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PALAEOPATHOLOGY: SIMILARITIES AND DIFFERENCES BETWEEN ANIMALS AND HUMANS

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Abstract: *Throughout the history of anatomical studies, humans and animals have been studied differently. Human medicine has characteristically driven research, while animals often served as indispensable substitutes in everyday autopsy work. The alternating and complementary roles played by humans and animals as subjects of pathological investigations have indirectly influenced their roles in archaeological enquiry. In this paper, human and animal remains from archaeological excavations are compared in terms of morphology, aetiology and taphonomy, in order to appraise the relevance of results in human palaeopathology to anomalies recorded on animal bone finds.*
Keywords: *Archaeozoology; Palaeopathology; Aetiology; Taphonomy.*

Introduction

Recently, palaeopathology has attracted increasing attention as a cutting edge branch of physical anthropology, not last owing to advances in sophisticated research techniques. Studying the majority of anomalies in ancient human skeletons, however, falls within the boundaries of macromorphology, a method still dominant in the pathological study of animal bone finds. Several problems in the archaeology of animal disease, therefore, may be of interest to researchers in both physical anthropology and archaeozoology.

This paper reviews the origins of and similarities between the osteomorphological analysis of human vs. animal disease in archaeology. Is the human/animal dichotomy in palaeopathology arbitrary – a result of people's fascination with their own species? Fundamental differences in research history, theory and method are reviewed to answer this question.

Research history

AD 2nd century Galenism, the ruling thought in medical science throughout the European Middle Ages, acquired anatomical information by the study of animal carcasses. This fell in line with the subsequent ban by the Catholic Church on dissecting human bodies. However, already in his 1224 edict regulating medical studies, Emperor Frederick II of the Holy Roman Empire ordered the dissection, every five years, of people who had died in hospitals or had been executed (Mayer 1927). As the autopsy of human bodies became increasingly acceptable, parallel investigations of animals have been put onto the back burner in anatomical research. Finally, it was probably the seminal work by Vesalius in 1534 [1967], "*De humani corporis fabrica*" which expressed most consistently the then revolutionary idea that while the dissection of animal bodies is an important source of scientific information, it is no substitute for the first hand study of the human body in medical science.

The development of veterinary anatomy in the so-called "Western World" has never recovered from this shift in emphasis. Characteristically, when the first veterinary nomenclature (directly relevant to archaeozoological studies) was drafted in Bern, Switzerland, in 1895, it was modelled after the *Baseler Anatomischer Nomenklatur*, developed in the same year. Today's *Nomina Anatomica Veterinaria* (NAV) was adopted in 1967 from the nomenclature used in human medicine as revised in Paris in 1955 (Fehér 1980). Similarly, Rudolf Martin's standardised system of human osteometry served as a basis for the systematic measurement of animal bones (Duerst 1926) in archaeozoology.

A recent exception of anecdotal significance is the historical application of DNA studies. The first ancient DNA molecules were recovered from the skin of a stuffed quagga (*Equus quagga*), an extinct wild Equid from South Africa (Higuchi et al. 1984), while studies on a human mummy from Egypt followed "only" a year later (Pääbo 1985).

Animal palaeopathology has also developed on the fringes of investigations into ancient human disease. The first comprehensive work by R. L. Moodie (1923) summarised data on disease in both human and animal palaeontology. Another book, which dealt exclusively with pathological animal remains, was published in Hungary by András Tasnádi Kubacska (1960), who studied animal disease in both invertebrate and vertebrate palaeontological finds. Meanwhile, shorter review papers on animal disease in archaeozoology were written, for example, by von den Driesch (1975), Siegel (1976) and Van Wijngaarden-Bakker and Krauwer (1979). Baker and Brothwell (1980) co-authored the first palaeopathological book with an entirely archaeozoological focus, i.e. discussing anomalies on animal remains recovered from ancient cultural contexts. Pathological phenomena observed on animal remains have been consistently described in individual site reports by many, including the late Sándor Bökönyi, as well as the scholars of the "Munich School" of archaeozoology. Such information, however, has tended to remain isolated in sometimes hard to come by publications.

Differences between human and animal palaeopathology

In this paper, an attempt is made to explain the current, relatively underdeveloped state of animal palaeopathology in archaeology through contrasting its most specific features to those of human palaeopathology.

Differences in objectives

One difficulty animal palaeopathology faces is that, beyond technical similarities, only a few of the principles of similar studies on human bone are applicable to it. The objectives of human palaeopathological research, recently put forward by Miller et al. (1996), include:

1. The diagnosis of specific diseases in human remains,
2. The analysis of the impact of diseases in human populations through time and space,
3. The clarification of evolutionary interactions between humans and disease.

Evidently, these requirements can be met at best partially by animal palaeopathologists for the following reasons:

Ad 1. Diagnostic protocols developed in physical anthropology are not directly relevant to morphologically heterogeneous animal remains.

Ad 2. Currently, although disease and injury observed in archaeozoological assemblages may be of help in the interpretation of various forms of animal exploitation, data seem to be too scattered to permit outlining of coherent diachronic or geographical trends.

Ad 3. Evolutionary interactions between the animal world and disease are immensely complex and manifold, in fact, they are simply intangible at the present level of understanding animal palaeopathology.

Within an archaeological context, the different objectives of animal palaeopathology are not only dictated by necessity. Ideally, the study of diseased animal bones from cultural contexts should be aimed at:

1. Diagnosing pathological laesions, understanding their taxonomic variability and developing adequate protocols for their description,
2. Elucidating a special aspect of the human/animal relationship at a given time/place (mundane animal exploitation, ritual treatment etc.) as indicated by pathological phenomena,
3. Creating an interpretative framework within which pathological observations can be integrated for the purposes of hypothesis testing.

These objectives may look modest, but are intrinsically more complex than those set out for human palaeopathology. At the root of the difficulties lie further differences between the pathology of humans and animals.

Different selection pressures on living populations

The classical point made by Moodie (1923) seems applicable for early humans and wild animals alike: "No constitutional diseases [of the bison] are known, nor should we expect to meet any. Animals afflicted with disease or injury, whether young or old, very soon succumbed to the hostile acts of predatory animals or man. Few survived sufficiently long for osseous changes to develop, for life with the ancient bison was a fierce struggle for existence".

In the spirit of the Hippocratic Oath, however, keeping the patient alive became a priority in western medicine. Consequently a number of chronic conditions reach an advanced stage in which the skeleton is severely affected. In the case of animals, such disease either results in early natural death or emergency culling. Manifestations of human disease in the skeleton are thus better understood, although the lack of modern reference collections is a problem even in human palaeopathology (Sandison 1968).

In contrast to Moodie's 1923 statement, deformations of the skeleton in wild animals vary between broad limits depending on the degree of selection pressure. For example, moose remains from Kenai Peninsula (Alaska) and Isle Royale (Lake Superior, MI) have exhibited ample evidence of skeletal pathologies related to age, nutritional status, genetic and/or environmental causes (Peterson et al. 1982). Such animals typically fall victim to animal predation in populations, which are regularly preyed upon. Even traditional hunters, however, could easily take animals of prime age and condition using sophisticated hunting techniques and thus did not need to harvest only substandard individuals Kay (1994). Wild animal remains in archaeological assemblages therefore may be biased by human behaviour presenting an unusually low percentage of diseased prey items in comparison with, for example, wolf kills.

Archaeological evidence also suggests that the lives of top predators are less directly affected by a variety of disorders. Although handicapped carnivores sooner or later will be at disadvantage in the "struggle for life" and starve to death, at least they are less acutely threatened than disabled herbivores.

Specifics of skeletal morphology

Human medicine has to deal with only one species. Veterinary science, even in its form reduced to the treatment of farm animals, is often confronted with particular features characteristic of only one of many species. Osteological symptoms are directly dependent on the specific skeletal morphology of animals and their allometry.

Differences are evident in the pathological deformation of bones whose presence or peculiar morphology is limited to certain taxonomic groups (Bartosiewicz 2000). The situation is more complex when the incidence of laesions is reviewed between taxa in comparable regions of the skeleton. The percentual distribution of bone fractures in two gross animal groups, the orders of Carnivora and Artiodactyla respectively, are summarised on the basis of pooled data by Baker and Brothwell (1980) and Bökönyi (1984) in Figure 1. The trend shown in this graph largely corresponds to several decades of independent, modern-day clinical statistics recorded at the University of Veterinary Sciences in Budapest (Tamás 1987).

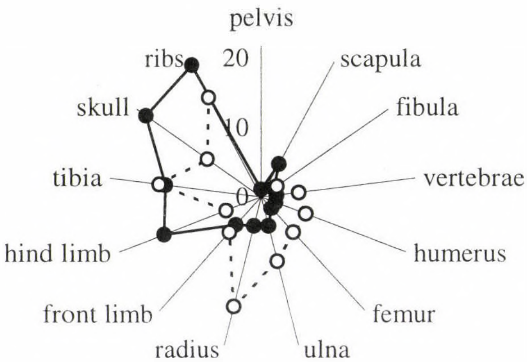

Figure 1: Anatomical differences between the percentual distribution of bone fractures in even-toed animals (Artiodactyla, n=93, full circles) and carnivores (Carnivora, n=74, open circles).

The greatest differences between Carnivora and Artiodactyla, apparent in the relative frequency of radius and ulna fractures, clearly illustrate the point in question. Fractures of the human forearm in archaeological assemblages can be interpreted as consequences of intraspecific, interpersonal violence (e.g. Angel 1974, Salib 1968, Ortner and Putschar 1985) within the context of bipedalism. The healing of such fractures is also common in the similarly well-developed ulna and radius of carnivores (Baker and Brothwell 1980, Table 1), since healing may have been facilitated by the complementary roles of these parallel bones as well as the relatively small body weight exerted on the injured limb. The healing of this trauma, however, is exceptional in large herbivores (Tamás 1987) whose radius is the only weight bearing bone in the forearm. The bad prognosis of radius fractures in this latter group is directly illustrated by the rare occurrence of healed fractures in the radius of horse or cattle at archaeological sites.

Differences in deposition

Most human remains are found as articulated skeletons at archaeological sites. Therefore laesions in the same individual can be studied comprehensively, in relation to each other. Age, sex and social status can also be often reconstructed from the mode of burial. To most physical anthropologists, having to work with disarticulated and mixed skeletons is rather a curiosity than standard practice. Difficulties involved in drafting an anthropological profile from such materials is clearly illustrated by a recent analysis of 1388 vertebrae from a Byzantine Period mass grave near the Old City of Jerusalem (Nagar et al. 1999, Figures 5–7). It is under such complex circumstances when a large and reliable database becomes even more indispensable in drawing conclusions, a problem constantly haunting the unexplored corridors of animal palaeopathology.

Animal remains, most typically originating from food refuse, are brought to light as isolated fragments, often in secondary positions. Animal burials are more an exception than a norm. One of the few examples when pathological phenomena may be reviewed by individuals is protohistoric horses, enterred in graves throughout Central Europe (Ambros and Müller 1980, Müller 1985, Müller and Ambros 1994, Takács et al. 1996). In Figure 2, the number of laesions identified on individual animals in these cemeteries is compared to similar data recorded in inhumation graves. Amongst the increasing number of human palaeopathological analyses, a classical prehistoric set of data by Regöly-Mérei (1962) was singled out for comparison. Potential bias caused by taxonomic and, in fact, chronological differences in morbidity was minimised by standardising the incidence of laesions only to pathologically affected individuals (100 %). In light of the different sample sizes (humans in 232 graves were compared to 131 horse burials), the statistical significance of the striking similarity apparent in Figure 2 had to be tested. The homogeneity of distribution within the categories defined on the basis of the observed frequencies of laesions was studied on the basis of Table 1.

Table 1. The observed and expected numbers of laesions by individual in human and horse burials.

Co-occurrence	Human		Horse		Total
of laesions	observed	expected	observed	expected	
single	122	116.3	60	65.7	182
double	77	76.7	43	43.3	120
triple	22	25.6	18	14.4	40
quadruple	7	7.7	5	4.3	12
multiple	4	5.8	5	3.2	9
Total	232		131		363

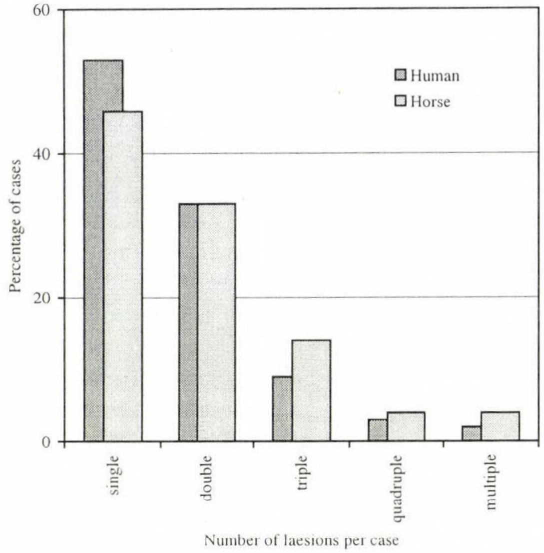

Figure 2: The relative frequencies of pathological laesions in human (n=232) and horse (n=131) burials.

Differences between the frequencies of co-occurring (double, triple, etc.) laesions in human and horse skeletal assemblages are characterised by a $Chi^2 = 3.788$ value ($df = 5$, $p \leq 0.100$; Williams 1979) and thus should not be considered statistically significant: the distribution of laesions is comparable in human and animal skeletons deposited in similar ways. (It was hypothesised that the chances of some multiple pathological phenomena having been accumulated independently of each other throughout the individual's life were similar in humans and horses).

Evidently, horse is a very special animal in terms of palaeopathological diagnoses, since it has been accorded a near-human treatment in many burials, particularly during the Migration Period of the Carpathian Basin (Bartosiewicz 1998). Similarly to common anthropological finds, the age, sex and stature of such horses can be estimated to complete the diagnostic picture. Skeletal finds of horse thus illustrate most clearly the dramatic difference between the diagnostic values of complete skeletons and isolated animal bone fragments in food refuse.

Fragmentation, fossil diagenesis and bone preservation

It is evident that heavily leached and badly eroded bone fragments are difficult to recognise, something that has a direct bearing on the identification of pathological laesions as well. Owing to the greater relative surface of fragmented materials, deposits of discarded animal bone are more prone to this loss of information as well. Increased mineralisation may render sophisticated methods of laboratory diagnosis useless. Aside from the loss of organic compounds, indispensable for the identification of certain diseases, the absorption of new elements creates additional bias as was the case with the magnetic resonance imaging of subfossil cattle bone, whose results could not be evaluated owing to contamination by ferrous soil substrates (Bartosiewicz et al. 1997a).

At the other extreme, a less evident source of bias should be reckoned with. Some well-preserved excavated specimens may exhibit surface deformations that, although pathological, were likely mild or asymptomatic in the living individual (Miller et al. 1996). Smaller laesions on the bones of wild animals in the archaeological material may fall within this category. Not even diagnostic criteria of modern medicine include all subtle changes often visible only on "dry" bone such as excavated specimens.

Conclusions

Palaeopathological studies of humans and animals differ on many levels. In spite of these discrepancies, however, the systematic study of disease-ridden animal bone in archaeological assemblages can be best evaluated in light of advancements in human palaeopathology. Although fundamental differences between the manifestations and diagnoses of skeletal disorders in humans and animals determine the course of palaeopathological research in archaeozoology, many useful analogies are still available in physical anthropology.

Relatively close parallels can be drawn between markers of occupational stress in humans and draught animals, although the forms of skeletal symptoms and the bones involved may strongly differ. The progressive nature and often symmetric manifestation of such conditions, however, cross-cut taxonomic boundaries (Bartosiewicz et al. 1997b).

Experience gained in human palaeopathology is also more directly adaptable to diseases of ancient pets and high status animals such as dog and horse. Not only were such animals frequently sheltered from rigorous natural selection and enterred in formal burials; the treatment of their ailments is also most advanced in modern veterinary medicine. For example, the unusually detailed knowledge of bone neoplasia in dogs (Baker and Brothwell 1980, Fig. 2) may be a combined product of cumulative inheritance in modern dogs and distinguished attention paid to this condition during the late 20th century.

When unaccounted for, the differences between human and animal palaeopathology, listed in this paper, have the potential of creating noise in the interpretation of deformations in ancient animal bone. However, a thoughtful, multidisciplinary integration of modern medical and veterinary information with excavation data, as well as the expansion of relevant archaeozoological collections will help to further advance research into animal palaeopathology.

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