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A Romano-British horse burial from Icklingham, Suffolk

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ABSTRACT: This case study describes a Romano-British horse skeleton from Icklingham, Suffolk. Although the skeleton was articulated and was found near a human skeleton, the two burials appear to be unrelated. The horse was not accompanied by artifacts and appears to have been disposed of after a violent, traumatic injury to its back, which probably indirectly caused its death.

KEY WORDS: HORSE, ROMAN, BRITAIN, PATHOLOGY, TRAUMA

RESUMEN: En el presente informe se describe un esqueleto de caballo de época romana procedente de Icklingham, Suffolk. Si bien el esqueleto se encontraba articulado y se recuperó junto a un esqueleto humano, no parece existir relación causal entre ambos. El caballo no incorporaba ningún artefacto y parece haber sido desechado tras una violenta y traumática herida en su espinazo que probable e indirectamente pudo haber sido la causa de su muerte.

PALABRAS CLAVE: CABALLO, ROMANO, BRITÁNICO, PATOLOGÍA, TRAUMATISMO

ARCHAEOLOGICAL CONTEXT

In the course of excavations carried out in Icklingham, Suffolk in 1999[1] under the direction of Dr. C. M. Hills[2], an oval pit[3] containing a horse skeleton was revealed; (Figure 1). The horse was not accompanied by any artifacts and the fill in the pit contains few potsherds or bones from other animals, though many were found in deposits near and above the pit. The horse burial, F14, was adjacent to a Roman road and cut into an earlier Roman period burial of an elderly woman, F13 (Figure 2). Several other human burials, dating to the Roman period, have also been excavated close to the horse, but they are not directly associated with it. The radiocarbon date for the horse skeleton is AD 100 to 320[4].

[1] Lark Valley Project, Mitchell's Field, Icklingham (IKL 127A 99).
[2] Department of Archaeology, University of Cambridge.
[3] horse skeleton [1077], pit fill [1076], pit cut [1075].
[4] Beta-153745: uncalibrated, 1820±40 BP; calibrated 1 sigma AD 130-240, 2 sigma AD 100-320; using the 1998 calibration database (Talma & Volge, 1993; Stuiver & van der Plicht, 1998; Stuiver *et al.*, 1998), 13C/12C ratio –21.4‰.

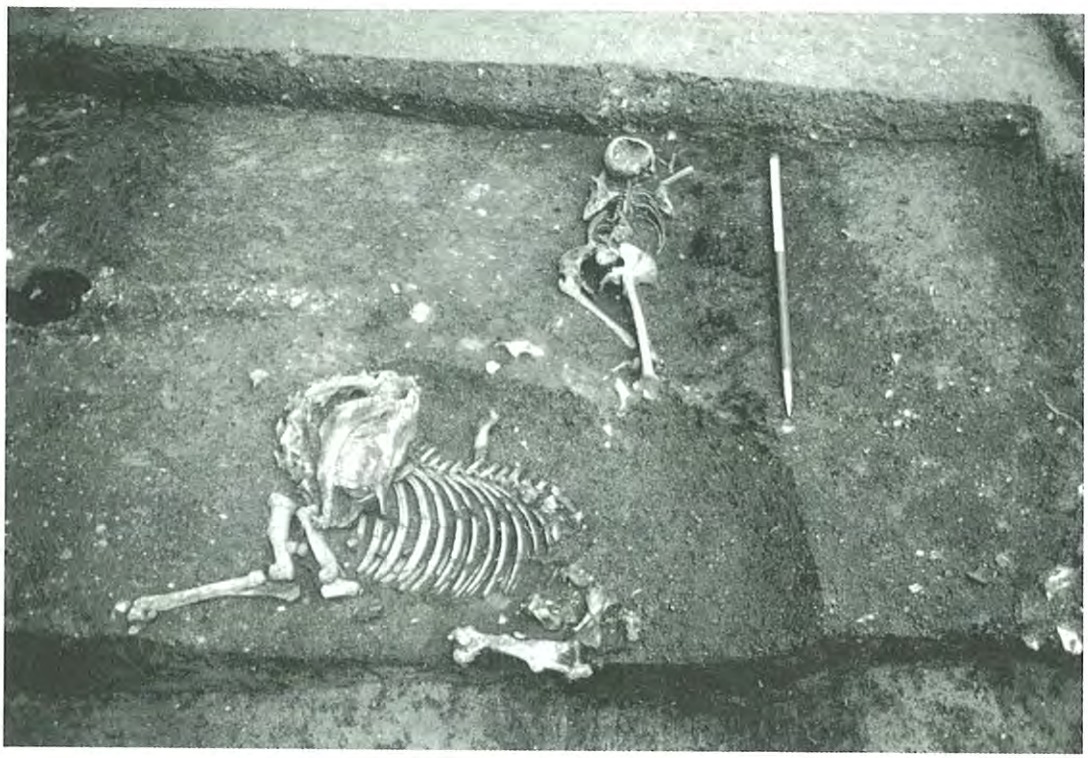

FIGURE 1
Excavation photograph.

CONDITION OF THE SKELETON

The majority of the horse bones were articulated and unbroken and there was relatively little surface damage to most of the anatomical elements. The skull, however, suffered serious post-burial compression damage and virtually disintegrated when the soil holding it together was washed away. The articulated part of the skeleton was scarcely disturbed, aside from the collapse of the pelvis and damage to the spinal column, especially the atlas and the lumbar vertebrae. The pit fill (1076) was dry sieved using a 2 mm mesh.

Unfortunately before the skeleton was discovered, sondage 1037 had been excavated though the western part of pit 14, cutting through some of the lower limb bones (Figure 2). Some of these bones were recovered from 1037, as well as from contexts 1046, 1066, 1067 and 1076, but others appear to have vanished (Figure 3). Missing elements include phalanges and metapodials. The fill from the sondage was not sieved, but the bones were collected by hand. Most of the missing anatomical elements are much too large to have been moved any distance by rodents and should have been recovered even though the deposit was not sieved. It is possible that they were removed in the course of farming or construction activities sometime after the horse's burial. It is also possible that they could have been removed from the carcass before it was buried to be used for tool fabrication, as has been described for a number of sites from the Netherlands (Lauwerier, 1999; Lauwerier & Robeerst, 2001).

AGE AND SEX

According to its epiphyseal fusion (Appendix 1), the skeleton was from a $3^1/_2$ - 4 year old (Sisson & Grossman, 1950; Levine, 1979). According to the incisor and canine eruption and wear state

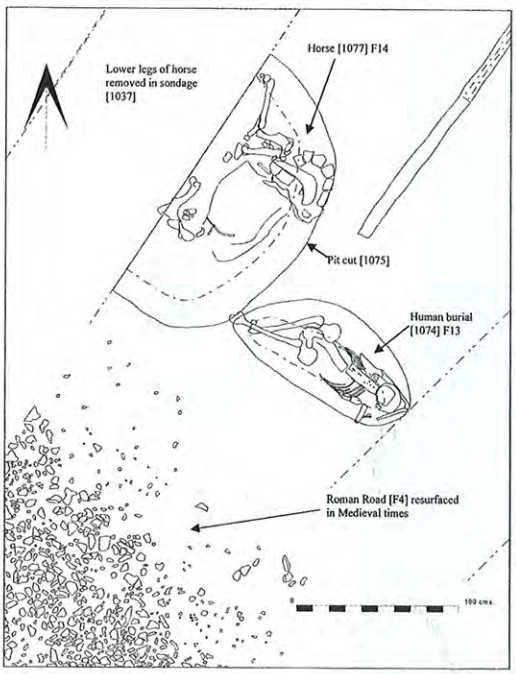

FIGURE 2
Plan of excavation.

(Appendix 2), the horse was about $3^1/_2$ to $4^1/_2$ years of age (Cornevin & Lesbre, 1894). According to its cheektooth eruption, wear and crown height (compared with New Forest Pony measurements), it was approximately 3 to 5 years of age (Levine, 1982). Because its teeth are considerably smaller than those of both the New Forest Ponies and the Palaeolithic horses used in Levine's published tables (Levine, 1982), its cheekteeth could not be aged more accurately.

The presence of full sized canines suggests that the horse was male. Unfortunately, the pelvis is too damaged to confirm this. That the skeleton was from a pony, rather than a small horse, is indicated by two features of the vertebrae: 1) The dorsal spinous processes are spatulate when viewed from the side (Figure 4); and 2) there are relatively large spaces between the dorsal spinous processes; this is confirmed by the absence of hyperextension moulding on the articular processes.

SIZE

The withers height of skeleton 1077 was calculated on the basis of the method devised by Kiese-

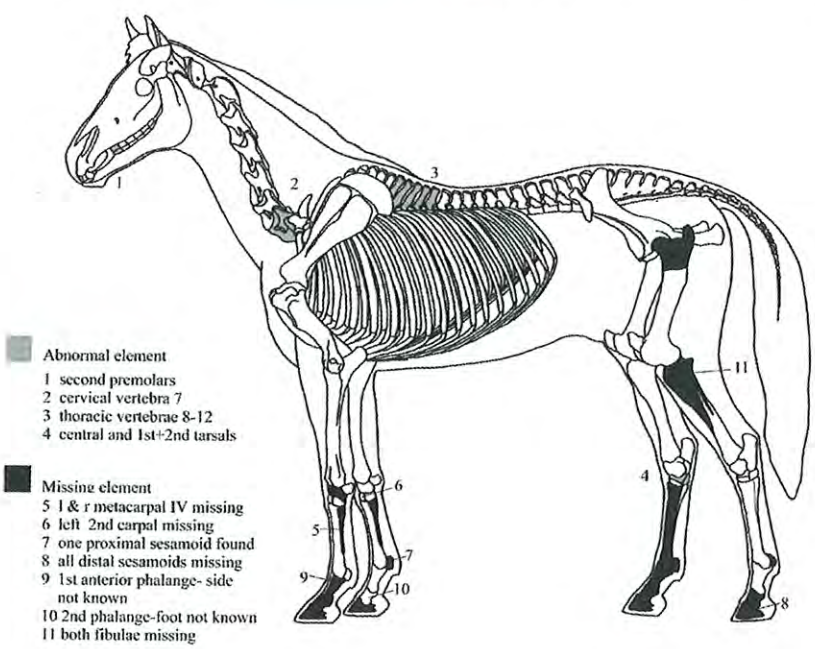

FIGURE 3
Drawing of horse showing anatomical elements not recovered from 1077 and pathological elements.

FIGURE 4
17th thoracic vertebra – right lateral view (the fracture is post-mortem).

walter (1888), as described by Driesch & Boessneck (1974). According to this method (Table 1), a greater withers height is indicated by the lower limb bones (radius, metacarpal and metatarsal) than by the upper limb bones (femur and humerus). The most likely explanation for this is that this skeleton came from a population which had different limb proportions than that used by Kiesewalter for the construction of his withers height constant. That the Icklingham horse was not yet fully grown might also be relevant. Although it is thus impossible to say with much precision how tall this individual was, it clearly was rather small, even by pony standards: around the same size as a rather small Exmoor or Dartmoor pony (Peplow, 1998).

Other measurements taken from skeleton 1077 are listed in Appendices 1 and 2.

PALAEOPATHOLOGY

Ethnographic data from Kazakhstan and Mongolia show that in traditional societies horses are not normally broken in before the age of 2-3 years (Levine, 1999). It is unlikely that the Icklingham pony would have been used to carry heavy loads any earlier. It is thus highly improbable that such a young (3½ to 4 years) and small (120-130 cm at the withers) animal as this, could have been used for heavy work for any length of time before its death. It would therefore have been unlikely to develop the kinds of work related abnormalities often observed in older domestic horses (for example, Bökönyi, 1968; Baker & Brothwell, 1980; Benecke, 1994; Levine *et al.*, 2000). This suggestion is supported by the very low incidence of bone abnormalities, aside from the injury that was the

Element	Measurement description	Measurement value	Constant	Withers height in mm
Radius	GLatL	302.4	4.34	1312
Metacarpal	GLatL	204.0	6.41	1308
Metatarsal	GLatL	248.4	5.33	1324
Femur	GLatL	339.3	3.51	1191
Humerus (unfused)	GLatL	250.1	4.87	1218

TABLE 1
Withers height measurements. GlatL is grestest lateral length as illustrated in Driesch (1976).

ultimate, if not the proximate, cause of the pony's death.

THORACIC VERTEBRAE:

The thoracic vertebrae 8-12 show evidence of significant pathology, almost certainly the result of severe trauma (Table 2; Figures 3, 5-12). Figures 5 and 6, showing the assembled T7 - T13 viewed from the left side, permit a direct comparison of the gross bone specimens with their radiographic appearance. The radiograph confirms the extent of the back injury, the incomplete fusion of the vertebral epiphyses, and the loss of the caudal epiphysis of T10. The dorsal spinous processes of T9, 10 and 11 are attenuated due to ante-mortem fractures. The fractured fragments are missing. Thoracic vertebrae 1-7 and 13-18 show no evidence of abnormality.

So what could possibly have happened to this horse? Our initial reaction had been that the horse had reared up and fallen over backwards and crashed onto its withers, crushing the dorsal spinous processes. However, there was no evidence of injury to the spinous processes at the highest part of the withers, T4-7, where most damage occurs when a horse rears up and falls over. It is highly unlikely then that the injury to the pony's vertebrae could have been caused by a fall. A non-traumatic explanation for the pathology is also unsatisfactory. The bone spurs on T9, if natural - that is, non-traumatic in origin - would have taken a long time to develop. However, the new bone development on T10-T12, which must also have resulted from the injury, was much less extreme. T9 must therefore have been the focus of the injury, which additionally distorted T8 and crushed the summits of T10 and T11.

We can only hypothesise about what might have happened to this individual. It does not seem possible that the damage to the thoracic vertebrae manifested here could have resulted from something the horse did to itself. The most likely explanation seems to be that the horse was struck across the back perhaps by a person with an axe or other heavy, sharp implement. The blow apparently struck the dorsal spinous process of the T9 directly, splitting it, while crushing the summits of the dorsal spinous processes of T10-11. It clearly was a very serious injury, but the deposition of new bone on T9 to T12 shows that the horse survived some time after the attack. In fact, comparison with a vertebra from a 5 year old horse with a 20 day old fracture callus, (Figure 13), suggests that pony 1077 might have survived around 1-2 weeks after being injured. Such an injury would never have healed entirely. It is possible either that the attack debilitated the animal, the wounds became infected - possibly causing septicaemia - which left it in such a weakened state that it died 'naturally'; or that it was eventually destroyed. Because of the severity of its injuries, it would never again have been able to tolerate any weight on its back. No cut or chop marks could be identified on any of the injured thoracic vertebrae[5].

The skull was too damaged by taphonomic agents (the weight of the soil resting on it, soil conditions, etc.) for any evidence of injury to be detectable. No new bone was found on the fragmented bone of the skull and its damaged state

[5] In fact, no cut or chop marks were found on any of the bones from this skeleton.

Vertebra	Description of pathology
T8	The dorsal third of the dorsal spinous process bends to the horse's right (Figure 7).
T9	The fractured dorsal spinous process has a spike of bone projecting from the caudal border of the dorsal extremity. The bone immediately below the spike deviates slightly to the left; the right side is rough and pitted. The radiograph shows this area to have a distinct focal radiolucency (Figure 6). There is also is a wide v-shaped downward cleft in the anterior border of the spinous process. There is local new bone development (Figures 5, 6, 8-10).
T10	The dorsal extremity of the fractured dorsal spinous process is splayed and new bone has developed on both left and right sides. There is probably some secondary, post-burial damage to the summit (the sponginess of the new bone present would have made the bone more vulnerable to natural taphonomic agents of bone destruction) (Figures 5, 11-12).
T11	The damage is very similar to that on T10. New bone has developed on both the left and the right sides of the dorsal spinous process, whose extremity is spongy and splayed. (Figure 5)
T12	The dorsal spinous process shows a small amount of new bone on the right side, but its height is normal (Figure 5).

TABLE 2
Thoracic vertebrae pathology.

does not allow us to say whether or not the horse was finally killed with a blow to the head.

It is probably impossible to determine how these vertebral injuries could have come about. It is very difficult, if not impossible, to believe that anyone could think that whacking a horse across the back was a sensible way in which to kill it. Pointless and extreme cruelty, or possibly violence related to some form of civil disturbance, seem to be the most likely explanations for such an attack.

CERVICAL VERTEBRA:

The only other vertebra with an observable abnormality is the 7th cervical, on the right cranial articular process of which there is small spur of new bone (Figure 14). This part of the bone has post-burial damage, which makes a detailed assessment of the abnormality impossible. However, the bony spur is relatively small and unlikely to have distressed the horse.

1st & 2nd AND CENTRAL TARSAL:

The right 1st and 2nd tarsal is fused to the central tarsal, a situation that is somewhat unusual, but has no implications for the horse's health or performance (Figure 15). What is significant in this case is the roughening of the distal articulation of the central tarsal. This was probably caused by erosion of the cartilage and a possible fracture. Unfortunately, modern damage to the bone has obscured its condition and the 3rd tarsal with which it articulated has not been recovered. These bones were found in the sondage [1037].

FIGURE 5
Photograph of 7th – 13th thoracic vertebrae - lateral view.

TEETH:

The upper and lower 2nd premolars (both left and right sides) have a rather odd pattern of wear (Figures 16-18). In the case of both lower teeth, the whole occlusal face is worn flat, but with a bevel that extends from the mesial edge to the distal end of the metastylid. Using the measurement method described in Brown & Anthony (1998), the lower P2s appear to have huge bit-wear bevels (13.6 mm and 9.1 mm). But there is no bevel on either of the upper P2s. In fact, they hook downwards and occlude perfectly with the occlusal surface of the lower P2s. This contrasts strongly with two skulls with obvious cases of bit-wear: the Buhen horse (Egypt), described by Clutton-Brock (1974), and a skull from the Scythian site of Lisovichi (Ukraine), (Figures 19-20). The mesial borders of upper and lower P2s from both of these skulls do not occlude. This suggests that the bevelled edges on the teeth of the Icklingham pony did not result from chewing the bit, but rather from abnormal occlusion. This kind of wear has also been observed by A. von den Driesch (pers. comm.) and indicates that a mesial bevel on the lower P2 is not synonymous with bit-wear, and probably should not be described as such in the absence of the upper P2.

DISCUSSION

Excavations of articulated horse burials, not directly associated with human skeletons and dating to the Roman period, do not appear to be very common in the UK. Besides Icklingham, a number of other records of this type of horse burial

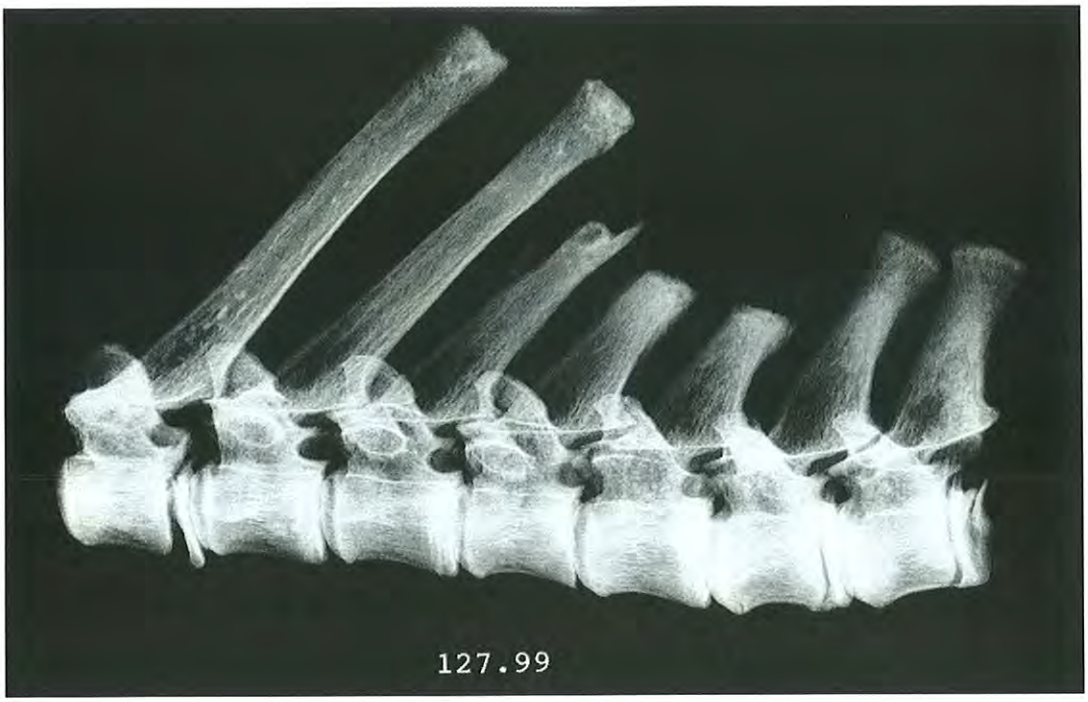

FIGURE 6
Radiograph of 7th – 13th thoracic vertebrae - lateral view.

have nevertheless been located. One was of a horse skeleton recovered from the 2nd century AD gravel pit fill at a Roman site at West Tenter Street, London (Whytehead, 1986). The site was also used for human burials. As at Icklingham, although the human and horse burials were near one another, they were apparently unrelated. Such burials have also been observed at a Roman cemetery in York: "*Occasionally the burial of a whole horse is recorded in apparent association with a human corpse, but a clear association is not attested and the horse skeletons may be intrusive*" (Royal Commission 1962, p. 79). Ingrem and Clark (in press) describe two horse burials from the Stratford Market Depot Site, East London, which - in contrast to the other skeletons mentioned here - were not associated with a human cemetery. A horse skeleton from what was described as a "ritual" burial, by a somewhat unconvincing "process of elimination", was found during an excavation of Roman Chelmsford (approximately late 1st or early 2nd century AD).

In contrast to Great Britain, a considerable number of horse burials, not directly associated with human skeletons (though at sites sometimes used later as cemeteries) have been described from the Netherlands and other parts of Roman northern Europe (Lauwerier & Hessing, 1992; Lauwerier, 1999; Lauwerier & Robeerst, 2001). This raises the question of whether the paucity of British finds might not be the result of our lack of resources to delve into the British archives. Some of the skeletons from the Netherlands do seem to be associated with ritual activity (for example, at Wijster, Druten and Raalte-Heeten). However, at other sites the contexts suggest carcass disposal (for example, Kesteren) rather than ritual interment. This also seems likely to be the case with the Icklingham burial.

When a domestic animal – especially one as large as a horse – dies, its carcass must be disposed of as quickly as possible. Healthy livestock - cattle, sheep, goats, pigs etc. - are usually consumed. Unhealthy animals are often disposed of in pits, fed to dogs or left to wild carnivores and omnivores. Many societies have taboos against the consumption of horse flesh (Levine, 1998). Like the post-Medieval British, the Romans apparently generally

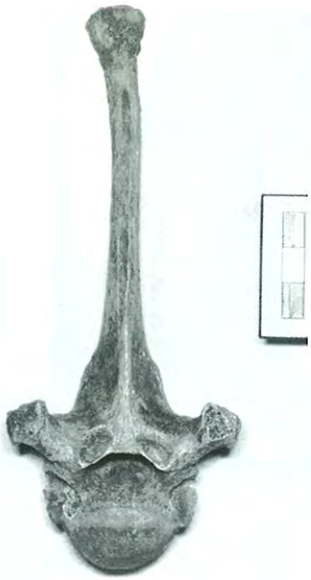

FIGURE 7
8th thoracic vertebra – cranial view.

FIGURE 8
9th thoracic vertebra – left lateral view.

FIGURE 9
9th thoracic vertebra – right lateral view spinous process.

FIGURE 10
9th thoracic vertebra – cranial view.

FIGURE 11
10th thoracic vertebra – caudal view.

FIGURE 12
10th thoracic vertebra – right lateral view spinous process.

FIGURE 13
Modern horse with 20 day old fracture callus on lumbar vertebra– left lateral view articular and spinous processes.

FIGURE 14
7th cervical vertebra – dorsal view.

FIGURE 15
1st & 2nd tarsal fused to central tarsal – distal view.

FIGURE 16
Upper and lower 2nd premolars – buccal view.

FIGURE 17
Upper and lower 2nd premolars – buccal view occluding.

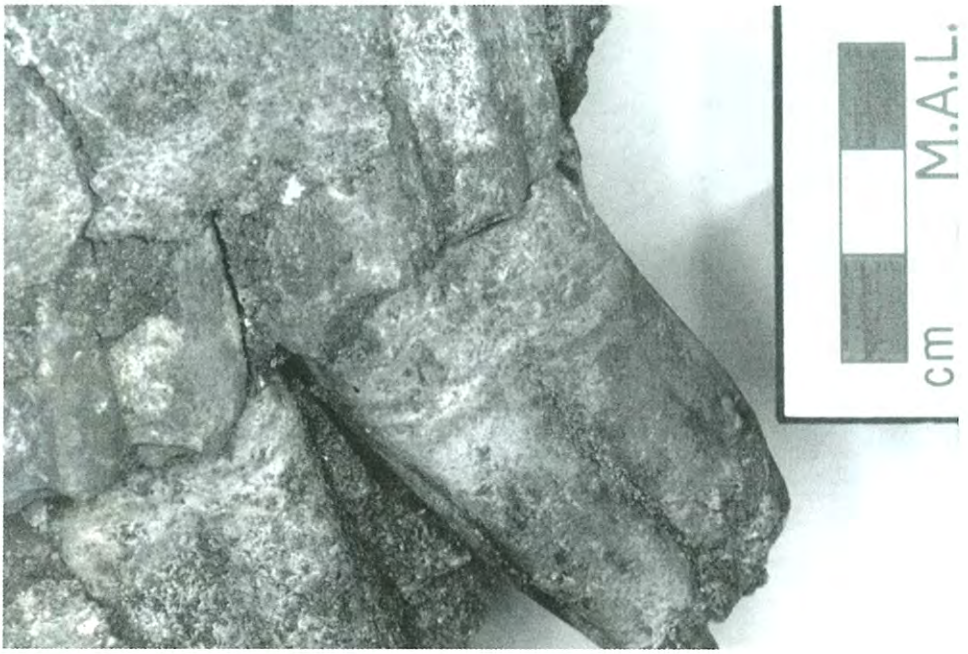

FIGURE 18
Upper and lower 2nd premolars – buccal view in skull bone.

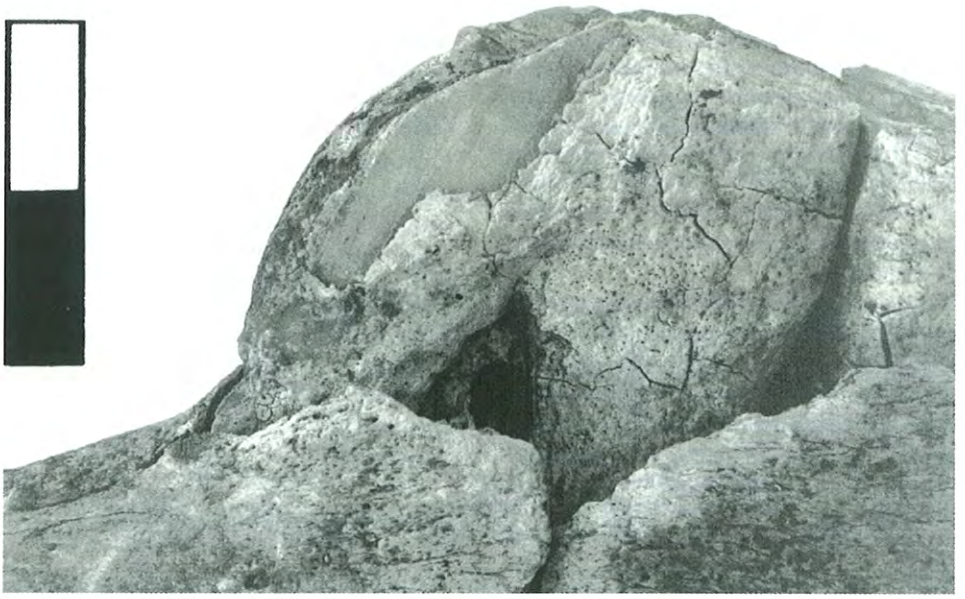

FIGURE 19
Lisovichi lower 2nd premolar – buccal view.

FIGURE 20
Lisovichi upper 2nd premolar – buccal view.

avoided eating horsemeat, but the picture in the provinces was complicated, on the one hand, by the presence in the Roman army of peoples originating in the far-flung corners of the Roman Empire and, on the other hand, by the locals, whose habits were often at odds with those of their conquerors (Lauwerier, 1999). Thus, even the carcasses of healthy horses might be buried whole or fed to carnivores. However, even if his owners had been willing to consume horseflesh, a week or two after his injury - by the time the Icklingham pony died - his carcass might no longer have been fit for human or even animal consumption.

It is not possible to account for the position of the horse in the grave. There are two basic possibilities: 1) It was led into the pit and slaughtered there; 2) It died of natural causes or was slaughtered outside and dragged into the pit. From the animal's posture, particularly in view of the absence of and/or disturbance of its lower limb bones, it is not possible to state with any conviction which is the most likely scenario. It does appear, however, that the positioning of the horse in the pit was rather badly misjudged. Although the pit would have been large enough to accommodate the horse without any difficulty, the animal was placed or dropped right against the south-east edge, with its head twisted around, possibly in order to fit it into the hole. Alternatively, the horse might have died with its head in that position. Such a head position has been observed for other articulated horse burials and in modern animals (for example, Callery, 1992; Lauwerier & Hessing, 1992; Ingrem & Clark, in press).

In modern veterinary science it is now normal, routine practice to investigate suspected back injuries in horses by the use of radiography. It is hoped that placing on record the radiographic appearance of this unusual spinal lesion will facilitate a direct comparison of the injury to this Roman horse with injuries sustained in modern horses. Further insight into the causation of the injury may thereby become apparent in the future.

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Appendix 1 – description of postcranial elements

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*[1]	*Meas No*	*Value*
thoracic/lumbar	irrelevant	almost whole	indeterminate	2032	TR.A[1077]R8	O		
scapula	left	dist.[2] end + shaft (1/2)	prox. irrel. and dist. fused	2002	TR.A[1077]scap 1	AM5	3	55.3
							4	80
							5	49.1
	right	dist. end + shaft (> 1/2)		2003	TR.A[1077]scap 2	C	3	56.2
							4	79
pelvis	left	ilium wing frag.	indeterminate	2004.1	TR.A[1077]1	G		
	right			2082.8	TR.A[1077]	GT		
		acet + ilium + aceb br isch.	acetabulum fused	2006,1998.1	TR.A[1037,1077]	C	14	55.3
humerus	left	whole	prox. unfused and dist. fused	2011	TR.A[1077]8	MI	1	256.8
							2	83.8
							3	46.5
							4	69.4
							5	77.8
							7	30.8
							8	40.9
							10	71.1
	right	almost whole		2017	TR.A[1077]14	MM1MI	1	258.8
							2	81.5
							3	46.7

[1] See Appendix 3 – certainty code.
[2] See Appendix 4 – abbreviation code.

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
humerus	right	almost whole	prox. unfused and dist. fused	2017	TR.A[1077]14	MM1MI	4	68.8
							5	78.2
							7	30.3
							8	41.4
							10	70.8
radius	left		prox & dist fused, fused to ulna	1646	TR.A[1067]	G	2	310.4
							3	75.3
							4	67.9
							5	39.5
							7	68.3
							8	58.2
							9	40.4
							10	33.7
							11	34.7
							13	303.1
	right	whole		2001	TR.A[1077]	C	1	380.9
							2	311.5
							3	73.5
							4	66
							5	39.2
							6	33.3

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
radius	right	whole	prox & dist fused, fused to ulna	2001	TR.A[1077]	C	7	68.4
							8	58.1
							9	40.8
							10	32.7
							11	34.5
							12	23.6
							13	301
							16	302.4
ulna	left	prox. end + shaft (< 1/2)	ulna pr unf, shaft fused to rad.	2010	TR.A[1077]7		14	71.1
							15	41.9
	right	almost whole		2001	TR.A[1077]		14	68.7
							15	40.8
rib	irrelevant	fragment - artic	indeterminate	2072.1	TR.A[1077]V12			
				2081	TR.A[1077]			
		fragment - shaft + artic.	prox. fused and dist. irrel.	2073.1	TR.A[1077]V13			
				2070.1	TR.A[1077]V10			
				2079	TR.A[1077]V19	GT		
		prox. end + shaft (1/2)		2038	TR.A[1077]R14	C		
		prox. end + shaft (> 1/2)		2039	TR.A[1077]R15			
		prox. end + shaft (<1/4)		2081	TR.A[1077]			
		whole		2042	TR.A[1077]R18			

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
rib	irrelevant	whole	prox. fused and dist. irrel.	2043	TR.A[1077]R19	C		
				2058	TR.A[1077]R34			
				2041	TR.A[1077]R17			
				2059	TR.A[1077]R35			
		almost whole	indeterminate	2030	TR.A[1077]R6			
				2033	TR.A[1077]R9			
				2034	TR.A[1077]R10			
				2029	TR.A[1077]R5			
			prox. fused and dist. irrel.	2057	TR.A[1077]R33			
			indeterminate	2050	TR.A[1077]R26			
			prox. fused and dist. irrel.	2052	TR.A[1077]R28			
				2053	TR.A[1077]R29			
				2056	TR.A[1077]R32			
			indeterminate	2031	TR.A[1077]R7			
			prox. fused and dist. irrel.	2037	TR.A[1077]R13	O		
				2040	TR.A[1077]R16	C		
			indeterminate	2027	TR.A[1077]R3	G		
			prox. fused and dist. irrel.	2047	TR.A[1077]R23	C		
				2046	TR.A[1077]R22			
			indeterminate	2045	TR.A[1077]R20			
				2028	TR.A[1077]R4			

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
rib	irrelevant	almost whole	prox. fused and dist. irrel.	2044	TR.A[1077]R21	C		
		prox. artic. - frag.		2081	TR.A[1077]			
			indeterminate					
			prox. fused and dist. irrel.					
		prox. artic. + shaft - frag.		2082.11				
		dist. end + shaft (> 1/2)	indeterminate	2049	TR.A[1077]R25			
		dist. end + shaft (<1/4)			TR.A[1077]			
				2060				
		dist. end + shaft (> 3/4)		2048	TR.A[1077]R24			
				2035	TR.A[1077]R11			
		shaft (< 1/2) tube		2083	TR.A[1077]R2			
		shaft (1/2) tube		2036	TR.A[1077]R12	PT		
				2055	TR.A[1077]R31	C		
		shaft (> 1/2) tube		2054	TR.A[1077]R30			
				2051	TR.A[1077]R27			
		shaft (<1/4) tube		2060	TR.A[1077]			
femur	left	dist. end + shaft (> 1/2)	prox. indeter. and dist. fused	1996.2, 1998	TR.A[1037]	G	5	404.4
							8	33.1
							10	107

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
femur	left	dist. end + shaft (> 1/2)	prox. indeter. and dist. fused	1996.2, 1998	TR.A[1037]	G	12	45.4
	right	almost whole	prox. fusing and dist. fused	2000.1	TR.A[1077]	AM4AM5	1	339.3
							2	313.6
							3	48.6
							4	81.7
							5	104.6
							8	35.5
							10	106.6
							12	46.1
tibia	indeterminate	epip frag	prox. unfused and dist. indeter.	2082.7		G		
	left	dist. end + shaft - sh. long.	prox. indeter. and dist. fused	1996.1,1998	TR.A[1037]	GAM4AM5	4	66
							5	40.4
	right	almost whole	prox. fusing and dist. fused	1995.2,1998		G	6	37.3
							7	30
patella	left	whole	irrelevant	2000.2	TR.A[1077]	C		
				2004.4	TR.A[1077]1			
central MC III		almost whole	prox. and dist. fused	1634	TR.A[1066] spit 2	GAM6	1	213.2
							6	42.6
							9	30.7
							10	23.2
							11	19.3

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
central MC III	right	almost whole	prox. and dist. fused	1995.1	TR.A[1037]	GMM2MM3AM9	1	213.8
							2	45
							3	44.3
							6	43.8
							9	30.7
							10	23.3
							11	19.3
							12	204
central MT III	left			1646	TR.A[1067]	C	1	255.56
							2	47.5
							3	47.3
							6	44
							7	45.4
							8	35.2
							9	28.8
							10	27.6
							11	23.8
							12	248.4
sternum	irrelevant	sternum segment	unfused	2013	TR.A[1077]10			
				2019	TR.A[1077]16			
				2014	TR.A[1077]11			

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
sternum	irrelevant	sternum segment	unfused	2012	TR.A[1077]9	C		
				2018	TR.A[1077]15			
				2009	TR.A[1077]6			
MC II (med)	left	prox. end + shaft (< 1/2)	access. metap. unf. w. main	1998.6	TR.A[1037]	G		
MT II (med)	right			1992	TR.A[1031]			
MT IV (lat)	left	prox. end + shaft (> 1/2)		2084.10	TR.A[1076]			
	right			1998.4	TR.A[1037]			
costal cartil	indeterminate	fragment - shaft	indeterminate	2060	TR.A[1077]	C		
				2009	TR.A[1077]6			
	irrelevant			2060	TR.A[1077]			
			irrelevant	2015	TR.A[1077]12			
radial carpal	left	whole		1997.7	TR.A[1037]		1	25
							2	25
							3	38
	right			2001.4	TR.A[1077]		1	24.8
							2	24.7
							3	37.8
ulnar carpal				2001.3			1	22.1
							2	32
intermed. carpal				2001.6			1	25.6
							2	27.4

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
Intermed. carpal	right	whole	irrelevant	2001.6	TR.A[1077]	C	3	22
							4	33.7
accessory carpal	left			1997.8	TR.A[1037]	G	1	29.1
							2	26.7
							3	38.2
	right			2001.5	TR.A[1077]	C	1	29.6
							2	27.3
							3	38.2
2nd carpal		almost whole		2082.5				
3rd carpal (grand os)	left	whole		1997.6	TR.A[1037]		1	18.6
							2	38.5
							3	35.8
	right			2082.9	TR.A[1077]		1	18.1
							2	38.9
							3	35.9
astragalus	left			1634	TR.A[1066]spit 2	MM4PA	1	53.2
							2	54.2
							3	38.4
							4	47.3
							6	53.4
	right	almost whole		1997.4	TR.A[1037]	G	1	54

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
astragalus	right	almost whole	irrelevant	1997.4	TR.A[1037]	G	2	54.6
							3	37
calcaneum	left		prox. fused and dist. irrel.	1997.1		AM5MM7	1	101.2
							4	18.6
							5	39.6
							6	46.8
							7	46.3
	right			1997.2		G	1	101.6
							2	28.1
							3	46.1
							4	18.3
							5	40
							6	47.5
central tarsal	left	whole	irrelevant	1998			1	45.1
							2	39.4
	right	almost whole		1998.10		GAM1	1	45.9
1st+2nd tarsal	left	whole		1992	TR.A[1031]	G	1	30.5
	right	almost whole		1998.10	TR.A[1037]	C		
3rd tarsal	left	whole		1993	TR.A[1031]	G	1	43.2
							2	40.6
sesamoid - proximal	indeterminate			2084.2	TR.A[1076]		1	27.3

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
sesamoid - proximal	indeterminate	whole	irrelevant	2084.2	TR.A[1076]	G	2	22.3
							3	17.7
1st phal.-ant.		entire bone long. spl.	prox. and dist. fused	1998.2	TR.A[1037]	GE		
	right	whole		1997.5		GAM7	1	75.8
							2	69.5
							3	50.3
							6	43.7
							7	41.2
							8	22.9
							9	31.5
1st phal.-post.	left	almost whole		1563	TR.A[1046]	GAM1	1	72.2
							2	67.2
							6	42.4
							7	40.4
							8	22.8
							9	31.3
2nd phal.-ant.	indeterminate	> 1/2 present		1998.5	TR.A[1037]	GAM2AM6	2	48.9
							6	41.5
atlas	irrelevant	1/2 present	irrelevant		TR.A[1077]	C		
axis		> 1/2 present	centrum - 1 epip unf, 1 irrel.		TR.A[1077]N1			
cervical 3		whole	centrum - 1 epip fusing, 1 unf	2021	TR.A[1077]N2		1	38.2

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
cervical 3	irrelevant	whole	centrum - 1 epip fusing, 1 unf	2021	TR.A[1077]N2	C	2	67.1
cervical 4		almost whole		2022	TR.A[1077]N3		1	49.9
							2	60.2
cervical 5			centrum - both epip fusing	2023	TR.A[1077]N4	AM2	1	54
							2	52.9
cervical 6			centrum - 1 epip fusing, 1 unf	2024	TR.A[1077]N5		1	55
							2	41.7
cervical 7				2025.1	TR.A[1077]N6		1	61.5
							2	33.5
thoracic 1				2025.2			1	26.6
							2	41.6
thoracic 2		> 1/2 present		2080.1, 2025	TR.A[1077]V20	C		
thoracic 3			centrum - both epip fusing	2079.1	TR.A[1077]V19		2	37.7
thoracic 4		almost whole	centrum - 1 epip fused, 1	2078	TR.A[1077]V18		2	138
thoracic 5		> 1/2 present		2077	TR.A[1077]V17		2	37.6
thoracic 6		3/4 present		2076	TR.A[1077]V16		2	36.1
thoracic 7		almost whole		2075	TR.A[1077]V15		2	34.3
thoracic 8				2074	TR.A[1077]V14		2	35.2
thoracic 9				2073	TR.A[1077]V13		2	35.6
thoracic 10		caudal centrum epip		2072	TR.A[1077]V12			
thoracic		centrum (epip frag)	centrum - 1 epip fused (other indeter)	2080	TR.A[1077]V20	T		

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
thoracic 11	irrelevant	almost whole	centrum - 1 epip fused, 1 fusing	2071	TR.A[1077]V11	C	2	36.3
thoracic 12		whole	centrum - 1 epip fusing, 1 unf	2070	TR.A[1077]V10		2	36.7
thoracic 13		almost whole	centrum - 1 epip fused, 1 fusing	2069	TR.A[1077]V9		2	37.4
thoracic 14		whole	centrum - both epip fusing	2068	TR.A[1077]V8		2	37.7
thoracic 15		almost whole	centrum - 1 epip fusing, 1 unf	2067	TR.A[1077]V7		2	37.6
thoracic 16				2066	TR.A[1077]V6		2	38.3
thoracic 17			centrum - 1 epip fused, 1unf	2065	TR.A[1077]V5		2	38.7
thoracic 18		caudal centrum epip	centrum - both epip unfused	2064	TR.A[1077]V4			
lumbar		centrum (body)		2084.8	TR.A[1076]	G		
		centrum (epiphysis)	centrum - 1 epip unf (other indeter)	2084.4				
		spinous process (vert.)	indeterminate	2061.1	TR.A[1077]v1			
		transverse process (vert.)		2026.1	TR.A[1077]r1	C		
				2061.2	TR.A[1077]v1	GE		
		dorsal arch		2062	TR.A[1077]v2	C		
ant thor vert 3-8		spinous process missing			TR.A[1077]			
	irrelevant	spinous process (vert.)						
sacrum		sacrum segment 1>half	centrum - both epip fused	2006.1, 2082.4,2084.5	TR.A[1077,1076]3			
		spinous process (vert.)	indeterminate	2082.2	TR.A[1077]			
				2063	TR.A[1077]v3			
		transverse process (vert.)		2084.9	TR.A[1076]	G		

Element	*Side*	*Part*	*Ageing*	*Cat No*	*Coord*	*Certainty*	*Meas No*	*Value*
sacrum	irrelevant	sacrum segment	centrum - both epip unfused	2084.6	TR.A[1076]	G		
				2005	TR.A[1077]2	C		
				2004.2	TR.A[1077]1			
caudal 1		almost whole		2084.7	TR.A[1076]	GE		
caudal 2		spinous process missing		2082.3	TR.A[1077]			

Appendix 2 - description of cranial elements

Jaw	*Side*	*Tooth*	*Wear*	*Root*	*Certainty*	*Meas No*	*Value*
indeterminate	indeterminate	i3	27[1]	developed and unbroken	C[2]		
upper	left	C	unworn	developing and broken	SI J		
		P2	worn to whole occl. face[3]	developing and unbroken	MM4 PA	1	48.8
						2	35.1
						3	31.9
						4	23.2
						5	9.9
						7	53.4
		P3	not to whole occl. face	embedded in bone	C	2	27.9
						4	24.3
						5	12.2
		P4		undeveloped	MM1 AM3 PA	1	73.1
						2	25.3
						3	24.4
						4	21.4
						5	11.7
		M1	occlusal face splayed	embedded in bone	C	2	25.4
						4	24.2
						5	12.4
		M2		developing and unbroken		1	73.2
						2	25
						4	21.6
						5	11.3

[1] Wear stage 27 refers to Cornevin and Lesbre (1894), Figures 62 to 66 – 3 ½ to 4 ½ years of age.
[2] See Appendix 3 – certainty code.
[3] See Appendix 4 – abbreviation code.

Jaw	*Side*	*Tooth*	*Wear*	*Root*	*Certainty*	*Meas No*	*Value*
upper	left	M3	slightly worn	undeveloped	MM1	1	62.1
		I1	27	developing and unbroken	SI J E		
		I2		developing and broken			
		I3					
	right	C			SI J		
		P2	worn to whole occl. face	developing and unbroken	AM1 PA	1	49.42
						2	34.7
						3	31.6
						4	23.1
						5	9.4
						7	52.2
		P3	not to whole occl. face		C	1	68.2
						2	28.5
						3	24.8
						4	24.7
						5	11.8
		P4		undeveloped	MM1 AM2 AM4	1	71.2
						2	25.8
						4	21.9
						5	11
		M1	occlusal face splayed	developing and unbroken	C	1	65.8
						2	25.1
						3	21.4
						4	24.4
						5	12.12
		M2				1	74.3

Jaw	*Side*	*Tooth*	*Wear*	*Root*	*Certainty*	*Meas No*	*Value*
upper	right	M2	occlusal face splayed	developing and unbroken	C	2	24.8
						3	20.2
						4	21.5
						5	11.7
		M3	slightly worn	undeveloped	MM1	1	65.2
		I1	indeterminate	developing and broken	SI J E		
		I2	27				
lower	left	C	unworn	embedded in bone	C		
		P2	worn to whole occl. face	developing and unbroken	PA	1	43.2
						2	30
						4	13.1
						5	14
						6	13.6
						7	45.9
		P3		undeveloped	AM1	1	64.4
						2	27.6
						3	26.1
						4	14.4
						5	14.8
		P4	not to whole occl. face		C	1	74.4
						2	24.8
						4	12.8
						5	12.3
		M1	worn to whole occl. face	developing and unbroken		1	67.2
						2	26.4
						4	14.1

Jaw	*Side*	*Tooth*	*Wear*	*Root*	*Certainty*	*Meas No*	*Value*
lower	left	M1	worn to whole occl. face	developing and unbroken	C	5	14.4
		M2	occlusal face splayed			1	73.9
						2	27.5
						4	12.1
						5	12.5
		M3	slightly worn	undeveloped	MM1 PA	1	62.3
		I1	27	developing and unbroken	SI J E		
		I2		developing and broken			
		I3		undeveloped			
	right	C	unworn	developing and broken	SI J		
		P2	worn to whole occl. face	developing and unbroken	PA	1	41.9
						2	31.1
						4	13.2
						5	14.6
						6	9.1
						7	46.2
		P3			C	1	64.1
						2	27.7
						3	25.3
						4	14.8
						5	14.5
						7	69
		P4	not to whole occl. face	embedded in bone		2	25.8
						4	12.1
						5	12.4
		M1	occlusal face splayed		AM2	2	25.7

Jaw	*Side*	*Tooth*	*Wear*	*Root*	*Certainty*	*Meas No*	*Value*
lower	right	M1	occlusal face splayed	embedded in bone	AM2	4	12.7
						5	13.9
		M2			C	2	26.9
						4	11.9
						5	13
		M3	enamel only worn		MM1	1	62.2
		I1	indeterminate	developing and unbroken	SI J E		
		I2	27	developing and broken			
		I3		undeveloped			

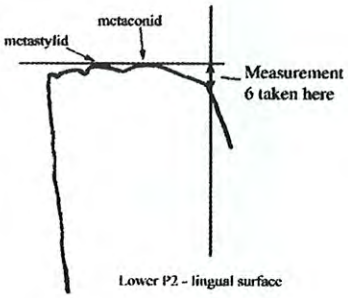
Appendix 3 - certainty code

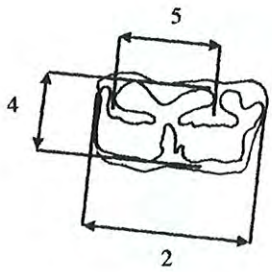
Code id	Certainty
C	certain
CX	context
SV	sieving
G	group
T	taxon
SI	side
S	sex
A	ageing
J	jaw
E	element
PT	part
GN	gnawing
CR	crown
ER	eruption
WE	wear
B	butchery
W	working
O	other
MM	minimum measurement
AM	approximate measurement
L	measurement on lateral condyle
PA	abnormality/pathology
MI	measurement of immature individual

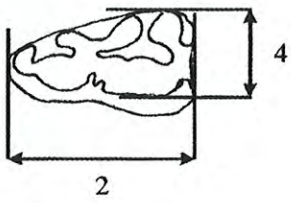
Appendix 4 – abbreviations

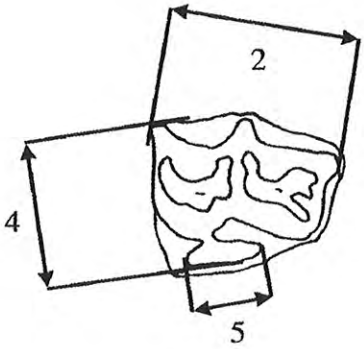
Abbreviation	Whole word
irrel	irrelevant
indeter	indeterminate
occl	occlusal
dist	distal
prox	proximal
med	medial
lat	lateral
pr	proximal
ant	anterior
post	posterior
frag	fragment
artic	articulation
sh	shaft
long	longitudinally split
epip	epiphysis
acet	acetabulum
br	branch
isch	ischium
unf	unfused
rad	radius
MC	metacarpal
MT	metatarsal
intermed	intermediate
metap	metapodial
access	accessory
phal	phalange
thor	thoracic
vert	vertebra

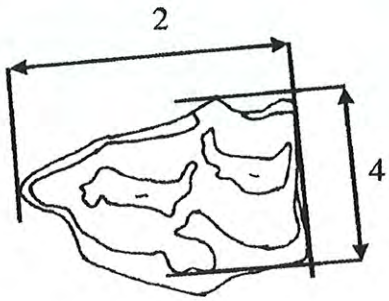
Appendix 5. Measurements

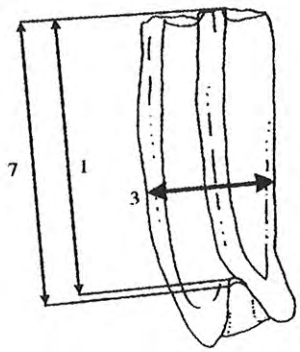


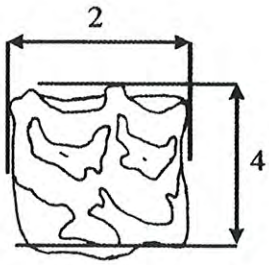


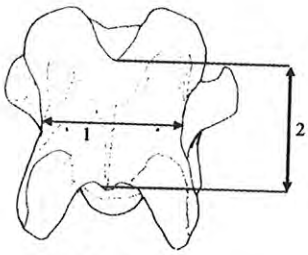




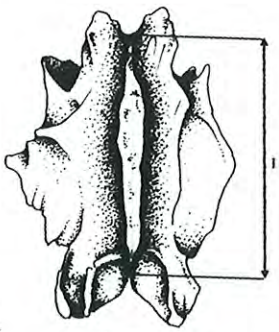




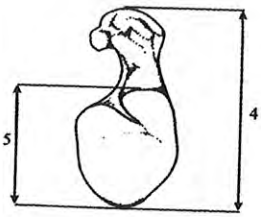




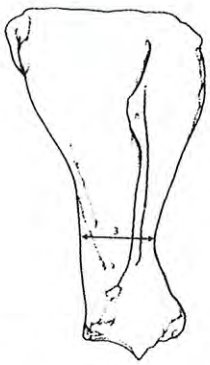
cervical 6 - dorsal view



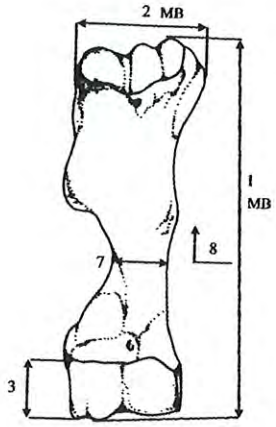
thoracic vertebra 18
dorsal view



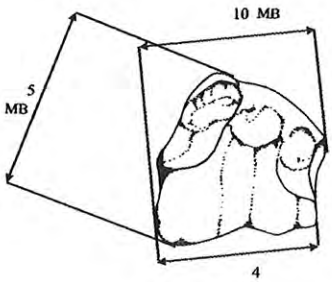
scapula
distal end view



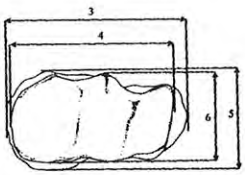
scapula
lateral surface



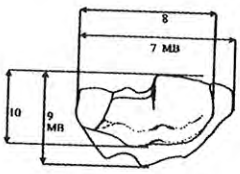
humerus - right
front view



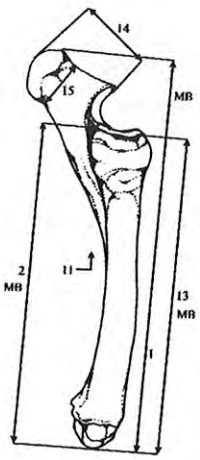
humerus - right
distal, end view



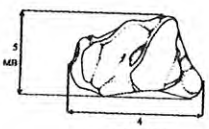
radius - left
proximal, end view



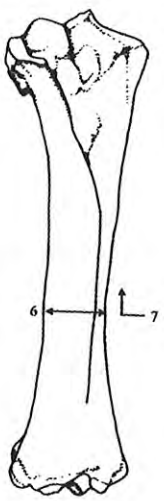
radius - left
distal, end view



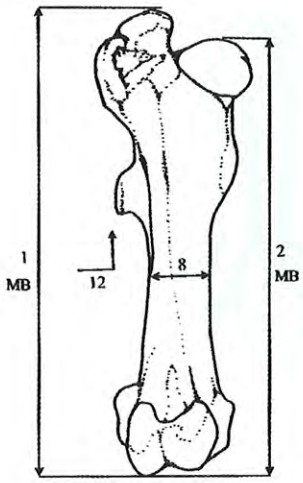
radius-ulna - left
medial view



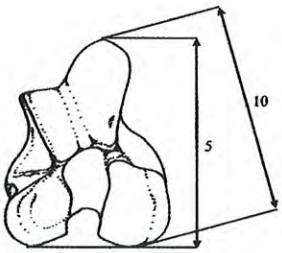
Tibia - left
distal end view



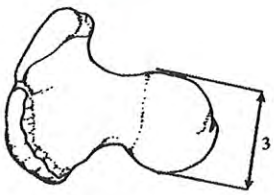
Tibia - right
anterior view



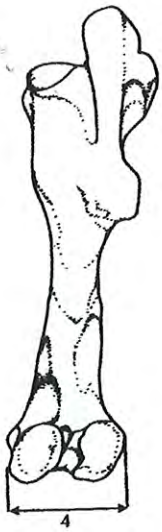
femur - right
anterior view



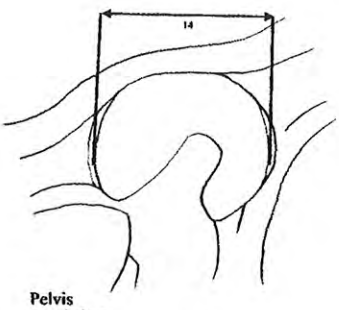
Femur - right
distal end view



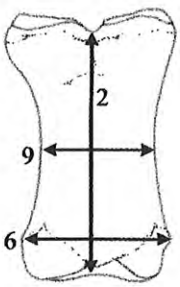
femur-right
proximal end view



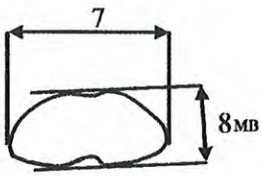
Femur - right
posterior view



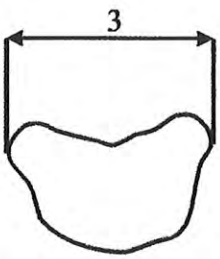
Pelvis
acctabulum



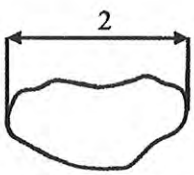
1st phalange
anterior view



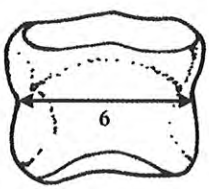
Outline of distal 1st phalange -
end view



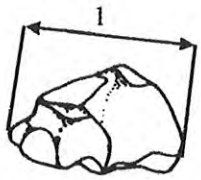
Outline of proximal 1st phalange -
end view



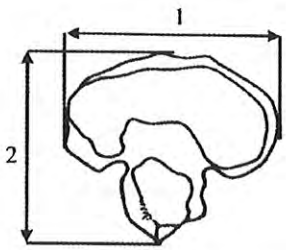
Outline of proximal 2nd phalange - end view



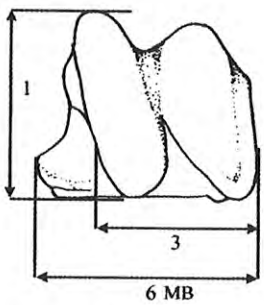
2nd phalange
anterior view



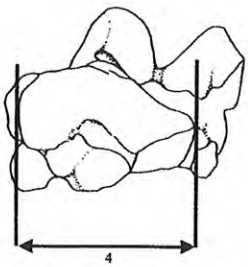
1st and 2nd tarsal - left



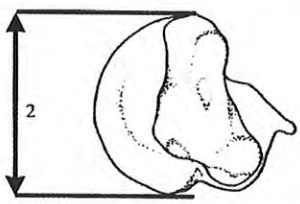
3rd tarsal - left



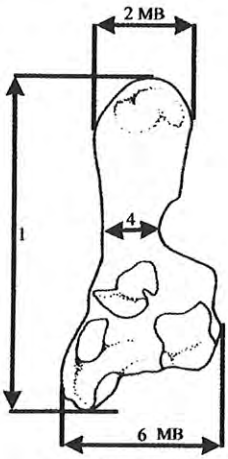
astragalus
anterior view



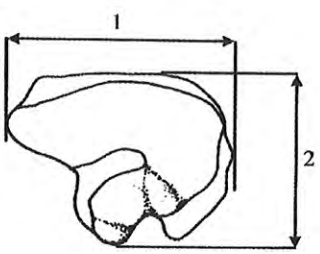
astragal
distal end



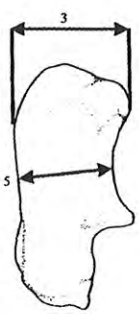
astragalus - right
medial view



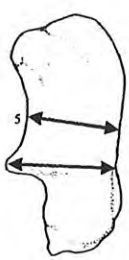
calcaneum - right
dorsal view



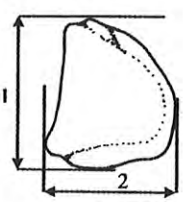
central tarsal - left



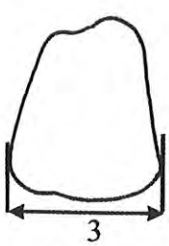
calcaneum - right
lateral view



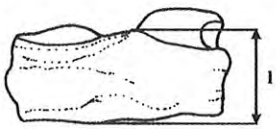
calcaneum - left
lateral view



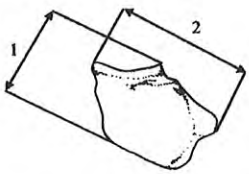
sesamoid
anterior view



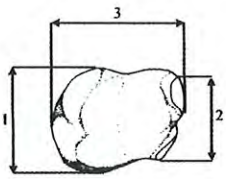
sesamoid
distal end view



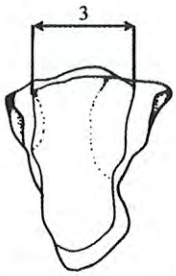
third carpal - left
anterior view



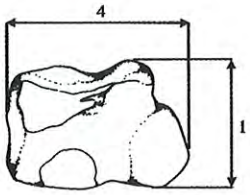
ulnar carpal - left
lateral view



accessory carpal - left
medial view

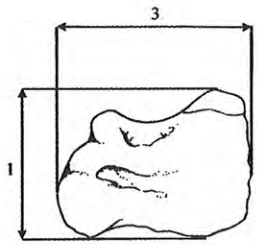


intermediate carpal - left
distal view



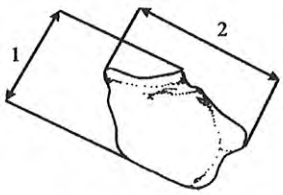
intermediate carpal - left
lateral view

intermediate carpal - left
proximal view

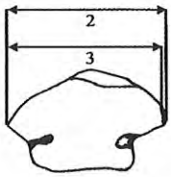


radial carpal - left
medial view

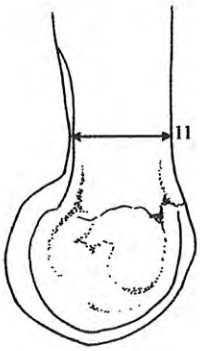
radial carpal- right
proximal view



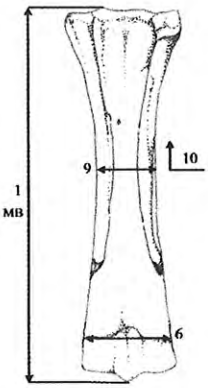
ulnar carpal - left
lateral view



Proximal metacarpal -
end view



Distal metapodial -
lateral view



Metapodials -
posterior view