearly stated by Wilson (*ibid.*, 43) is that the differences in biological life in different areas and differences in receptivity and vulnerability are most important in the occurrence of disease. By linking biological evidence for disease and cultural data together to answer questions about migration, the impact of this very common human behaviour, which has had a long history, may be better understood.

Linked very much to the effect of travel on health is the immune system. The strength of the immune system or the ability of a person or population to fight off disease will be determined by exposure to pathogens during a person's lifetime, i.e. what you meet in the environment has an ongoing effect and long-lasting influence on your immune cells (comment by J. Stanford in Hamilton, 1998: 30). We assume that the improvements in living conditions, hygiene, water supply and sewage disposal are key to health but that may not necessarily be the case: '…an obsession with cleanliness and hygiene carries a hefty price tag' (*ibid.*, 26). Playing in the dirt as a child was good for us! The immune response our bodies have to a pathogen is very much determined by how many viruses, bacteria or other pathogenic organisms our immune system has had to deal with in childhood and adulthood. In a clinical sense, despite knowing much of what our immune system is about, we can only guess the strength of immune systems in the past by looking at pathological lesions: chronic healed lesions are taken to indicate that the person had a strong immune system, but was that so for all his or her life?

In transitional settings people spend a lot of time being sick (Findley, 1990), and that must have been true in the past, although few of these 'transitions' have been studied. Most of the work in palaeopathology to date has been focused on the transition to agriculture but there is room for much more work looking at, for example, migration of rural populations to urban settings (common today). Armelagos (1998) recognised three major epidemiological transitions, each sparked by human activity. The first was the transition to agriculture around the world, the second came this century when the war on the infectious diseases appeared to have been won, and the third we are experiencing now. The third is characterised by new diseases appearing over the past two decades as a result of, for example, increases in population and urbanisation of people, environmental degradation, global warming and improved transport. As he states, 'we are, quite literally, making ourselves sick' (*ibid.*: 27). However, it is possible to see other 'transitions' within these main three transitions in the past, for example the first moves to urban living, development of craft specialisation, and the development of trade and contact (Dobyns, 1993; Larsen, 1994). Each brought with it new health risks and challenges. Whilst we also generally think that we live in a healthy world in the west, there are probably more problems to face than our ancestors had to experience. Increasing length of life and development of chemotherapy has led to change in disease load seen. The degenerative diseases such as those relating to the cardiovascular system, and cancer, are prices we have to pay — '…the new survivors are not necessarily the healthy survivors' (Verbrugge, 1984). What is more, many new diseases are emerging, or old diseases re-emerging, in the world today which reflect the changes and damage we, as society, are imposing on our environments.

Start to discuss all these issues with respect to the differences between the biological sexes and, for the past, it becomes even more complex but fascinating. Differences in disease load between the sexes obviously illustrate behavioural differences which reflect social and cultural ideologies and values. Whilst people working in palaeopathology have usually provided disease data for males and females in their populations, there has been a lack of synthesis of these data with respect to why the differences are seen. A recent book (Grauer and Stuart-Macadam, 1998) has tried to redress the situation using perspectives from both medical anthropology and palaeopathology to explain sex differences in disease. Immune response, occupation and diet may be some of the more common influencing factors.

TREATMENT OF DISEASE AND INJURY

'The basic idea of medicine is to fix what goes wrong…to get back to a predetermined state of good health' (Alter, 1999: 43).

Clearly, there is much to be done despite much that has already been done in palaeopathology. Of course, accompanying disease is the treatment of disease, whether that be medically or surgically orientated. The thrust of this book is on the archaeology of medicine and it aims to show some of the evidence for treatment, and how it may be accessed and analysed. As with disease, the sources of evidence for medicine and surgery remain primary and secondary. Primary data comprises evidence on the human remains themselves, and secondary evidence may be found in documentary and art evidence (e.g. herbals, hospitals), archaeological evidence (e.g. dental and surgical instruments) and by studying traditional living societies and their concepts of disease causation and treatment. Primary evidence for treatment is limited (but more reliable) and secondary evidence is more plentiful (but less easy to interpret). Evidence for treatment of fractures (splints), head injuries (trepanations), and amputations have been found in the archaeological record (Backay, 1985; Bloom *et al.*, 1995; Elliott Smith, 1908), whilst direct application of copper plates to upper arm bones, probably to treat infection, have been noted in three different cultural contexts (Hallback, 1976–7; Janssens, 1987; Wells, 1964b; Fig. 12). Direct evidence for dental treatments are more abundant, ranging from fillings (Moller-Christensen, 1969), and drillings (Bennike, 1985) to dental restorative work (Zias, 1987).

Because dental remains tend to survive more readily in archaeological contexts, perhaps this is why there is more evidence for dental treatment than for treatment of problems in bone. Thus, while there is primary evidence for medicine and surgery, it is limited in what it can tell us about therapeutic systems, who had access to them (did specific social status, sex or age groups have priority, for example), and how effective they were. For example, poorer people may have been less likely to have access to 'first class' treatment than richer and more powerful members of a society. Indeed, today this is the case in both developed and developing countries. In fact, it has been suggested that some diseases may not be recognised as a problem (and therefore care systems not implemented) if only the poor suffer and not the rich (Farmer, 1996). Tuberculosis is one of these diseases that saw a decrease in its significance in the 1970s and 1980s in the wealthy nations of the world because of access to effective treatment. It is suggested now that tuberculosis in the poor groups of societies worldwide was still a major problem at that time which became more severe into the 1990s. Now that even the wealthier members of countries are being affected, nations are recognising the need to tackle the problem. The implication is that if a disease affects the poor then it does not matter. The alternative view of access to treatment might argue that if the poor were denied access to treatment in the past, they may have, within their own communities, developed adequate care and coping systems which worked well, i.e. don't wait for help to come, do something about it. As Withers (1961: 1) stated, '...in times of stress or of pain or of sorrow, the human being will go to any length to try and find help'.

Whilst one can guess and hypothesise about the availability of treatment for disease and injury in the past (and there is nothing as practical as a good theory — Marrow, 1969), it is mainly through secondary sources of evidence that the information comes as many of the chapters in this book will show.

THE WAY FORWARD: INTO THE TWENTY-FIRST CENTURY

'...there is growing evidence to suggest that archaeologists are incorporating skeletal studies into their research designs. This is especially the case for testing hypotheses and drawing inferences about diet and nutrition, health and disease, demography, and physical behavior and lifestyle in the past' (Larsen, 1997: 2).

So where does palaeopathology go from here and into the twenty-first century? This view is theoretical in nature which, in practice, may be difficult to achieve, especially in Britain. Notwithstanding the need to focus on linking biology with culture in palaeopathological study, a theme inherent in this chapter, recording of evidence is key to advancement. It is impor-

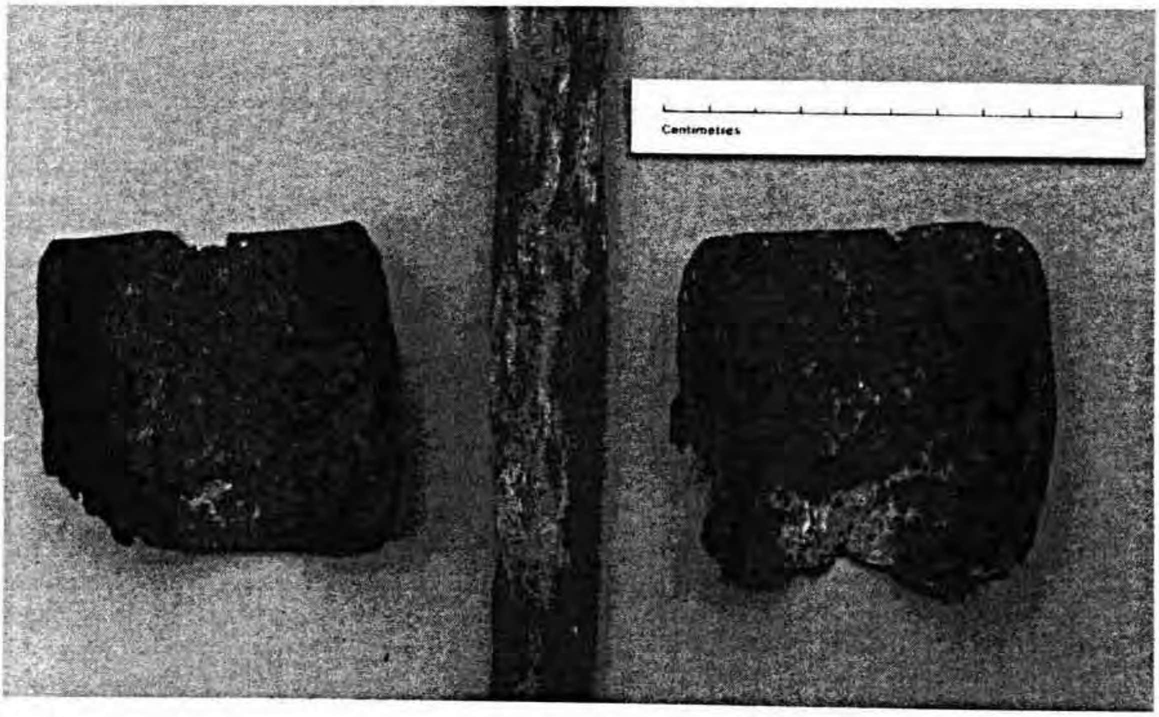

Fig. 12. Humerus with copper plates (originally lined with ivy leaves) indicating attempts at treatment of an infection.

tant to ensure that people working in the discipline are trained to recognise, record, and interpret pathological conditions in human remains; without this there is no point in palaeopathology. Inevitably, specialist training in this area is a prerequisite and a number of postgraduate courses exist to provide this training. Detailed recording of abnormal bone forming and destroying lesions, whether they are active or healed, and their distribution pattern on bones and teeth, and in the skeleton as a whole, form the basis of further analysis. Using a clinical base with which to interpret the distribution patterns, and providing a list of possible differential diagnoses, gives a starting point from which to think about the epidemiological aspects of the disease(s) observed. By considering age and sex, and the cultural context of the human remains, a more secure diagnosis (and specific aetiology to the disease seen) may be given. Appropriate photographs (especially for illustrating problematic or unusual cases, or to illustrate severity grading systems) and radiographs provide supporting evidence for the pathological observations seen. Methods for age and sex estimation must be given and recording methods for metrical and non-metrical data relevant to palaeopathology noted (for example, stature data, and non-metric traits which might be related to lifestyle). Details of the preservational state of the human remains (and definitions of terms used) are highly relevant to the final data collected because they will affect their quality. Not least, and of key relevance to investigating prevalence rates, is the recording of numbers of skeletal elements (including joint surfaces) and tooth types preserved so that actual prevalence rates can be determined.

HYPOTHESES, QUESTIONS, POPULATIONS VERSUS INDIVIDUALS

'In contrast to North America, the biocultural approach is yet to become established in Europe, but although population analyses are lacking... theoretical and methodological studies of measure of health are more abundant' (Bush and Zvelebil, 1991: 5).

Ideally, when recording any pathological lesion, there should be an hypothesis to test on which the work is based ('a statement of a hunch, expectation, or prediction or relationships or patterns that one seeks to test or examine' — Pelto and Pelto, 1996: 297), or a question that is being asked. This rests on considering the cultural context from which the skeletal material comes. For example, there is documentary evidence for a series of harvest failures during the period of the cemetery's use and therefore the expectation would be that the individuals from the cemetery might show signs of stress and dietary deficiency. Alternatively, a question might be: what skeletal changes (pathological and non-pathological) would be expected when a person starts to farm rather than to hunt and gather. These questions and hypotheses frame work, and should ideally be filling gaps in knowledge in a geographic area, time period or funerary context. In reality, it is not often possible to highlight these gaps because relatively little palaeopathological data has been published and still lies sitting on shelves waiting, especially in Britain. Whilst 'case studies' of interesting pathological conditions will always have their place in palaeopathology, the emphasis now should be on looking at health and disease from an aged and sexed population perspective, and preferably with large samples where analysis and interpretation will mean something. The question of sample representivity, however, should always be addressed.

To ensure good quality samples, the recommendation would be to employ trained biological anthropologists to work on cemetery site excavations whose expertise in recovering and processing skeletal material will enable due attention to be paid to the requirements of palaeopathology. For example, the recovery of all bones of the skeleton helps ultimately to diagnose disease, and the careful processing of material once excavated will ensure that delicate structures (e.g. calcified plaque, or calculus, on the teeth) do not get damaged before they reach the recording stage. Ideally, too, a bibliographic and skeletal database of previous work in palaeopathology would help in generating comparative work in the discipline. By identifying contemporary and different sites in the same and different geographic regions of the world, and assuming everybody has recorded data in the same ways, comparison of data is potentially possible and gaps in knowledge could be highlighted. Some of these databases are available but as soon as they are published they are usually incomplete and need updating. The Palaeopathology Bibliography (Tyson, 1998), and the annotated bibliography of the Paleopathology Association Newsletter, plus the numerous bibliographic database systems now available, covering most journals (obscure and not so obscure) provide an invaluable source of information for possible comparative work.

As we move into the 21st century, in many parts of the world including Britain, there exists a strong archive of skeletal material curated in museums and other institutions, supported by a strong archaeological base. This 'infrastructure' can allow very complex questions to be asked of past human behaviour in all respects. The strong archaeology base allows contextual (cultural) information to be potentially effectively integrated with biological information. However, to do this, we need the will, motivation and enthusiasm of all parties concerned. If humans are important today then surely they were so in the past. Furthermore, if they were important then if their health suffered did this not have an effect on their social, economic and political systems, and environment (and much more)? Alternatively these systems could have had an effect on their health. People are the key to understanding the past, and how better to study them but through their biological remains? However, we must reflect on what we have done already in palaeopathology, and not accept everything we read as true; never think that specific research in palaeopathology has had its final say (there is always room for improvement and extension of previous research with new data, even to the effect of demolishing of theories), and never be complacent or be frightened to admit we were wrong. We must also not study palaeopathology for its own sake; we have to justify our actions and have specific research objectives, something which is difficult to achieve with contract archaeology being dominant in many parts of the world. NAGPRA (Rose *et al.*, 1996) has shown that we must consider the study of human remains from archaeological sites as a privilege and not a right. We must ask the right questions, study the data in a scientific manner and be respectful to this valuable resource. We must also promote our studies through the media, whatever we think of that opportunity, because it is through informing the public of our work that we can show its value. With all this in mind, palaeopathology has a great future in the 21st century, a future which will contribute significantly to understanding how humans adapted to, changed and lived in their environments, and how those environments affected their health.

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