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14. Palaeopathology and Horse Domestication: the case of some Iron Age horses from the Altai Mountains, Siberia

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We discuss the use of palaeopathological indicators in horse skeletons as potential sources of evidence about the use of horses for riding and traction. We suggest that this type of information can provide an important and perhaps more reliable complement to other indicators of domestication such as morphological changes, kill-off patterns and bit wear, which suffer from various ambiguities of interpretation. We emphasise the importance of studying the skeletons of modern control samples of horses of known life histories as a constraint on the interpretation of palaeopathological evidence and demonstrate the viability of the technique through a comparison of free-living Exmoor ponies with Iron Age Scythian horse remains from Siberia. We demonstrate that stresses caused by riding produce characteristic lesions on the vertebrae which can be distinguished from age-related damage in free-living animals, and in addition that these stresses could have been moderated by changes of saddle design in the Medieval period. These results also throw new light on customs associated with horse burial.

Keywords: HORSE; DOMESTICATION; BONE LESIONS; PATHOLOGY; SIBERIA.

INTRODUCTION

Before the development of firearms, the horse was crucial to warfare and before the invention of the steam engine, it was the fastest and most reliable form of land transport. Not for nothing was the steam locomotive also known as the *iron horse*, and even now we measure engines by their *horse power*. However, we know very little about the earliest stages of horse domestication. Conventional zoological and archaeozoological methods for distinguishing domestic from wild animals are not applicable to horses, or produce results that are unreliable or ambiguous (Clutton-Brock 1987 and 1992; Levine 1990, 1993, 1996 and 1999; Levine and Rassamakin 1996; Levine *et al.* in press).

In this paper we discuss the use of palaeopathological indicators, which we believe offer, in principle, a more direct and reliable measure of the use made of horses for riding or traction. Like Anthony and Brown (1991 and 1998), we are interested in the effects of horse riding upon the skeleton. But in contrast to their work, which focuses solely on bit-wear, we concentrate on the postcranial skeleton, which provides a wider range of elements for comparison, and also offers the possibility of distinguishing the effects of riding and traction. We illustrate the application of our analytical method to the early Iron Age horse skeletons from Ak-Alakha 5, Kurgan 3, in the Altai Mountains (Fig. 14.1). The archaeological context of this site and its associated artefacts provide additional controls on the use of the animals as a cross check on inferences drawn from skeletal pathologies. We also emphasise the importance of comparing archaeological bone material with control samples from modern horses of known habits and life patterns. In addition we draw attention to the value of this research not simply as a means of utilising veterinary expertise to identify the use of horses by humans in the past, but also as a source of potential benefits to veterinary science in providing a long-term perspective on the biological consequences of changing husbandry practices.

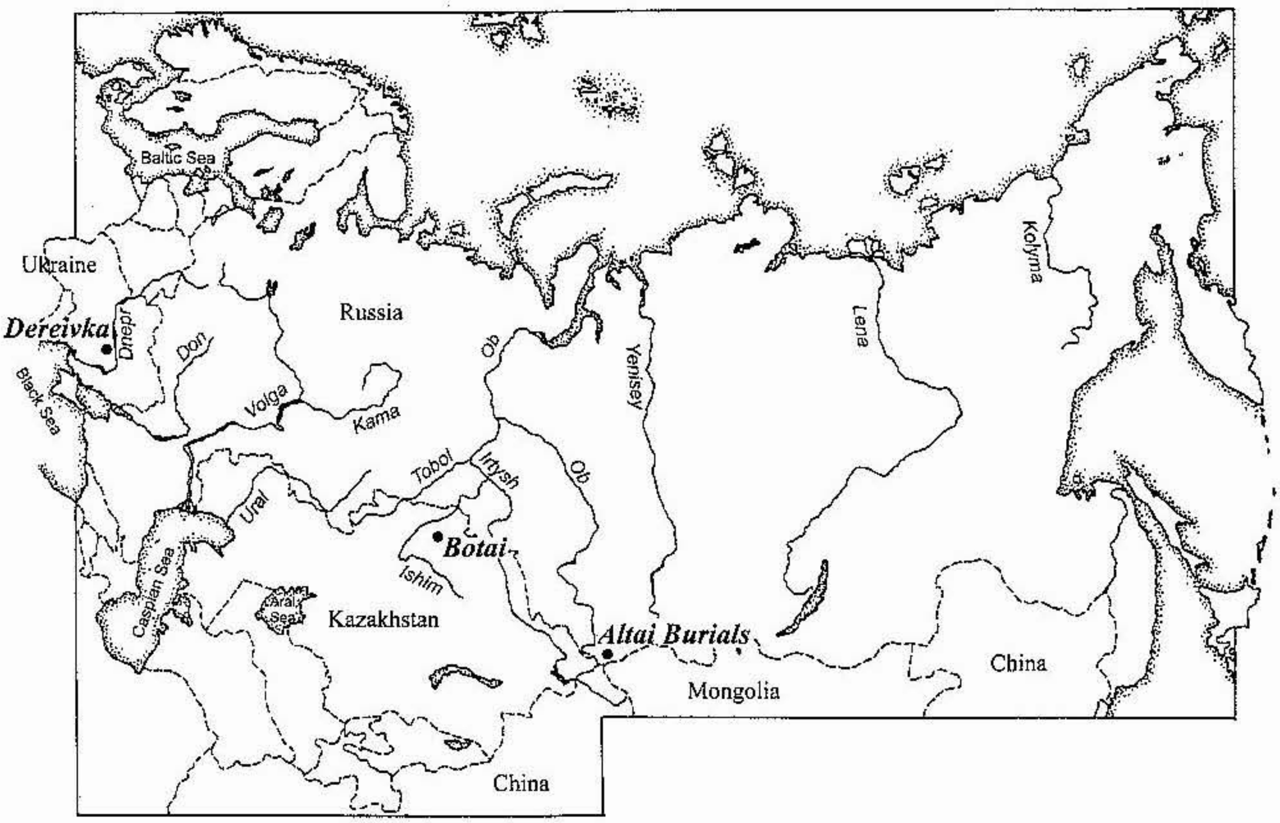

Figure 14.1. Map showing archaeological site locations.

PROBLEMS IN IDENTIFYING EARLY HORSE HUSBANDRY

In some situations it is, of course, very easy to show how horses had been used in ancient times. For example, the horses found in some of the south Siberian Iron Age kurgans, such as Pazyryk, Bashadar and Ak-Alakha 3, are accompanied by well preserved equipment such as bridles, saddles and harnessing (Polos'mak 1994; Rudenko 1970). However, at most sites, especially those dating from the period when horses were first domesticated for riding and traction, the situation is more complicated. Organic materials such as leather and wood are only very rarely recoverable from the archaeological record. In unfavourable soil conditions even bone is eventually destroyed. Moreover, not only can horses be ridden without the use of a saddle or bridle, but during the early stages of domestication they are also likely to have been ridden that way.

The problem of identifying the early stages of horse domestication is one that many researchers have grappled with (for example, Anthony and Brown 1991; Bibikova 1986a, 1986b; Bökönyi 1978, 1984; Brown and Anthony 1998; Levine 1990, 1993, 1996 and 1999; Levine and Rassamakin 1996; Levine *et al.* in press; Uerpmann 1990). Domestication is customarily defined as the controlled breeding of plants or animals by humans, and the conventional signature of such a process is the appearance of morphological changes which can be attributed to changed selection pressures resulting from reproductive isolation of the domestic stock (Clutton-Brock 1987). However, the effectiveness of reproductive isolation of domestic from wild stock in the early stages of husbandry is questionable. Moreover, the time lag between changes in husbandry practices – with or without reproductive isolation – and resulting changes in size and bone morphology is uncertain (Ingold 1980; Jarman *et al.* 1982; Jarman and Wilkinson 1972).

Kill-off patterns are similarly ambiguous. At Dereivka, an Eneolithic site in the Ukraine (Fig. 14.1), the absence of old animals and the high proportion of males have been argued as evidence of domestic stock (Bibikova 1986a and 1986b). But this pattern is much more consistent with hunting targeted on bachelor groups or stallions from family groups; most died during their prime reproductive years (Levine 1990, 1993 and 1999). The mortality curve of a population of horses used primarily for riding or traction is essentially the same as that of a population dying of natural causes. Both are characterised by mortality rates that are relatively high for infants and senescent individuals and low for prime adults. The archaeological context will often help to distinguish between the various possibilities, but not always.

Another problem with analyses of population structure is that they are not applicable to small samples, but these may be crucial to our understanding of the beginnings of horse domestication. If the route from hunting to herding had started with the taming of wild horses, perhaps initially as pets, but eventually as work animals, then it is possible that at first only very small numbers of individuals would have been involved. Moreover, it is also possible that the process of taming and domestication could have arisen within the context of horse hunting with foals orphaned in the hunt. In such a scenario, being able to distinguish tamed or domesticated individuals from the much larger population of hunted ones could be crucial to our understanding of the evolution of horse husbandry.

By convention the most commonly accepted centre for the origin of horse domestication is the central Eurasian steppe from some time in the 5th millennium BC onwards, when horse bones start appearing in large quantities in archaeological sites (Bibikova 1986a and 1986b; Bökönyi 1978; Nobis 1974; Sherratt 1979). Until recently the most important criterion used to support the identification of early horse domestication has been that of increased relative abundance by comparison with the preceding Mesolithic and Neolithic periods. However, throughout the Palaeolithic, from perhaps 1 million years ago or more up until around 12,000 BC, the archaeological record shows that horse meat was almost always an important component of the human diet. Therefore, the observed increase in the abundance of horses during the Copper Age could be explained as well, or even better, by increased hunting rather than by domestication. This hypothesis is supported by analyses of population structure carried out on data from the Eneolithic settlements of Dereivka and Botai (Fig. 14.1), but as noted above, some mortality patterns can have more than one mutually incompatible explanation (see also Levine 1990; 1999). Moreover, Anthony and Brown have claimed evidence of riding for some individuals from both these sites on the basis of bit wear studies (Brown and Anthony 1998). However, new radiocarbon dates for the Dereivka teeth have disproved the claims for early horse domestication at that site (Levine 1999; Levine *et al.* in press). It is clear then that alternative approaches need to be explored.

Palaeopathology and horse husbandry

The research discussed here approaches the problem of the origins of horse husbandry from a palaeopathological perspective. Our basic premise is that the horse did not evolve in nature to carry a person on its back or to pull wagons and carriages. Isolated empirical observations and anecdotal evidence suggest that the kinds and frequencies of abnormalities that we can expect to find in bones of wild horses differ from those in domesticated ones (Baker and Brothwell, 1980) and that there is good reason to undertake systematic research into this topic. The stresses connected with riding and traction differ from those related to natural activities. Furthermore, because the stresses associated with riding are different from those associated with traction, we would expect to be able to distinguish between these two activities in the case of horses used primarily for one or the other. This is not to say that every type of abnormality will be referable to a particular type of human-horse relationship. It is generally believed, for example, that some types of pathologies have a genetic component or are, at least partly, age and weight related. The hypothesis to be tested is not that any particular abnormality can have only one cause, but rather that working horses show higher frequencies of certain types of skeletal abnormalities than free-living ones.

Four parts of the skeleton are of particular interest to us here: the lower limb bones, hip, shoulder and spinal column (Fig. 14.2). These seem to be common sites for work-related injuries (Baker and Brothwell 1980). For example, it appears that shoulder and hip injuries are particularly characteristic of traction. On the other hand, injuries to the caudal thoracic and lumbar vertebrae seem to be primarily associated with riding. Lower limb bone injuries probably have more complicated explanations. Relatively high rates of such pathologies seem to be found in both riding and heavy traction animals, particularly those which have been worked on roads rather than open ground. We are also testing a hypothesis, suggested by Whitwell in 1996, that some kinds of abnormalities of the cervical (neck) vertebrae are related to confinement. A horse in open pastureland spends much of its time with its head down, either grazing, resting or dozing, while a horse in a stable or in other confinement tends to spend a lot of its time with its head up, looking through a window or over a door or fence. Confined horses are often fed from raised hay racks and mangers, which also results in head elevation for long periods of time.

If this approach is to work on bone material from archaeological contexts where the use of the animals is unknown, it is vital to develop a good understanding of the reasons for bone pathologies, and to study a wide range of modern comparative material from horses of known life history including both work horses and free-living ones. Our modern comparative material comes from a variety of sources. Firstly, we have access to a large assemblage of modern pathological material (curated by Whitwell). Many of these animals were ridden. Most were thoroughbreds, but a wide range of other types is available, for example, zoo-equids, British ponies, Arabians and draught horses. In many cases their recent veterinary history is known, allowing us to match the clinical veterinary problems with the changes found in their bones after death.

Secondly, we have collected skeletons of British free-

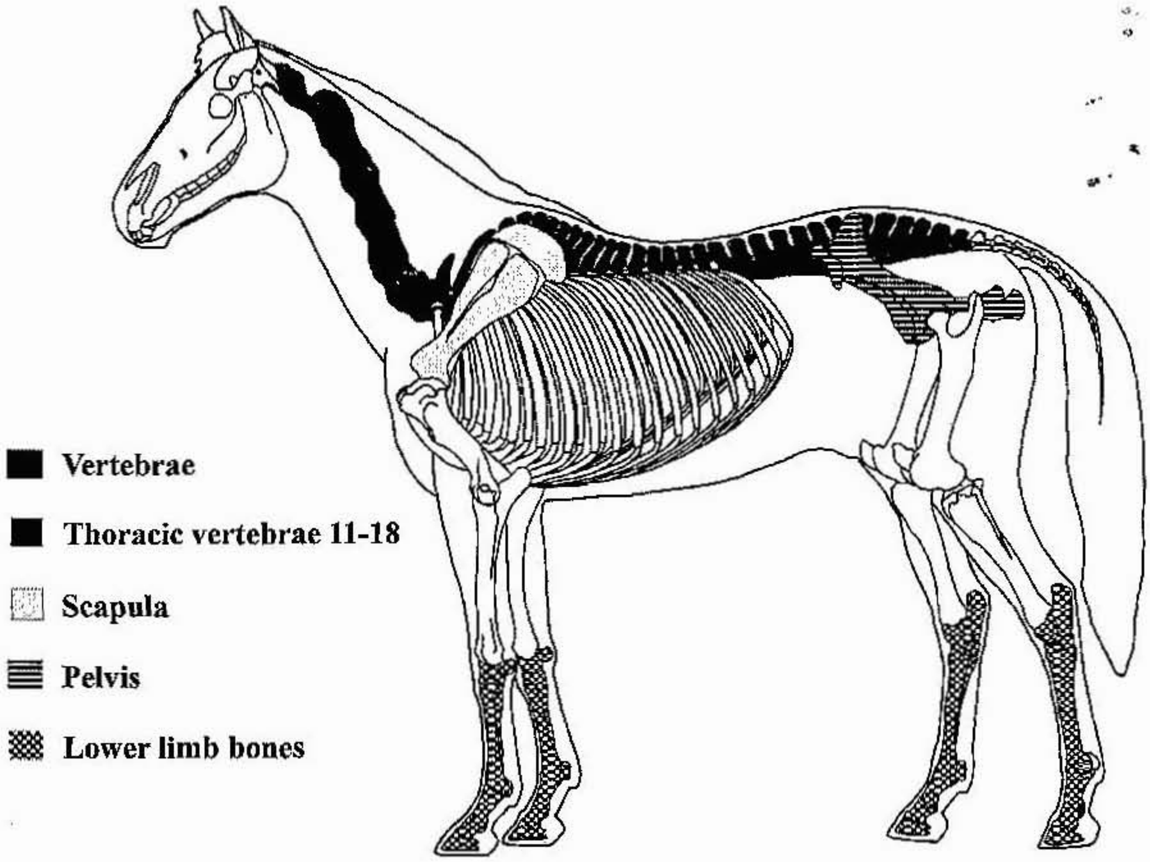

Figure 14.2 Horse skeleton showing anatomical sites of interest.

living ponies, especially Exmoor ponies. Our goal is 20 individuals, of which 13 have so far been collected. Ten New Forest pony skeletons are also available for study. Comparison of the veterinary collection with skeletons of free-living ponies should indicate whether unridden, unconfined horses have the same kinds and incidences of skeletal abnormalities as ridden ones.

Our third type of comparative material comes from archaeological deposits where we feel confident about the horse's lifestyle. Throughout Eurasia, from the Bronze Age through to the Middle Ages, horses were buried with or near human beings. During the Bronze Age, horses were often buried with chariots, while in the Iron Age they were buried with riding gear. Medieval burials may be associated with either riding tack or wagons. In some places, particularly in the Altai Mountains of Siberia, preservation has been excellent because of local environmental conditions. At sites located in the permafrost not only are bones preserved, but also flesh, and artefacts made out of perishable materials and associated with riding and traction.

In this paper we concentrate on some skeletal abnormalities from Iron Age horse burials in the Altai Mountains. The associated archaeological context of these burials strongly suggests that the horses were used for riding. By comparing the abnormalities of these horses with those of modern, unridden controls we have been able to suggest specific features which could be related to riding practices and burial customs.

EARLY IRON AGE HORSE SKELETONS FROM AK-ALAKHA 5, KURGAN 3

Six Scythian horse skeletons – two from Bashadar (Altai), three (out of a total of four) from Ak-Alakha 5, Kurgan 3 (Altai), and one from Lisovichi (Ukraine) – have been closely examined and show skeletal abnormalities. Some of the caudal thoracic vertebrae from each of these animals are pathological. Abnormalities of other anatomical elements are much less frequent and more variable in form. Here we concentrate on a group of pathologies which have been observed on the horse from Lisovichi and on the three so far examined from Ak-Alakha. Ak-Alakha 5 comprises a group of kurgans (burial mounds) located in the valley of the Ak-Alakha river in the Ukok highland (Kosh-Agach District of the Altai Republic). The Ukok, situated in the southernmost part of the Altai Mountains, bordering China, Mongolia and Kazakhstan, is a flat, treeless plateau about 2500 metres above sea level (Polos'mak 1994a). The Scythian burials from Ak-Alakha 5, dated from the 5th to the 3rd centuries BC, were excavated by Dr. Polos'mak in 1995.

The four horses from Ak-Alakha 5, Kurgan 3, were buried on top of one another adjacent to a Pazyryk culture burial chamber (Fig. 14.3). They were all wearing bits, suggesting that they were riding horses. Soft tissue was not preserved at this site, but the bones are in very good condition. The three horses so far examined have similar abnormalities of the caudal (or posterior) thoracic vertebrae 11–18 (Table 14.1):

1) Deposition of spurs of new bone (osteophytes) on the ventral and lateral surfaces of the vertebral bodies (centra) adjacent to the intervertebral space (Fig. 14.4).
2) Overriding or impinging dorsal spinous processes (Fig. 14.5).
3) Horizontal fissures through the caudal epiphyses (Figs. 14.6 and 14.7).
4) Periarticular exostoses: deposition of new bone on and above adjacent articular processes between vertebrae (Fig. 14.4).

Pathologies related to (1), (2) and (4) are frequently described in the veterinary and archaeological literature (for example, Baker and Brothwell 1980; Bökönyi 1974a; Jeffcott 1980; Klide 1989; Müller 1985; Rooney 1974 and 1997; and, for donkeys, Clutton-Brock 1993). All the references relevant to lesion (3) relate to archaeological discoveries (Benecke 1994; Müller 1985; R. C. G. M. Lauwerier pers. comm.). Müller and Benecke both worked on central European Medieval horses. Müller hypothesised that this type of lesion could have

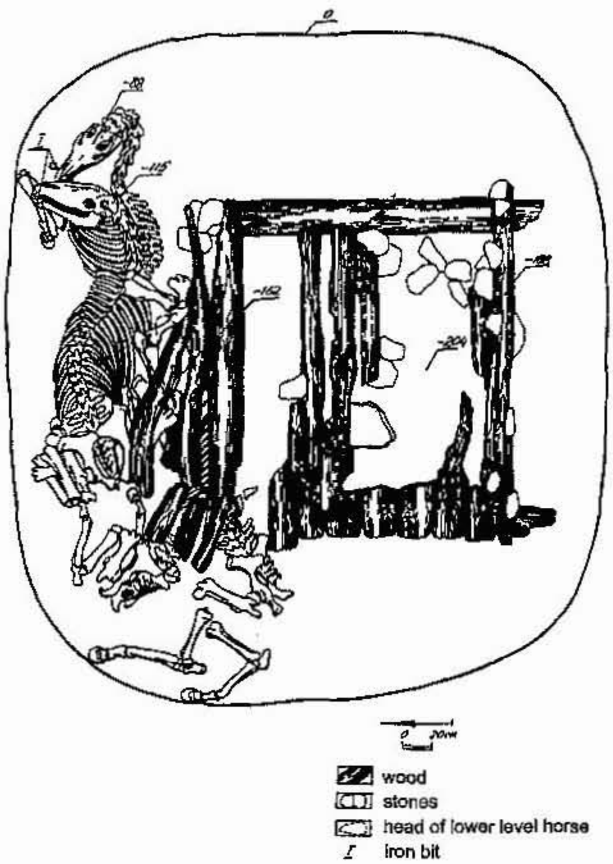

Figure 14.3 Position of horse skeletons in the grave of Ak-Alakha 5, Kurgan 3 (after N. Polos'mak, unpublished).

	Ak-Alakha 5			Exmoor	
Horse number	1	2	4	97/2	97/7
Age (yrs.)	16 +	10–15	7–10	12	23
Sex	male	male	Male (possible gelding)	female	female
Number of thoracic vertebrae	18	19	18	18	18
1) osteophytes on the ventral and lateral surfaces of the vertebral bodies adjacent to the intervertebral space	T11 to 18	Increasing from T11 to T14 (11 and 12 caudal; 13 and 14 caudal + cranial)	T13 to 15 most strongly developed, but extends to T17	not present	Slightly developed, T12–14
2) Impinging or overriding spinous processes	T16 – 18 (possibly T15 also)	T14 – 15 probably; T15 – 19 possibly	T10–12 probably	not present	not present
3) Horizontal fissures through the caudal epiphysis	T13 and 15	T13 and 14, (most developed on T14)	T13 and 14, (most developed on T14)	not present	not present
4) Periarticular exostoses	T16–17 small exostoses	T15–18 small exostoses	Exostoses increasingly from T14 to T17, then decreasing[1]	not present	T11–18 small exostoses
Figures	5		4, 6, 7		8, 9

[1] At T16–T17 and, to a lesser extent at T15–T16, these changes were pronounced and extended dorsally to involve the adjacent vertebral arches and lower regions of the spinous processes (see Fig. 4, arrow). This had not, however, resulted in the fusion of the vertebrae.

Table 14.1 Description of Thoracic 11 to 19 Abnormalities: Ak-Alakha Horses and Exmoor Ponies.

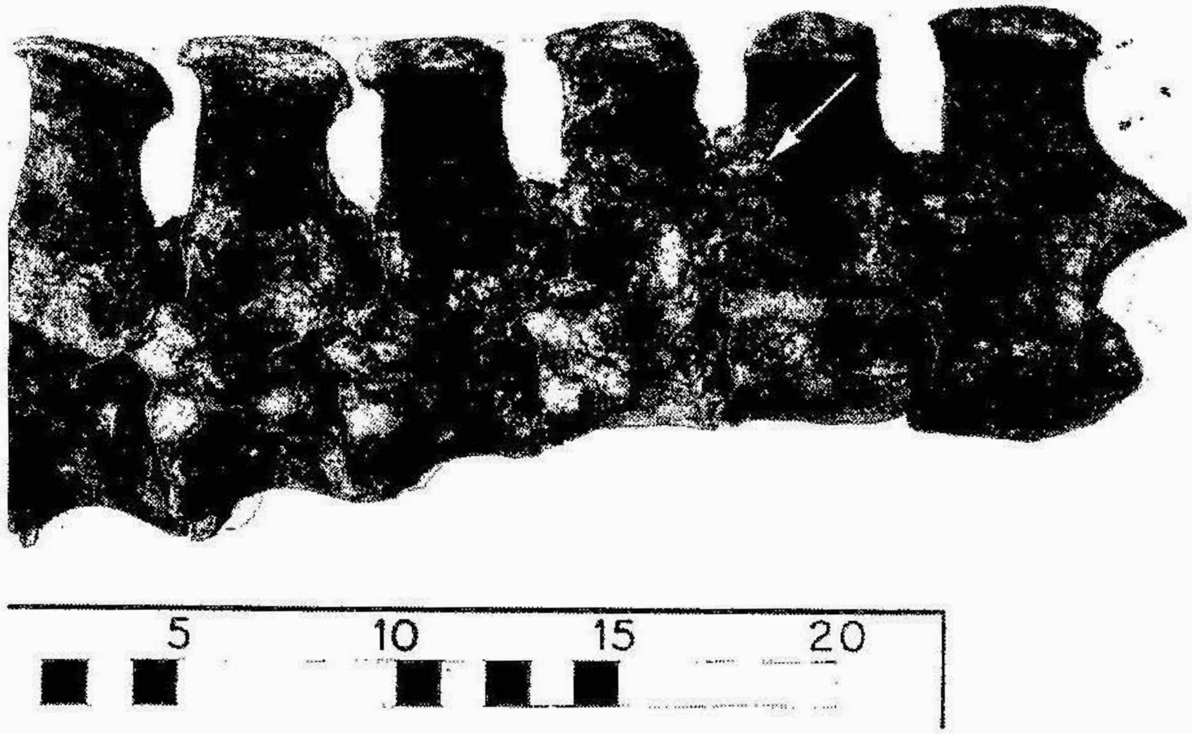

Figure 14.4 Ak-Alakha 5, Kurgan 3, Horse 4. 13th–18th thoracic vertebrae. New bone is deposited around the articular facets (especially at arrow).

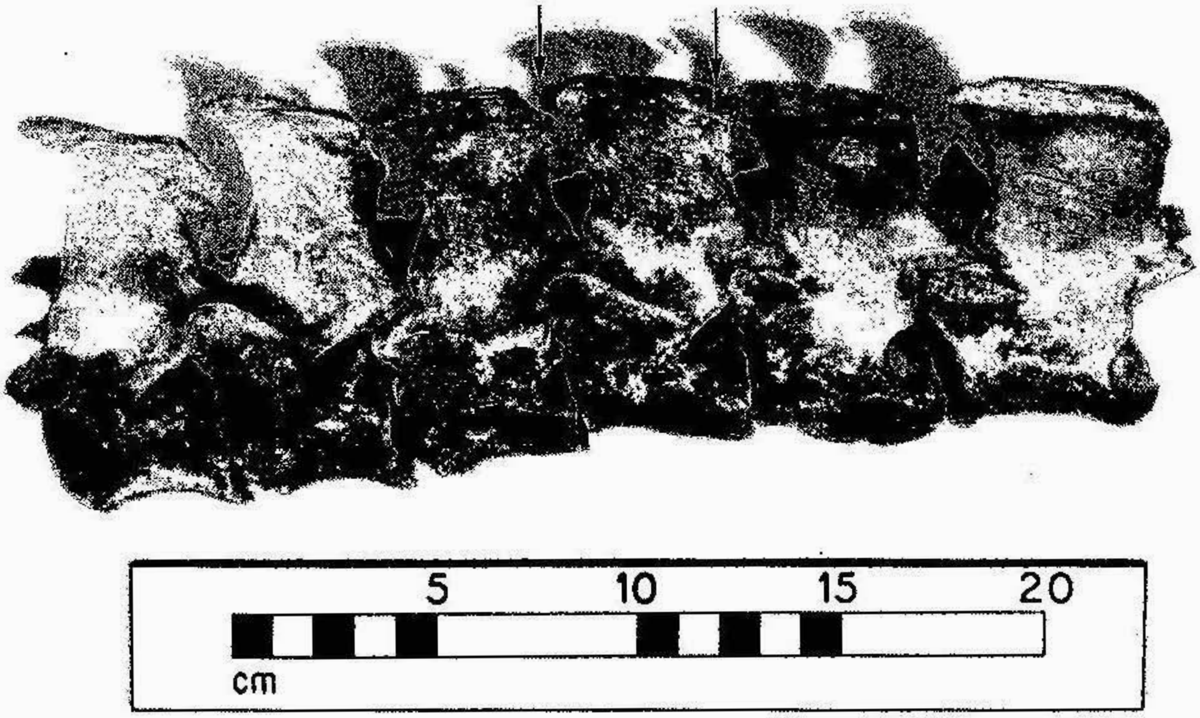

Figure 14.5 Ak-Alakha 5, Kurgan 3, Horse 1 (at least 16 years old), 14th–18th thoracic and 1st lumbar vertebrae. Impinging dorsal spinous processes.

Figure 14.6 Ak-Alakha 5, Kurgan 3, Horse 4 (7–10 years old). 14th Thoracic vertebra, caudal view. Horizontal fissure through the caudal epiphysis and new bone development on the ventral surface.

Figure 14.7 Radiograph of Ak-Alakha 5, Kurgan 3, Horse 4. 14th Thoracic vertebra, lateral view. It can be seen here that the fissure in the centrum epiphysis does not penetrate into the body of the vertebra, but is confined to the denser epiphyseal bone.

occurred when a horse wearing a badly fitting saddle was caused to jump. Benecke suggested that such an injury could have resulted when a horse was ridden too long and too hard.

Figure 14.7 is a radiograph of the 14th thoracic vertebra of Horse 4. It can be seen here that the horizontal fissure running through the caudal epiphysis does not penetrate into the spongy body of the vertebra, but is confined only to the denser bone of the epiphysis. This is the case for all six of the fractured Ak-Alakha vertebrae which were radiographed.

Rooney (1997) and Klide (1989) have demonstrated that lesions (1) and (2) are not just associated with domesticated horses or even only with *Equus caballus*. Both are connected with natural ageing processes and with congenital defects. It is generally believed that riding also causes or contributes to their development (Jeffcott, 1979). In order to disentangle the relative effects of ageing and other natural processes as compared with riding-induced stresses, it is necessary to examine modern control samples.

EXMOOR PONIES

Of the 8 Exmoor pony skeletons examined so far for this study, only two are more than 10 years of age. One was 23 years old (EP97/7) and the other 12 (EP97/2). They were both free-living and neither had ever been ridden. We focus here on the older individuals because of the suggested connection between lesions (1) and (2) and natural processes of ageing (Rooney 1997; Klide 1989; Jeffcott 1980). Our data indicate that ageing processes are relevant to these abnormalities, either directly or indirectly, but they do not entirely explain

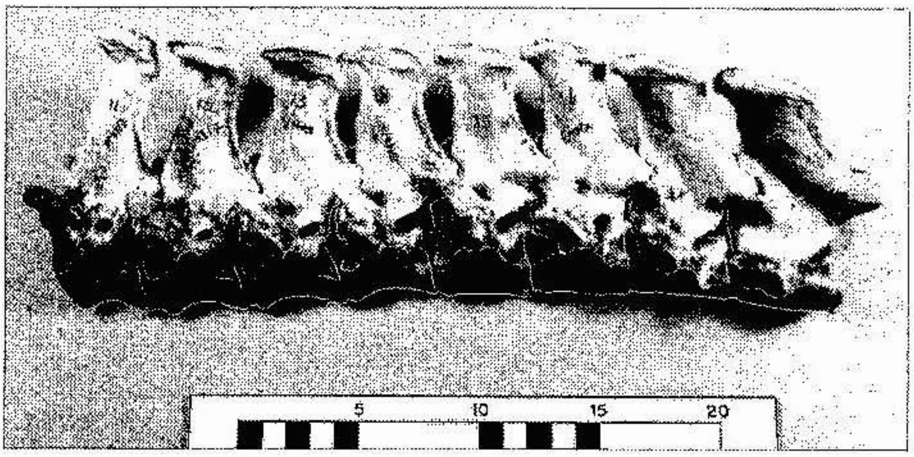

Figure 14.8 11th –18th thoracic vertebrae from a 23 year old Exmoor Pony (97/7). By comparison with the much younger horse from Ak-Alakha, the development of new bone around the articular processes and centrum epiphyses of this Exmoor Pony is relatively insignificant. Note, also, that the dorsal spinous processes are not in contact with one another.

them (Table 14.1). The caudal thoracic vertebrae of the 12-year-old pony have none of the lesions characteristic of the Ak-Alakha horses. The 23 year old Exmoor has only two types of lesions: (1) weakly developed new bone on the ventral surface of a few centra, and (4) new bone on the articular processes of thoracic vertebrae 11 to 18 (Figs. 14.8 and 14.9). Lesion (4) is more widespread on EP97/7 than it is on the Scythian horses, but less intense than on horse 4, which was only 7 to 10 years old. Ageing is important because over time the effects of all kinds of bony injuries and irregularities tend to be cumulative. The agents of vertebral damage, whatever they are, will have had less opportunity to develop in young animals. The evidence from the Exmoors indicates that the development of these pathologies is not inevitable and that even in quite old free-living animals these types of bone abnormalities are relatively slight.

SCYTHIAN SADDLES

Of course, both the archaeological and modern samples under consideration here are very small, but the results are so clear-cut that it would be hard to believe that they could be meaningless. Assuming that the high incidences (in all three of the horses) of pathological changes to the Scythian caudal thoracic vertebrae were significant, stress caused by riding would seem to be a possible explanation for the apparent ubiquity of lesions (1), (2) and (4). However, lesion (3), present in all three horses from Kurgan 3 (as well as at Lisovichi) seems to get little attention in the veterinary literature. The fact that ordinary radiographs of a horse would not show this lesion might at least partly explain this apparent omission. However, it is also worth exploring the possibility

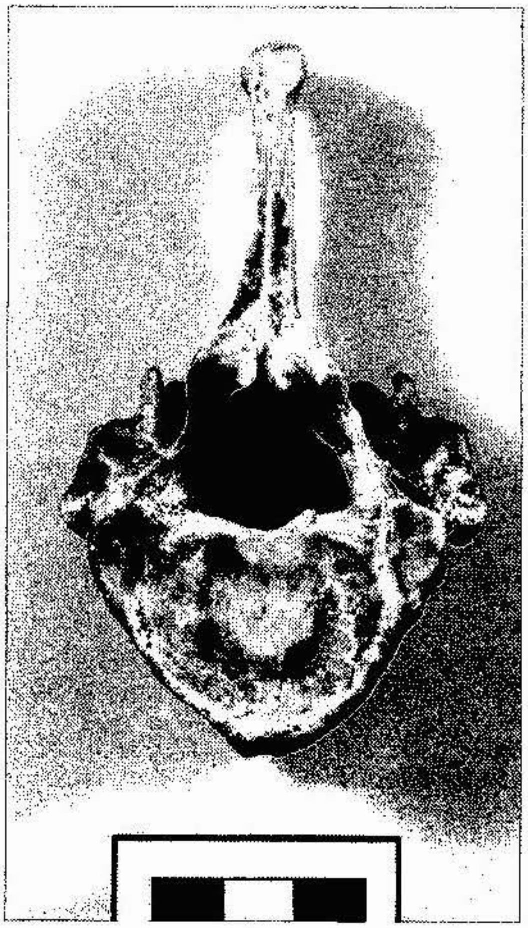

Figure 14.9 14th Thoracic vertebra from a 23 year old Exmoor Pony (97/7). None of this pony's centrum epiphyses are fissured and, in spite of its advanced years, the development of new bone is relatively insignificant.

that the high incidences of this lesion in Scythian horses are related not just to the fact that they were ridden but also to the way they were ridden.

The excellent preservation conditions and rich grave goods accompanying Scythian burials have provided us with a unique insight into contemporaneous riding equipment. One factor, which might be of particular relevance to the pathologies discussed here, is the Scythian saddle. The Pazyryk culture saddles recovered so far, for example from Ak-Alakha 1 and 3, Pazyryk itself and Bashadar, are all pad saddles. These are all variations on a theme of two leather cushions, stuffed with sedges or hair, joined together by an unpadded strip of leather (which rests over the horse's spine) and covered with felt (Fig. 14.10). Some of the saddles have high arches reinforced with wooden spacers at the *pommel* and *cantle*. Rudenko (1970) regards them as the first step in the evolution of the frame saddle (see also Polos'mak 1994a). Although distributed to some extent over the dorsal rib cage by the saddle cushions, the rider's weight would have rested to a large degree directly on the spinous processes of the thoracic vertebrae. It is hypothesised here that the use of such saddles, by irritating the dorsal processes of the vertebrae, stressing the vertebral bodies and increasing the lordosis of the spine, could have been an important factor in the development of the type of lesions found on the Ak-Alakha vertebrae. The possible effects of the saddle would be influenced, of course, by the number of hours per day it was worn.

The early Iron Age peoples of the Altai were not the only ones to put horses in their graves. The Medieval Turkic peoples, who used saddles with wooden frames, did so as well and like their Iron Age predecessors they buried their horses with riding equipment (M. Chemiakina and N. Polos'mak, pers. comm.; Molodin 1994). In contrast to the Scythian pad saddle, the frame saddle, when properly fitted, has no contact with the thoracic vertebrae. It distributes the rider's weight entirely on the horse's dorsal rib cage. In that case, we might expect these horses to have a different pattern of abnormalities compared with those ridden with pad saddles. It should thus be possible to test the pad saddle hypothesis further by comparing Scythian and Turkic skeletons. The 3 Turkic horses from Ak-Alakha 1, Kurgan 3 (10th century AD) were buried with riding tack, but unfortunately, because they were not frozen, the saddles were not preserved.

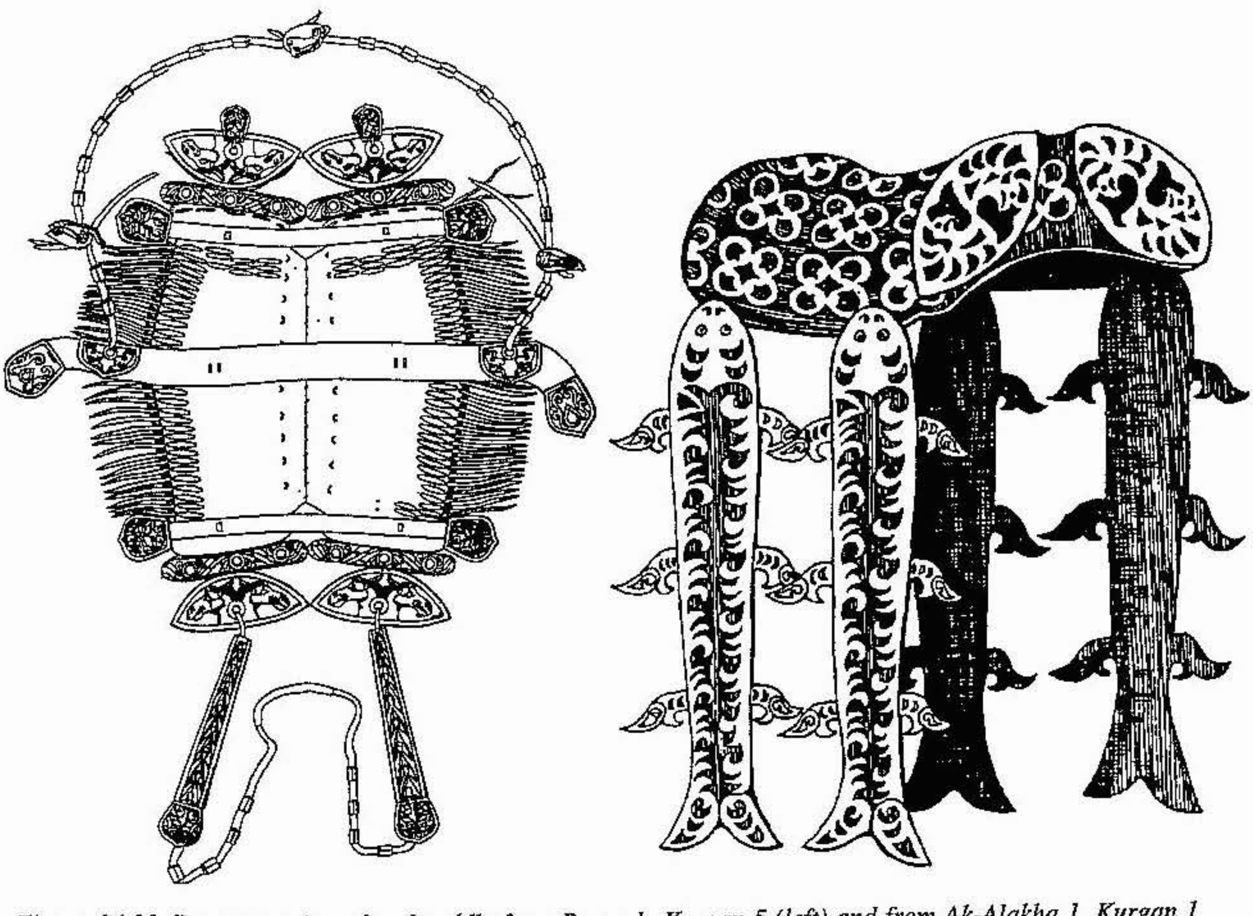

Figure 14.10 Reconstruction of pad saddle from Pazyryk, Kurgan 5 (left) and from Ak-Alakha 1, Kurgan 1 (right). Scythian saddles are made out of leather pads stuffed with grass and then covered with felt. The rider is supported directly on the horse's spine (after Rudenko, 1970 and Polos'mak 1994a).

DISCUSSION

Besides providing us with a valuable insight into the evolution of horseback riding, the study of the Pazyryk culture horse skeletons can help us to understand the early Iron Age culture of the Altai. For example, there has been considerable debate concerning the decision-making processes involved in the selection of the horses buried in the kurgans.

Many scholars have observed that the Scythian horses had considerable bone pathology (for example, Bökönyi 1968; Rudenko 1970; Tsalkin 1952; Vitt 1952). Bökönyi and Tsalkin concluded from this that the horses in the burials had been targeted for sacrifice because they were lame or too weak to ride. Bökönyi also claims that:

> "On these grounds one may assume that the other horses found in the graves whose bones do not display any pathological lesions must have suffered from some other disease and therefore were laid beside the dead in the grave" (Bökönyi, 1968, p. 51).

Rudenko drew a different conclusion from the data. He suggested that the horses would, like all the other grave goods accompanying the dead, have been their personal possessions in life:

> "Food was placed in the tomb with the corpse to sustain him during his journey to the next world, and in addition all the personal possessions that he would require there. There are no grounds for supposing that any kind of extraneous gift was buried with the corpse" (Rudenko, 1970, 118).

He pointed out that the age structure at Pazyryk, where 7 to 16 horses were found in each tomb, was as expected for the riding horses of a living person of high rank:

> "If we study the age of the horses buried in the Pazyryk barrows we notice that in each interment there were one or two young animals three and a half, or even two and two and a half years old, several of middle age, and some old, fifteen to twenty years or more." (Rudenko, 1970, 119)

Rudenko thus suggested that the horses were killed, not because they were unsound, but because they were sacrificed to accompany their owner to the afterlife as part of the burial rite. Although it seems reasonable to suggest that the abnormalities described in this paper were, for the most part, connected with the use of horses for riding, it has not been demonstrated that they would have rendered the animals unsound. It is probably the case that bony changes almost inevitably accompany the use of horses for riding. Whether they would have resulted in the animals being unfit for work is an altogether different question. Thus, the balance of evidence suggests that the buried horses did not comprise a biased sample, that is, of animals rendered unfit by back injuries. They were probably representative of the working horses of the time; their vertebral pathologies being the normal consequence of riding with a pad saddle.

CONCLUSION

The results described above demonstrate that distinctive abnormalities can be identified in archaeological bone material and interpreted with the aid of modern comparative studies to distinguish the effects of natural processes from cultural practices. Moreover the results do not simply give a better understanding of bone pathologies but contribute new information on the evolution of horse husbandry, and, in this particular case, they throw new light on Pazyryk culture burial traditions.

We have deliberately focused in this paper on a distinctive case study. The challenge in future work will be to identify the causes of pathologies where the stresses induced by riding or other human use are more subtle, and this is likely to be especially the case in the earliest stages of horse husbandry. We believe that the approach outlined here, especially if extended to other parts of the skeleton, and combined with a wide range of comparative studies on horses of known life histories, offers an objective basis for the study of equine palaeopathology as it relates to the evolution of horse husbandry. Moreover, we feel that palaeopathological research offers a potentially decisive contribution to resolving some of the most intractable ambiguities of existing methods of analysis. This is because the patterns of bone abnormalities that we have identified in the Ak-Alakha case, and expect to identify in other material, are the direct result of a change in the way that humans use animals, rather than an indirect expression of some indeterminate change in the selection pressures operating on them. This opens up a different field of enquiry, and one which in combination with other new approaches, such as the use of DNA analysis, should help to give a better and more reliable picture of the role of horses in human social evolution.

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