ROMAN ARCHERY EQUIPMENT

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INTRODUCTION

In the past Roman archers have been studied by students of the army concerned with prosopography and recruitment. Little attention has been paid by them to the equipment and skills which lay behind unusual recruitment patterns and the deployment of archers in the field or along the limites. On the other hand archer-antiquaries have examined the archery equipment with little understanding of Roman military contexts. The present study attempts to fill a gap recognised by Richmond[1] combining a detailed investigation of all the weapons and accessories in use in the Roman period with a study of their military and developmental setting.

A problem of nomenclature arises because types of bows, quivers and bow-cases were not 'Roman' per se but belonged to Levantine or Central Asiatic traditions influencing troops in Roman service. Many items of 'Roman' arms and armour may be traced back to Gallic, Celt-Iberian or other origins so that 'Roman' must be understood as a political rather than a cultural or strictly descriptive term.

The existence and geographical extent of the Roman Empire was important in spreading the use of composite bows but not in their typological development. Syria, Arabia and Armenia within the Eastern provinces provided Levantine archers for the Roman forces but they were part of a wider tradition embracing a region stretching across Mesopotamia and Persia to India. The Roman Empire and this eastern region were directly affected by Central Asiatic nomads who were both enemies of, and auxiliaries in, the Roman and Sassanid forces. Thus archaeological finds outside the Roman sphere must be studied in conjunction with those from inside the Empire.

Composite archery became important to Roman armies with their first Late Republican oriental contacts and became increasingly so through the Imperial period. The employment of archers in Roman armies has been studied in detail elsewhere making an historical rehearsal unnecessary here.[2] Following Jones the Roman period has been understood as extending up to the early 7th century A.D. Regiments with traditional titles were in existence in Syria and Egypt at least until the reign of

Justinian and in the latter area probably lasted until the Sassanid invasion during the reign of Heraclius.[3] Hunnic and Avar material is of direct relevance because of the influence exerted by these peoples in the 4th to 6th centuries A.D. on Roman forces.

Some technical aspects of archery are relevant to all historical periods, especially with regard to composite bows (Theory, below). One particularly rich source of comparative evidence is Islamic archery literature. Several treatises have been translated and edited by linguists collaborating with archer-antiquaries. The most useful are Taybughā's Ghunyah, dating to the second half of the 14th century A.D.; an anonymous Moroccan treatise written c. A.D.1500; a manual embodying traditional and contemporary Ottoman Turkish practices written by Mustapha Kani in the early 19th century A.D.[4] These all provide invaluable information on constructional techniques, the processing of bow stave materials and on archery training exercises. A 'control' for Roman comparisons is provided by remarkably similar constructional information recorded in the 1940s A.D. with regard to workshops still working in Ch'engtu, Sichuan Province, China.[5]

The archaeological and pictorial evidence examined in the present study points to the use of composite bows in Roman military contexts. This does not preclude the employment of self-bows in training or hunting in some regions but the main concern here is with war-bows. The types of bow discussed below may have been in predominant use at various times but contemporary multiplicity of variants may be assumed.

I. BOWS

1. THE EVIDENCE AND TERMINOLOGY

The principal problem in the study of 'Roman' bows is the paucity of contemporary evidence which is restricted to one class of archaeological finds, the 'laths', to a very small number of reliable pictorial representations and to scattered literary references.

No bows have survived intact from within the Roman Empire. Only the 'ear' of one with bone laths, and horn and sinews attached to a wooden core, remains preserved by arid conditions in Egypt (Fig.32). This is not surprising because of all the organic constituents making up a composite bow-stave, only the bone or antler laths are generally imperishable. The horn material employed is taken from the outer, keratin sheath, the least resilient part of the animal's horn.[1] The Parthian bow from Yrzi, discussed in detail below (Fig.2), is thus important because so much of it survives, again in desert conditions. It is also contemporary with the Early-Middle Roman Empire and it has ear-laths identical to most of those found in Roman contexts. However, it did come from outside the Empire and in many respects it may be atypical of bows in Roman service as suggested by the Roman pictorial evidence. Comparative material from Central Asiatic contexts is just as, if not more, helpful in providing direct analogies to the Roman weapons.

When first discovered the identification of the role of laths eluded scholars. Their "curving, sabre-blade" shape was emphasised and a 'rib-knife' explanation was offered.[2] Nash-Williams in referring to a lath from Silchester, in a supposedly civilian context, commented that it was "suggestive of a connection with primary industry like weaving or netting".[3] Von Groller with reference to the Carnuntum material, and MacDonald and Park with regard to the Bar Hill examples, admitted themselves baffled.[4] An assuredly correct explanation of the problem was provided in the 1920s and 1930s by the discovery of very similar bone laths in the Eastern European graves of Asiatic nomad cultures. In particular the work of Rau, Rykov, Sebestyén and Werner proved from the positions of the laths in situ, from their association with arrow-heads and quiver-fittings, and with the use of ethnographic parallels, that the laths in Roman contexts were attached to composite bows.[5]

The pictorial evidence can be unreliable as Rausing and Maenchen-Helfen warned,[6] particularly in general discussions of the structure of ancient bow-staves. Very often a binding around the stave obscured all useful details and shape alone can present

interpretational pitfalls. This problem is not so debilitating in the Roman sphere because most, if not all, of the bows in military service were of composite construction. Different problems arise from the degree of stylisation or misrepresentation of the artist and these must be recognised so that 'reliable' representations may be distinguished. Moreover, features exhibited by a stave's profile at rest may change or disappear at full draw. Ears which are acutely angles forward when the stave is unstrung may follow the limb's curve at rest or at full draw.

Most ancient authors, like the artists, were not skilled archers or bowyers and their descriptions of bows, arrows and releasing techniques tend to be more enigmatic than helpful. They are useful for the actual deployment of archers rather than for the elucidation of bow-types in use. The partial exceptions to this include the accounts of Ammianus Marcellinus and Procopius, and an anonymous 6th century Roman treatise on archery.[7]

The laths are usually referred to by archaeological commentators as 'bow-stiffeners'. This only indicates part of their function and 'bow-levers' might be more descriptive of their mechanical action. The present writer prefers the term 'lath' used generally in toxophilogical literature[8] and it will be used throughout this study.

For general discussion of the bow several specific terms must be employed (Fig.1). When a bow is held in the archer's left hand, his left arm outstretched, the face towards the target is the 'back', that towards him is the 'belly'. The left and right sides of the stave are the 'sides' forming the 'side view' or 'profile'. The archer holds the bow by its 'grip' or 'handle', which may be set back, and the parts above and below are known in general as the 'limbs'. The flexing sections of the limbs are dustārs (Arabic), the extremities are the 'ears' or siyāt joined at the 'necks' or 'knees'. The notches on the ears which take the bow-string are the 'nocks', a term also used for the notch at the feathered end of the arrow into which the bow-string slips. The feathers are 'fletchings', the arrow-shaft is the 'stele' (Fig.8). When the bow-string is removed the stave assumes an 'unstrung' or 'reflexed' position (Fig.7). When it is strung it is said to be 'at rest' or 'braced', and when the string is drawn to its furthest extent the bow is 'at full draw'. Bows are discussed with respect to the force (weight) needed to draw them so they may be light or heavy, weak or strong, and their length or 'side measurement' is taken along the line of the stave, not along the string between the ears. Thus laths may be referred to according to their position on the stave, as 'ear laths' or 'grip laths'. In describing ear laths in detail the

end nearest to the nock is the 'upper' end, the other is the 'lower'. No inference is made from this as to position on upper or lower limbs, this is purely a convention employed for clarity. The two faces of the lath are the 'convex' (smooth and polished sloping towards the 'back' and with a steep 'belly' edge), and the 'flat' (usually with scoring and saw-marks). On the convex face at the lower end sometimes occurs an area sawn away towards the end, referred to as the 'laterally sawn section'.

2. CATALOGUE OF ROMAN LATHS

This catalogue is thought to include all the British laths but it is unlikely to be complete with respect to the rest of the Empire. The scatter of finds in the Germanies and Raetia suggests that the Danubian picture is far from comprehensive and many Roman laths must exist unrecognised or unpublished in museum collections. The British material is important because the garrison of the province is tolerably well-known. On the Continent finds from Late Roman contexts may have been left by Roman troops influenced by steppe practices, or by Alans or Huns in Roman service, or by independent barbarian forces. Laths from Carnuntum and Intercisa for example have been included because they are associated with Roman military sites, whereas the Wien-Simmering burial material, although sited within the Empire, definitely belongs to one of the non-Roman classes.[9]

The laths are listed in roughly geographical order with dating where known. Types of garrison are given with names of known sagittarii purely for reference. No relationship between small-finds and type of garrison is necessarily suggested.

1. Bar Hill, Strathclyde (Britannia): 6 antler ear lath sections found in the principia well (1), in Refuse Pit 1 (1) and in the fort ditches (4).[10] They make up five distinct laths which, judging from the back zone scoring, represent three dexter and two sinister laths if positioned on the upper ear. Two are curving, two are straight. None are paired except the longest which is a special case. This lath, 27cm long, 2cm wide, tapering to 0.9cm (Figs.9 & 10) has back zone scoring on the convex face up to the nock, but not above it. On the belly edge of the convex face a zone 45cm long at the lower end of the lath has also been scored. On the flat face scoring overlies saw-marks. Unusually this lath has a double globular copper-alloy pin through it, 1.5cm long, at the upper end above the nock. The upper end in fact effectively has two convex faces, one only 3cm long terminating in a horizontal break below which the surface is a normal flat face with scoring. This lath originally formed a one-piece 'hairpin', sawn and scored up the middle, into which the

wooden bow core would have been inserted. The space formed by the removal of a sliver of antler would have been only a couple of millimetres wide and the distribution of the scoring on the flat face demonstrates that the uppermost part was inaccessible to the scoring tool. The lower tip probably ended in a sharp point. The nock is round in profile and unworn. The rivet passes through solid antler so is clearly not structural.

A second lath 8.5cm long, 1.5cm wide has a rounded upper tip and an iron pin through it. It is one of a pair with a wholly flat face and undamaged upper tip. At the lower end on the convex face occurs a laterally sawn section suggesting that only a little of this end is missing. This sawn section appears on a third lath, 6.5cm long, 1.5cm wide, which also has a very wide zone of scoring on the convex face. A fourth lath, 13cm long, has faint saw marks overlain by scoring in three directions on the flat face. The fifth lath, 6.1cm long, tapers to a point which seems to be an alternative lower end termination to the lateral cut-off. In addition to the usual scoring scored 'dashes' appear on the convex face, unaligned with the back zone scoring. The lath curves both towards the back and out from the convex face.

A minimum of 3 bows are implied here (Theory below).

Antonine. Auxiliary fort.
coh. I Hamiorum sag.; coh. I Baetasiorum c.R.

2. South Shields, Tyne and Wear (Britannia): 2 broken bone ear laths.[11] One is 5.1cm long, 1.7cm long, and is broken off irregularly 1.8cm below the proportionally large nock. The upper tip is rounded and the flat face has diagonal saw marks. No score-lines are present but scored 'dashes' appear. On the convex face the back zone is diagonally scored above the nock.

The second lath is 8.5cm long, 1.8cm wide, with a rounded upper tip, 'U' shaped nock and light back zone scoring. It is broken off at the lower end.

Two other bone pieces from the site are not laths although published as such.

Undated. Auxiliary fort and supply base.
Non-archer auxiliaries.

3. Corbridge, Northumberland (Britannia): 5 bone and 2 antler ear lath fragments making 6 distinct laths.[12] All were found in excavations of the 1970s. Maximum lengths are 7.1-16.8cm,

widths 1.6-2.3cm. All are incomplete.

One antler lath has an almost right-angled cut-off upper tip; the other exhibits a rounded tip. One bone piece appears to have a little back scoring above the nock and a second has scored 'dashes' in addition to scored diagonal lines all over the flat face. One bone lath has a diagonally cut-off upper tip and all the others have rounded tips.

A bone object with a very coarse cellular structure on its flat side exhibits a typical lath cross-section and was clearly originally worked towards use as an ear lath.[13] Perhaps because of its coarseness the craftsman changed his mind and started to cut it up for use as a latch-lifter (?). However, one deep knife cut and the general shape suggests that even this was abandoned as a bad job. There is no scoring as seen on all the other laths.

A minimum of 4 bows are implied here.

1st-4th century A.D. Auxiliary fort and supply base.
Non-archer auxiliaries and legionary personnel.

4. Chesters, Northumberland (Britannia): 2 bone ear laths, both broken.[14] Lengths 12.5cm and 9.3cm. Both have rounded upper tips and back zone scoring on the convex sides.

2nd-4th century A.D. Auxiliary fort.
Non-archer auxiliaries.

5. Chesterholm, Northumberland (Britannia): 1 antler ear lath, 13.1cm long, 2.2cm wide.[15] It is broken at its lower end, rounded at its upper with a slight point. The edges are damaged. On the flat face longitudinal scoring is present below the nock, lateral lines above it. Four longitudinal planes exhibit saw-marks on the convex face. Scoring along the back zone is less distinct than usual and some random scoring appears above the nock. The latter exhibits signs of wear.

Flavian II. Auxiliary fort.
Non-archer auxiliaries.

6. Colchester, Essex (Britannia): 1 bone ear lath, 2.15cm long, with a broken lower end, a 'U' shaped nock and a rounded upper tip.[16] It was found in destruction debris on the Balkerne Gate site.

c.A.D.100/125-c.150. Civitas capital/early provincial capital.

7. London (Britannia): 3 sections of antler ear laths.[17] The first, 20.8cm long, 13cm wide, has lost its lower end but this very likely pointed to judge from the narrowing profile. The convex face has a 0.5cm wide scored back zone and the flat face is heavily scored on several alignments. The upper tip is rounded and there is no scoring above the nock which is too broken for comment. Two lines of scored 'dashes' appear on the convex face of the lower end. This piece was found at the Bank of England site, unstratified.

The second piece, 32.5cm long, 0.75-2cm wide, is badly split and eroded on the back edge for all but the uppermost 3.01cm. The lower end is broken off but cannot have contributed a great deal more to the length. the upper tip is rounded and the nock is 'U' shaped in profile. The flat face is coarsely sawn and is horizontally scored lightly right at its lower end and over its upper half with several alignments. On the convex face a wide scored zone is overlain above and below the nock by some randomly scored lines. The unscored zone is reduced to 0.5cm in width. Found in the Walbrook, unstratified.

The third, 25cm long, 1.4cm wide, is broken at both ends and has coarsely sawn flat face with no additional scoring. The scored back zone on the convex side is up to 0.8cm wide and the back edge is eroded all along its length. The belly edge is very sharply angled away from the rest of the convex side. Found on the Bucklesbury House site, c. 1st-2nd century A.D.

The laths curve to the observer's right, left and left respectively, viewed from the convex face. The second and third laths do not form a pair, therefore at least two bows are implied here.

c. 1st-2nd century A.D. Provincial capital.
Mixed military presence.

8. Silchester, Hampshire (Britannia): 1 ear lath, 10.4cm long, broken off at the lower end.[18] It has a 'U' shaped nock and a rounded upper tip and a back zone of convex face scoring. Found at the West Gate. Boon dated it to the 3rd century on analogy with the Caerleon material.

Undated. Civitas capital.
Mixed military presence.

9. Caerleon, Monmouthshire (Britannia): Of 215 lath fragments approximately 127 represent 'middle' ear sections, broken at

both ends, with or without a back zone of scoring on the convex side, and a varying degree of curve. These average c. 1.75cm wide, some tapering in profile. A small number can be pieced together, fewer joined to ear or lower tip sections, and overall only 4 complete, or near complete, laths can be assembled (Figs.11 & 12).[19]

The 38 fragmentary lower tip sections are mostly pointed, some sharply, but one has a square-ended tip and two are rounded. 16 curve to the observer's left, 22 to the right when viewed from the convex face.

37 upper parts are either rounded or horizontally cut-off in profile. Only one example is pointed. Nocks are semi-circular, rounded or triangular, some being very crudely cut with knife-marks suggesting unfinished work. One has two nocks of different sizes on the same edge. Another fragment has a very small, unfinished nock. 15 have nocks to the left, 22 to the right when seen from the convex face.

Only one lath survives unbroken and intact, 30cm long, 1.7cm wide.[20] It has a rounded upper tip and a gentle curve overall. Four others are complete or near complete, but in pieces. The longest, in two pieces, is 37cm long, 1.9cm wide, with a rounded upper tip and a pronounced overall curve. the lower tip is pointed and there is a wide zone of back scoring on the convex face. a second lath, 35cm long, 1.8cm wide, is incomplete at its lower end to which c. 5cm might be added in length. Overall it is very straight, curving only very slightly at its lower end. A less complete third lath, 26.5cm long, 1.4cm wide, has a square-ended upper tip and curves in two planes. Its lower end is lost but curiously the zone of concave face scoring is on the belly edge, not the back. Lastly, a complete lath in two pieces has a rounded lower end and a square-ended upper tip. It is very thin and without any scoring.

Many laths curve out from the concave face and some even do so then curve inwards again. In this respect they follow the irregular curve of the parent bone, usually rib in these cases. Some appear slightly twisted.

Another group of laths display distinctly different features to those above (Figs.13 & 14). The pieces are characterised by a 'waisted' profile, two square ends and two laterally sawn sections at the ends on the convex face. They are much narrower than the normal ear laths, c. 1.2-c. 1.8cm in width in the middle and are 12.4-16.5cm long. They are slightly curved or flat when viewed from the long edge. The second longest has scoring all over its convex face and some

of the others are characterised by a cross-section with sharply angled sides which are likewise scored. 12 fragments make up 6 complete and 2 fragmentary laths.

96 fragments of bone and antler debris or wasters were also found. One substantial piece of antler, in course of shaping, 17.5cm long, 2.5cm wide, had been roughly cut in outline, preparatory to sawing off a lath. These fragments indicate a constructional context for the lath group which is the largest from any Roman site. Other bone objects such as the scabbard-chapes found in the same building may also have been manufactured there. The crudely cut nocks and very roughly cut upper tips of the ear laths suggest that many were unfinished. Moreover, the irregularly curved ribs employed, the extremely coarse and brittle cellular structures of some bone pieces and the example with two nocks do not inspire admiration of the workmanship exercised. Several laths have knife marks across the convex face which in at least one case has caused a subsequent break. Only two ear laths make up a pair (the longest lath and one other) and in such a constructional deposit the conclusion must be drawn that most, if not all, of the laths were never actually applied to bows. Whilst none of the laths are quite as badly tooled as the Corbridge example, it is possible that some of them were 'failed' pieces and consequently discarded. As a bone-working shop the site need not necessarily have been a fabrica producing bows. Composite staves may have been constructed elsewhere in the fortress. It is very difficult to distinguish between bone and antler materials except where cellular structure makes it obvious. Ox-ribs were found on site with varying degrees of tooling. The majority of laths are most likely made of bone but a large proportion of antler is present.

The laths were found in a rampart-back building in the Prysg Field with arrow-heads, spear-heads, helmet-fittings, scabbard-fittings, ballista bolt-heads, pilum-heads, caltrops and mail. The building was constructed in c. A.D.200 and was in use until the end of the 3rd century. The finds from this workshop/weapon-store seem to date from the later part of the period.[21]

A minimum of 19 bows are implied by the fragments with nocks if they were ever applied to bows.

Later 3rd century A.D. Legionary fortress.

10. Waddon Hill, Dorset (Britannia): 1 ear lath, apparently of bone, length 11.6cm, width 1.8cm.[22] It narrows to a horizontally cut off upper end. The convex side has a wide

zone of back scoring above and below the 'U' shaped nock.

Claudian-Neronian. Invasion period fort.
Mixed garrison.

11. Velsen (Germania Inferior): A group of unpublished ear lath fragments from the harbour area.[23]

Auxiliary fort.

12. Oberaden (Free Germany): 1 ear lath, 8.5cm long, 1.5cm wide.[24] It curves to the observer's right when viewed from the convex face. Up to half of the width of the latter has back zone scoring. On the lower half of its length this is split away. How much of the overall lath length is lost is difficult to estimate. The piece comes from a well and is one of the earliest datable pieces yet identified.

c. 10-8 B.C. Lippe legionary base.

13. Mainz (Germania Superior): At least 3 ear laths have been found outside the legionary fortress together with evidence for an antler-working industry in the canabae.[25] One straight lath is possibly complete, 14cm long, 1.4cm wide, and has a sharp lower tip, a rounded upper end and a 'U' shaped nock (undated). A second from Obere Zahlbacher Strasse, 17.6cm long, 1.8cm wide, curves gently, has a rounded upper end and a very wide zone of convex face scoring. Saw-marks are very evident on the flat face and the lower end is broken off. Lastly, an incomplete lath, 7.9cm long, 1.7cm wide, has a large nock and a rounded upper tip. This piece comes from the canabae outside the south-east side of the fortress, and dates to the 3rd century A.D. A fourth ear lath, exhibiting a diagonal channel, or 'string guide', cut across the convex face from the nock, is most likely Early Medieval in date.[26]

At least 2 Roman bows are implied if the laths were ever applied.

3rd century A.D. Legionary fortress, canabae and nearby auxiliary fort.
Pre c. A.D.70 coh. I Ituraeorum sag. and ala Parthorum et Araborum.

14. Zugmantel (Germania Superior): 1 ear lath, apparently of bone.[27] Possibly unfinished with a very small nock similar to one Caerleon example. Undated.

Later 1st century to pre c. A.D.260. Auxiliary fort.

Units of non-sagittarii.

15. Heddernheim (Germania Superior): 1 ear lath of bone, length 11.2cm, width 1.7cm.[28] Rounded upper ends above 'U' shaped nock. Tapers slightly towards the broken lower end. Back zone scoring on the convex face . Found in a barrack area.

    2nd century A.D. Auxiliary fort.
    Units of non-sagittarii.

16. Stockstadt (Germania Superior): 2 ear laths, length 33.7cm, width 1.7cm and length 10.6cm and width 1.7cm.[29] The longer example is broken off approximately level with the nock and the upper tip is lost. When complete it must have been c. 35cm long. It has a scored back zone on the convex face and the lath tapers to a diagonally cut off lower end. The shorter lath has a diagonal cut-off or break and a downward inclined nock. Both laths were found in Mithraeum II which went out of use after A.D.210.

    Date unclear. Auxiliary fort.
    Units of non-sagittarii.

17. Osterburken (Germania Superior): upper end of 1 ear lath, apparently bone.[30]

    Pre c. A.D.260. Auxiliary fort.
    Unknown garrison.

18. Selz, Alsace (Germania Superior): 1 ear lath.[31]

    Undated. Auxiliary fort?
    Unknown garrison.

19. Windisch (Germania Superior): 10 ear laths found between 1904 and 1928 in the Schutthügel, lengths 8.5-22.5cm, widths 1.5-2cm.[32] Scored flat faces. All are square-ended except two with rounded upper tips. The 2 largest laths, which seem to be complete, represent one of each tip variant (length 22cm and 22.5cm) so do not form a pair. Of the others four are straight (one with rounded tip) but none of these form pairs either. 4 have the nock on the observer's right, 5 on the left when viewed from the concave face. The usual profiles and back zones scoring are present. At least 5 bows are implied here.

    c. A.D.45-100. Legionary fortress.

20. Dangstetten (later Germania Inferior): 1 ear lath.[33]

Pre c. 9 B.C. Legionary base.

21. Rißtissen (Raetia): 4 fragmentary bone ear laths.[34] Two have semi-circular nocks, and one is square-ended, the other has a slightly rounded upper end. Length 7.2cm, width 1.4cm and length 6.3cm, width 1.4cm respectively. The other 2 pieces are broken at both ends and taper, lengths 3.5 and 4.7cm. Nocks correspond but these do not form a pair. At least 2 bows are implied.

c. Claudian-Domitianic. Fort.
Mixed garrison.

22. Buch (Raetia): 2 ear laths, apparently bone.[35] Rounded upper tips and 'U' shaped nocks. One lath possibly complete. Not a pair although the nocks are on corresponding back edges.

Pre c. A.D.260. Auxiliary fort.
Non-archer auxiliaries.

23. Straubing (Raetia): 7 ear laths, apparently bone.[36] The longest and only complete example is 28.5cm long, the others are 9.4-17cm long. 4 curve to the observer's right and 2 to the left when viewed from the convex face. The complete lath is widely scored on the convex face along the back zone with a little scoring above the nock. All have 'U' shaped or semi-circular nocks. The seventh lath has been repeatedly cut into horizontally and was never used on a bow. At least 2 bows are implied here.

Pre c. A.D.260. Auxiliary fort.
Hadrian onwards coh. I Flavia Canathenorum mill. sag. (eq.?).

24. Carnuntum (Pannonia Superior): 32 bone and antler ear laths were discovered by von Groller in Building 6 by the west wall.[37] This was probably a weapon-store in use in the 4th century A.D. according to coin evidence. All are broken, ranging in length 6-34.5cm, in width 1.5-2cm. The lower tips are either blunt and rounded or taper to a point. The upper ends are either square-ended or are slightly rounded. The longest example curves to the observer's left when viewed from the convex face and is very similar in appearance to the longest pieces from Bar Hill and London. Nocks are semi-circular, 'U' shaped or rounded triangular, some exhibiting signs of wear. The usual scoring appears on flat and convex faces. Apparently, many form pairs. One has a metal pin through it above the nock, as seen on two of the Bar Hill pieces. There is some question about the date of the context because the deposit was disturbed and scholars have confusingly suggested an Asiatic cultural explanation

rather than a Roman one.

Three more lath fragments were found in the 1968-74 excavations, one in association with 1st to 2nd century A.D. glass.[38] This piece has a rounded, slightly pointed upper tip and an asymmetrical rounded nock. A second fragment is very sharply pointed so appears to be from the lower tip of an ear lath.

1st-2nd century A.D. Legionary fortress.

25. Intercisa (Pannonia Superior): 17 fragments of ear laths found outside the fort to the north and west and inside associated with Building 6.[39] They range from a near complete lath 32.5cm long to a fragmentary lower tip, 4.6cm long. Six pieces have nocks and all surviving upper ends are rounded. Most fragments have some convex face scoring and two pointed lower tips are represented. Some are clearly unfinished.

The presence of the laths within the fort suggests bow-manufacture on site. Intercisa is rich in Late Roman material but the presence of a Hunnic cauldron and the insistence by some commentators that all Danubian lath finds are associated with foederatae or Attila-period Huns complicates the dating problem. Units of sagittarii were present throughout the Roman period and there is nothing distinguishing the Intercisa laths from either 'Hunnic' finds or pieces found in Early Imperial contexts within the Empire.

At least 3 bows are implied if the laths were ever applied.

4th-5th century A.D. (?). Auxiliary fort.
equites sagittarii (Notitia Dignitatum, Oc., XXXIII,38).

26. Dura-Europos (Syria): 4 bone ear lath fragments, 2 with nocks, were found by the Joint Expeditions excavating sites in and around the town but none were published in the interim reports.[40] They will be fully described in the forthcoming Final Report on the arms and armour.

27. Belmesa (Aegyptus): The complete ear of a composite bow was presented by Flinders Petrie in 1897 to Henry Balfour for the Pitt Rivers Museum collection.[41] It had been preserved in arid conditions. This is the most completely preserved fragment of a composite bow found within the Roman Empire to date and it is immensely important for its constructional details (Figs.15-18).

The wooden core is enclosed by a pair of polished bone ear laths which are yellowed and ivory-like in appearance, overall length 15.5cm, width 2.2cm. The laths butt together above and around the nock. They touch at the back edge down to the point where the ear curves, then they diverge. On the belly they diverge exposing the core to view. The upper ends are gently rounded and there is no back zone of scoring.

Black remains of glued sinew appear on the back of the laths where they diverge. This is the most vulnerable constituent and intact fibres do not survive. However, more black material adheres to one edge of the horn backing suggesting that the ear at this point was completely enclosed in sinew leaving only the horn exposed. Diagonal score-marks on both laths across the convex faces where the curve starts suggest that the sinew was trimmed with a knife and that it did not extend up onto the straight section of the ear. The horn strip on the belly is damaged at its upper end but a horizontal knife-cut on the core, extending onto one of the laths, strongly implies that little horn has actually been lost. The line corresponds with the lath scoring indicating a similar termination level of sinew and horn on the ear. A black substance higher on the back is probably glue which had oozed out from between the laths and does not represent sinew. A thick layer of hard glue is visible between horn and wooden core and filling a place exposed to the lath fracture at the lower back. The horn is dark brown, slightly translucent and highly polished. It overlies the belly edges of the laths. There is no evidence for any overall binding but a sinew whipping, covered with black leather, binds the laths together above the nock where there is no core between them. Light scoring on the bone is visible where the binding has fallen away. The grain of the core-wood follows the curve of the ear.

Undated.

3. ROMAN BOW REPRESENTATIONS

The sculptural monuments of the Roman capital were, by their very nature, removed from the detailed reality of the frontier events they purported to depict. Nevertheless, in a few instances credible attempts were made to represent bows carried by Roman troops.

On Trajan's Column Roman archers are depicted on five occasions.[42] In Scene LXVI four archers shoot from a wood in support of a body of auxiliaries but their bows have not

survived. In Scene LXX six sagittarii fulfill a similar role. Their bows have a uniform 'segmental' curve, and the ears curl over, presumably without ear laths (i.e. they are 'whip-ended'). In Scene XXIV an archer in normal auxiliary dress shoots such a bow (Fig.19). The Daci use a similar weapon (e.g. XXIV, XXXII) as do the Sarmatae (XXVIII). Its size is comparable to bows seen in Scythian art but the Scythian bow had a set-back handle, not a segmental curve.[43] Another type of bow appears in Scenes CVIII and CXV. In the former a marching sagittarius holds a large, strung composite bow with recurved limbs. Curiously the stave does not appear to be bound because lines on its side indicate the laminated construction (Figs.22 & 23).[44] The archers in Scene CXV hold bows at full draw with strongly recurved limbs and set back handles. One bow displays curled-over ears but another does not (Fig.20).

The curled-over ears are difficult to reconcile with the lath evidence. They are a common feature of Roman deity depictions and may belong to the stylising Hellenistic element of which Robinson was so cautious.[45] Whilst curled ears do appear in the contemporary art of the Sarmaticised Crimea,[46] this feature does not occur in the Column's pedestal reliefs. Here strung, barbarian bows are represented with gently curving limbs and set back handles (Fig.21). Perhaps the curled ears and staves of Scenes CVIII and CXV are a feature of that patchy accuracy which marks the depiction of objects on the Column. Helmet details, shield-sizes and lorica segmentata fittings, for example, vary greatly in their correspondence to archaeological finds. Some are approximately correct, others are wildly stylised. The pedestal reliefs by contrast are something of a 'still-life' study in stone.

The detail on the Marcus Column is reduced to a minimum for the purposes of clarity. Overall the reliefs are more stylised and even less reliable than those on the earlier column. Archers appear in Scenes XV, XXVIII, XXXIX and LXXVIII, and a horse-archer in Scene LVII.[47] All the bows are very small and most have curled ears over which the strings are looped (Fig.24). The infantrymen appear to be Levantine symmachiarii and the horseman is a regular auxiliarius (Fig.25). It is doubtful if any reliance may be placed on these bows.

The development of stylised depictional shorthand continued to such a degree that none of the Eastern barbarians on the Arch of Septimius Severus (Forum Romanum) hold bows (surviving or in antiquarian drawings). Without the monumental context they are quite indistinguishable from Dacians, Sarmatians or other adversaries. However, an interesting contemporary (?) siege relief in S. Paulo fuori le mura depicts an archer shooting a bow with set-back handle (the ears are lost). On the Arch of

Constantine archers of curious aspect appear shooting very short bows reminiscent of those seen on the Marcus Column. These soldiers have been identified as Moors so it is difficult to know what to make of these simplistically rendered weapons.[48] The pedestal reliefs of the Arcadius Column in Constantinople apparently depicted many composite bows with set back handles but such details may merely be noted considering their non-survival and transmission through antiquarian sketches.[49]

In the West a number of figured Roman military tombstones depict auxiliary sagittarii. Unfortunately these are not as useful in supplying details of equipment as this genre generally proves to be. The 1st century A.D. stelei of Hyperanor and Abdes of the cohors I sagittariorum from Kreuznach (W. Germany) depict bows but the surviving details are insufficient for any firm conclusions to be drawn.[50] They would be weakened anyway because the overall style and other equipment details suggest that the same sculptor produced the Daverzus stele, thus casting doubt on the detailed individuality.[51] On the other hand the half-figure relief of Monimus, of cohors I Ituraeorum at Mainz is more promising. The deceased is depicted holding a bow by the grip, with the upper limb, string, and a little of the lower limb visible (Fig.28). The stave is clearly double convex with a set back handle and without prominent ears. It appears to be slackly strung because the string touches Monimus' hand and the upper ear is not bent very far back. Rather similar is the bow on the stele of Dagnas of cohors II Cyrrestarum from Salaria (Yugoslavia). In the lower dexter panel of this 'door tombstone' is a pair of sharply barbed arrows. In the sinister panel a bow is depicted strung, with a slightly canted, set back handle but again without prominent ears.[52]

A full-figure stele from Housesteads (Northumberland) represents an archer holding a bill-hook in his right hand and the upper ear of a well-depicted bow in his left (Figs.26 & 27).[53] The short ears of the stave angle forward at he necks, the limbs are well recurved and the handle is considerably set back. The marked foreshortening of the man's legs affects any calculations of the bow's side length proportional to the man's height. However, it may be noted that the upper limb is longer than the lower (23cm to 20cm). Although the bow is braced no string is depicted. The strung state is obscured by the sculptor's desire to fit the bow into a restricted space. The ears should project back onto the frame of the niche whereas the actual positions would make the string-line cross the handle obliquely rather than pass it as it should on its belly side with room to spare. The upper ear is also further back in the belly direction than the lower ear so that it might be said that the upper limb is strung and the lower is unstrung! The handle is slightly angled forward or 'canted' as appears to be the case

with Sassanid bows, but it is doubtful if the accuracy of the carving may be taken so far. The sculptor was certainly familiar with composite bows or was working to the specifications of a knowledgeable customer. If this is indeed a military tombstone it may depict a member of cohors I Hamiorum sag., stationed at Carvoran, another fort on Hadrian's Wall. It cannot be pre-Hadrianic and the style of depiction may be closely compared with early 3rd century figures of Mars Thincsus from Housesteads.[54]

There are some five cavalry tombstones depicting horse-archers. Whilst these constitute important evidence for the other equipment of the equites sagittarii they are rather crude and add little to the foregoing material. A Tiberian horse-archer from Mainz, belonging to the ala Parthorum et Araborum, draws a short bow the upper ear of which seems to be stiffened but the lower limb is unrealistically rendered (Fig.31).[55] The modelling of the figures is not to the best contemporary standards and the deceased appears to be nocking three arrows at the same time! A second stele at Mainz, dating to the second half of the 1st century A.D. (?), belongs to an eques singularis Augusti, and the figure is even less well-proportioned (Fig.29).[56] Both ears of a small bow curve towards the back, suggesting a reflexed bow, but it is too crude to support further comment. The man has drawn his bow in such a way that the stave and string encircle the horse's neck! Clearly the sculptors of these two stones were not familiar with their subject. Two very similar tombstones of equites from ala I Augusta Ituraeorum sag., dating to the first half of the 2nd century A.D., have been found at Gÿor (Hungary)[57] and Tipasa (Algeria)[58] (Figs.30 & 32). They both depict a very small bow with set back handle. The similarity between the two horsemen is striking but they are too crudely executed for detailed discussion. Lastly, a 1st century A.D. stele from Walbersdorf (Austria) of an eques of ala Scubulorum depicts a horse-archer charging a kneeling adversary.[59] The archer draws a slightly longer bow than that seen on the preceeding two examples. All that may be said about the bows on these five stelei is that they are short, as may be expected of bows to be used on horseback.

Palmyrene sculpture hardly ever depicts bows being drawn and when associated with stylised cuirassed gods the strung bows are small, asymmetrical and of dubious value. Rider-gods only appear with unstrung bows in bow-cases though occasionally the stave profile strongly suggests the application of ear laths. Most useful are the pages which appear associated with funerary banquet reliefs.[60] These figures often carry hunting equipment, including strung bows at rest very similar to those with set back handles on Trajan's Column (Fig.34). No details of laths or stave construction are provided but the staves are medium-sized

(compared with the archer), have recurved limbs and ears which are not angled forward. The best examples appear to be asymmetrical with a longer upper limb and a canted handle.

Several Roman deities were normally depicted bearing a bow, notably Hercules, Diana, Atys, Cupid and Apollo. These attributes are almost always a stylised version of the small Scythicus arcus and consequently of no value to the present discussion. Bows carried by Mithras and his attendants, with the exception of the Dura mithraeum frescoes, exhibit no useful features.[61] A signal exception is an oolite statue of Atys from London.[62] The deity is depicted with a bow cradled on his left forearm which is unusual in being seen from the back of the stave (Fig.35). The sculptor has scaled it down ridiculously but preserved the aspect of the working limbs which rapidly widen out above and below the grip. They taper towards the ears and here the sculptor has compromised, perhaps to clarify his subject, because the ears are turned over to reveal their profiles and nocks. They are narrow and bulbous at the tips, the upper being turned over to the observer's right, the lower to the left. Ignoring the overall diminution this is a good rendition of a composite bow corroborated by the Yrzi example (Fig.2) and more modern bows.[63]

Rather unexpectedly Late Roman mosaics from Syria prove to be of some value for their inclusion of archers in hunting scenes. The 'Worcester Hunt' mosaic from Daphne has a vigorous horse-archer holding a large bow at full draw (Fig.36). The handle is very long and stiff, the ears have been damaged but the overall aspect is very realistic.[64] The 'Trichinos' hunt mosaic from Apamea Syriae depicts a pair of archers with bows also at full draw (Fig.37).[65] These staves are strongly recurved with stiff handles and it takes very little imagination to see in the mosaic details the delineation of ear laths and horn belly strips. Unfortunately the 6th century Great Palace horse-archer in Constantinople has lost most of his bow (Fig.38).[66] A strung bow also appears on a 4th century AD silver dish displaying very short working limbs, a well set back handle and long, stiff ears, angled at the knees.[67] Its proportions stongly suggest Sassanid influence.

4. COMPARATIVE EVIDENCE

The Roman evidence discussed above is rather scant. Many of the artistic depictions are unreliable. Apart from the Belmesa ear only the bone or antler laths from Roman bows survive archaeologically. It is inevitable, therefore, that comparative evidence be sought from the areas adjacent to the Empire and from

other, more or less contemporary, cultures.

It is true to say that the Roman period is the only time in which composite archery employing the hand-bow was widely employed in Western Europe. This was a function of the Roman Empire's spheres of interaction with the Near East and Asia.[68] There existed what might be termed the 'Near Eastern' or 'Levantine Tradition' and the 'Steppe Tradition'. These were not mutually exclusive because of the areas of joint influence, such as India, Persia and the Roman Empire itself, and because the Parthians who constituted the greatest Mesopotamian influence on Rome originally came from Central Asia bringing new bow-types with them. Something of a synthesis was brought about in the areas of the Early Islamic conquests but by the Late Omayyad period the Steppe Tradition was dominant and remained so into modern times.[69]

Mountainous areas where hunting was at long range and where closing with an enemy was difficult were particularly favourable to the development of archery skills. The Cretans and Armenians amply demonstrated this but even greater skills were exercised from the back of a horse in favourable countryside.[70] The plains of Mesopotamia and Syria, with access to suitable horse breeds and bow materials, was a region which saw from the Late Hellenistic period onwards the dominance of horse-archers in warfare and the concomitant developments in armour for protection against their arrows.[71]

A near complete bow was discovered within the Parthian sphere at Yrzi, near Baghouz on the Euphrates, dating between the 1st century B.C. and the 3rd century A.D. (Fig.2).[72] The wooden grip and one limb are intact. Only a short section of horn belly survives in the grip area. The sinew backing remains around part of the grip and approximately one-third of the length of the surviving limb. Some overall sinew binding appears also around the grip and on the belly of the limb. One pair of laths is 22.5cm long, the other is 19cm. There are no grip laths. The wooden core consists of two long limb section (wood unidentifiable) scafed together with two oak and elm grip sections making for a very long, stiff handle. The profile of the stave when strung and drawn is difficult to determine without a working reconstruction (Fig.7). Even then differences in proportions of the constituents could have affected the profile considerably but it is likely to have been a slightly flattened segmental curve. Assuredly the bow was without a set back handle or sharply forward angled ears but had asymmetrical limbs. The side measurement was c. 147cm. The wood, horn and bone laths were scored to increase glue adhesion.[73] The ear laths are identical to those found on military sites within the Roman Empire, having rounded tips, 'U' shaped nocks and back zone

scoring on the convex sides. Mr Edward McEwen kindly informs the writer that his working replica, in course of construction, has a draw-weight of 60-70lbs. Rausing saw the whole bow as typical of those in Parthian use.[74] The bows employed by the Roman auxilia, numeri and irregular symmachiarii he judged to be of one type which he termed the 'Yrzi Bow'. The presence of ear laths distinguished it from his 'Scythian' type and the absence of grip laths (and a set back handle) from his 'Qum-Darya' type.[75]

A similar bow in Parthian use is seen on a terracotta plaque in the Staatliche Museum, Berlin (Fig.39).[76] A galloping horseman holds his bow at full draw with only the upper limb visible. The curve of the stave strongly suggests the lever action of a stiff ear. The handle does not seem to be set back though the profile at rest may have exhibited this feature. A beaker discussed by Rostovtzeff has a bow drawn back so far that the handle profile may not be gauged.[77] It is likely that the use of ear laths was introduced by the Parni in the mid 3rd century B.C. because no laths appear in the Achaemenid contexts.[78]

The present writer objects to the 'Yrzi' classification on the grounds that the bow found near Baghouz was not necessarily typical of those in wide 'Roman' employment. The few reliable Roman pictorial representations suggest that a set back handle was a common feature. Contrary to Rausing's assertion there is evidence of grip laths in Roman use (see below).[79] Where care is taken in the depiction of bow profiles in Dura graffiti (to which 'Roman', 'Palmyrene', 'Parthian' or 'Sassanid' labels are equally applicable) they are virtually all with set back handles and strongly recurved working limbs. The assumption that the single surviving bow from Yrzi is a representative sample is, therefore, unwarranted.

The Dura evidence points the way towards another bow type conveniently termed 'the Sassanid Bow'.[80] This is best observed on Sassanid silver dishes where mounted kings are depicted hunting animals with bows (Fig.44).[81] The latter exhibit well set back handles, proportionally very short, curved working limbs and long stiff ears. The upper limb is often longer than the lower when both are visible and the handle is generally canted forward. It must be assumed that the ears are stiffened with laths, the upper pair longer than the lower it seems. In some cases the constituent materials of the limbs may be indicated, and this is best seen on a 4th century A.D. Kidarite bowl in the British Museum.[82] Here the stylisation of the relative ear to dustār proportions marking the Sassanid dish representation is less-marked. Lines on the dustārs may indicate horn and sinew construction. The ears are sharply angled at the knees. The Kidarite link with Central Asia of course raises the problem of

how far the Sassanids were influenced directly by Asiatic practises. Similar bows appear on a 3rd to 2nd century B.C. Greco-Bactrian bowl suggesting on early development of the type. On the Sassanid dishes bows are often shown over-drawn with too great an angle between string and ear. Paterson reconstructed these bows with 18-20cm long ears, reducing their proportions to the dustārs considerably, calculating an overall side length of 130cm for the stave (Fig.7).[83] The hunting scenes at Tāq-i-Bustān contain less stylised bows seen both in braced and in full draw positions (Fig.40). The lever action of the ears is clear but the angle of the knee is far less acute and at rest the ears lie approximately parallel with the string.[84] The bow's profile at full draw is very similar to that suggested for the Yrzi bow, the set back handle disappears, and perhaps this represents a third stave variant.

Whether or not the profile of the Yrzi bow is representative of bows in use by Roman forces it is vitally important for its information on constructional materials and techniques. The Belmesa ear is of little help in discussing stave proportions but again the relationships of its constituents are very important. It may be the case that the Yrzi bow represents the earlier Levantine tradition with the specifically Parthian addition of ear laths. This might suggest that the set back handle was also a Parthian period innovation influenced by steppe practices. Whatever the evolutionary relationships it must be noted that bow types can never be exclusively applied so that 'Yrzi' and 'Sassanid' bows may be seen as contemporaneous variants.

The Steppe Tradition impinged directly on the Roman frontiers along the Danube and around the Black Sea. Each wave of nomads following the 'steppe gradient' bore modified bows differing in size, construction and proportions from those of their Asiatic predecessors. The Scythian bow was very small, c. 75-100cm side length, and was whip-ended. No laths appear in Scythian cemeteries and bows were represented in contemporary art with curled ears.[85] These went into the classical repertoire and appeared in the Roman period born by deities. Before Hunnic contacts, laths are lacking in Sarmatian contexts and this explains the whip-ended bows depicted on the Crimean tomb reliefs and tomb frescoes.[86] the Greek cities of this area were heavily Sarmaticised, particularly in weaponry, and it is likely that a Scythicus arcus form was used by Arrian's cohors Bosporanum.[87] The Thracian alae and cohors sagittariorum probably also carried this weapon given the long Thracian history of mounted skills and Scythian contacts.[88]

Thraci and Bosporani apart, the Steppe Tradition was far subordinate to the Levantine before the Late Imperial period. Sarmatian contacts were influential in the use of the contus and

of increasingly heavy forms of cavalry armour, but there is no evidence for the Roman adoption of Sarmatian bows.[89] On the contrary, Levantine sagittarii were greatly favoured for use as a counter to Sarmatian and the latter's archery may have been inferior.[90]

This situation changed dramatically with the appearance of the Huns in the West. This Turkic horde brought a bow radically different from the Scythicus arcus. Rausing termed it the 'Qum-Darya Bow' from the type-site at the mouth of that river.[91] The alternative, 'Hunnic', begs questions of nomenclature for the Central Asiatic peoples so will only be applied here with reference to the forces of Attila, Ruga etc. The type-site was in fact not 'Hunnic' but Han Chinese.

The bow itself was found in Mass Grave 1 and was preserved almost intact because of arid conditions. The cemetery was associated with the Chinese frontier post of Lou-lan and the deposit dated by analogy to c. 1st century B.C. to 3rd century A.D.[92] One photograph exists of the bow complete, from which a measurement of 140-150cm, ear to ear, was calculated, but the stave was broken up on a camel-back journey before it could be examined in detail (Fig.42).[93] Only the upper half of one limb (Piece A) and the ear of the other (Piece B) now survive (Fig.4). It was, incidentally, very similar in profile to the bow in Scene CVIII of Trajan's Column (Fig.23). The ears curve without a change of angle at the knees. Piece A, 339cm long has a surviving wooden core, a horn belly strip and a sinew backing on the back and sides up to just below the nock. The ear laths have a rounded lower end, a horizontally cut-off upper end and a 'U' shaped nock. They are 25.5cm long, 1.5cm wide. Piece B, 31.5cm long, has its wooden core and a horn belly consisting of two overlapping strips. The sinew backing survives for much of its length as does a sinew binding over one section. The ear laths have been lost except for the end of one (7.5cm length remaining) which tapers to a point. An overall lath length of 32cm was rather dubiously calculated. A grip lath is identifiable from other surviving fragments, apparently with a wedge-shaped end.[94]

Fittings from this type of bow appear right across Asia from Korea to the Crimea.[95] Alanic graves in the Volga region dating to the 3rd to 4th century A.D. signal the adoption of the Qum-Darya type by Sarmatian peoples from Hunnic groups advancing from the East. It was these Alanic deposits which led to the original identification of the role of ear laths, not only for Eastern European contexts but also for the Roman material.[96]

Hunnic finds per se appear along the Volga, in the Crimea, and in Western Europe on sites such as Blučina and Wien-Simmering.[97] This has led to a good deal of confusion

between 'Hunnic' and 'Roman' contexts, notably at the latter site. Researchers keen to extend the body of Hunnic finds have gone so far as to assume that all laths are Alanic or Hunnic representing Asiatic troops in Roman service.[98] The Carnuntum group (Catalogue No. 24) has been interpreted in this way and indeed the disturbed stratigraphy does not make a Roman Waffenmagazin context assured.[99] The finds in Britain, however, are of course securely Roman, despite Maenchen-Helfen's fictions.[100] One lath from Mainz with a string-guide is likewise insecurely dated. The guide appears on other, definitely Hunnic pieces.[101] There are also problems with the Intercisa laths.

In general, Hunnic/Qum-Darya bows had two pairs of ear laths identical in every respect to those found on Roman limes sites.[102] The only difference is that there are proportionally a greater number of longer laths (like those Roman examples from Bar Hill and London). In addition the grip of the bow was stiffened by three laths. On the sides were glued a pair of trapezoidal laths with their longest edges towards the back. On the belly was glued a third lath, varying in shape but often narrow with parallel sides and splayed ends.[103] Therefore, each bow possessed seven grip and ear laths, compared with none on the Scythian and Sarmatian bows and four (ear) laths on the Yrzi bow. The bow may be reconstructed with a set back handle and asymmetrical limbs, c. 130-60cm long overall to judge from lath positions in situ.

A rather more spectacular Hunnic practice was to sheath model bows, or cover only the ears of working bows, in gold sheeting. Two-thirds of a model bow's sheathing was found at Jacuszowicze (Poland) and stippled decoration carefully outlined the shape of the ear laths as they would have appeared on a real bow. Golden ears from working bows appeared at Novogrigorjevka, Borovoje (Russia) and Pécsüszög (Hungary). The latter exhibits a rivet-hole above the nock passing right through the ear. Both ear sheaths were recovered and the holed piece exhibited a tapering upper end whilst the other piece was square-ended.[104]

Hunnic skills in horse-archery were profoundly influential on the Roman Army of the 5th to 6th century AD.[105] It is most likely that Levantine bows in Roman use were superceded by the Hunnic type for at least the best quality archers. Both Avitus and Aetius are recorded as having been skilled archers, one surpassing the Huns (panegyric!), the other taught archery and horsemanship by them whilst in captivity.[106] Stilicho employed Hunnic troops as did Belisarius whose personal archery skills Procopius mentions.[107] Roman cavalry in the campaigns described by Procopius, with their Hunnic allies, were almost all bow-armed and devastatingly effective against Germanic adversaries.[108] There is no evidence as to what type of bows the psiloi used.

Unfortunately, because of changing burial practices the laths do not appear in Late Roman funerary contexts, although they do occur in some Frankish and Alamannic graves.[109] Bivar saw Procopius' description of Roman and Sassanid archery at Callinicum as a confrontation between 'Hunnic' and 'Sassanid' bows, the advantage being with the former.[110]

The next wave of nomadic invaders were the Avars in the later 6th century AD. Maurikios' Strategikon demonstrates the influence this people had on Roman military equipment. Avar lamellar armour, saddles,gorgets, stirrups, horse-armour, lance-pennons, belts, cloaks and, one may add. bows were adopted.[111] The numerous laths from Avar graves reveal a number of bow modifications demonstrating that the Qum-Darya bow was superceded by an 'Avar' type.[112] This differed radically in the number and shape of the laths. The grip laths stayed essentially the same except that a fourth piece was sometimes glued to the back of the handle enclosing it with bone on all four faces. The belly lath was often parallel-sided with splayed ends.[113] The ear laths became much wider in profile above the nock and less rounded, giving a bulbous aspect. The nock was often further away from the upper end than on Qum-Darya type examples.[114] Additional laths were usually added to the belly and back of the ear thus enclosing both ends of the stave on four faces. This made a total of up to 12 laths on an asymmetrical bow with stiff, set back handle.[115] Examples measured in situ suggest bow lengths of 120-40cm. When unstrung the ears reversed sharply forward at an angle of 50-60°. Some ear laths, for example a pair from Üllő, have a rivet-hole near the upper end and several pieces from Feherto B and Gátér (Hungary) actually had bronze rivets surviving in place.[116] Working reconstructions of Avar and later Magyar bows have been made with great success by Dr G. Fabian.[117]

A clear picture emerges of the Hunnic and Avar bows in Late Roman use, each type incorporating modifications in design and, presumably, improvements in performance. Apart from the original identification of laths as bow fittings, two features of these steppe laths add to the understanding of Levantine bows in Roman use. Firstly the Hunnic and Avar belly grip laths are identical in size and shape to the group of eight laths from Caerleon (Figs.13 & 14; Catalogue No. 9). Without reservation the latter may be identified as grip laths and a bow with five laths must have been in Roman use, at least in Britain. The number of finds from the Roman East or Mesopotamia is small and it is not at all surprising that no others have appeared on Western sites but with the present publication of the Caerleon pieces it is hoped that this class of artifact will be recognised elsewhere. Secondly, rivets were put through the ears of Hunnic and Avar bows in a similar fashion to the rivets in the Bar Hill and Carnuntum

examples (Catalogue No. 1, 24). These are clearly not structural, as proved by the Bar Hill one-piece pair (Figs.9 & 10). Some other function must, therefore, be sought. For the Bar Hill examples Macdonald and Park suggested a suspension role without knowing the bow-attachment of the laths.[118] This seems to be the only reasonable explanation which presents itself. When stored unstrung English longbows were hung by a ribbon tied around the upper ear. Any good composite bow must be unstrung when not in use to retain the elastic qualities of the sinew backing. To keep out the moisture the Ch'engtu bowyers kept bows stored in a drying cabinet over a charcoal brazier. On the other hand Lt-Cdr Paterson sees no need for the rivet, and suggests that bows would have been hung up by the nock or in a bow-case from a strap.[119]

5. THE COMPOSITE BOW: THEORY

Rausing defined the composite bow as "any weapon where the constituent layers of the stave have been joined with any kind of adhesive, and where the materials employed have been selected so as to make the back stretch around an incompressible belly, and where at least one ingredient, generally wood, gives the necessary dimensional stability".[120] In the examples from Belmesa, Yrzi and Qum-Darya the stave was bellied with horn and backed with sinew. This is the case with surviving Mongolian, Manchu, Indian, Persian and Turkish bows and, it must be concluded, these materials were in general Roman use.

The thin wooden core provides adhesive strength and the general shape but plays a minor part in the bow's physical actions. When a stave is drawn the horn belly is pulled into a compressed curve and the back sinew is stretched. The bow is constructed to elicit the maximum distance of curve and stretch by making it in a 'reflexed' shape so that it reverses itself when unstrung (Figs.2 & 7). The extra distance from the reversed to strung positions gives a greater potential energy storage than with a straight self-bow stave. Small Turkish flight-bows reverse into a 'C' shape with the ears almost touching. Longer bows, such as that from Qum-Darya, assume a squarer 'C' or a very shallow 'V' shape. Thus the materials are used to create an artificial elasticity whereby on release the belly springs back and the backing pulls the stave to a rest position.[121]

The superior properties of horn and sinew allow the stave to be much shorter than a comparable wooden construction, and for the limbs to be drawn through a greater arc.[122] Scythian and Sarmatian bows demonstrate this shortness which is convenient for horseback use and the crudely depicted bows on Roman horse-archer tombstones may reflect this (Representations above). However, "it is unlikely that an archer could shoot as strong a bow on

horseback as he could on foot. Though the main power comes from the shoulders and the back muscles, with the arms playing a relatively minor part, when shooting a powerful bow an archer normally needs a firmer footing and, if the ground is slippery, he may have difficulty in controlling his bow. Some loss of such support would naturally result from shooting from the saddle so that the mounted archer would probably have used a slightly lighter bow on horseback than he would have used on foot".[123] For this reason units of infantry-archers, for example those in Roman use on the Parthian front, would have been of great tactical importance in confrontation with horse-archers because of their ability to outrange them and to cast heavier and thus more penetrative arrows.[124]

It is not always the case that bows used on horseback were short, however, and the trend in central Asia was for an increase in length over time, but a composite design still made for a weapon mechanically superior to a wooden stave. One advantage is the possible increase in draw length. This depends initially upon the length of the archer's left arm and the width of his chest. In addition he may draw the string to various points: to chin, ear or right shoulder. If the handle of the bow is set back, as on the Qum-Darya or Housesteads bows, this draw distance may be slightly increased. The greater possible curve of the composite limbs allow for a proportionally longer draw and the addition of long, stiff ears increases this by allowing a greater angle between string and ear. The angle of the 'V' of the string at the hand depends upon the variant of the 'lock' or 'release' employed (below, Thumb-Rings and Bracers).

The bow's handle must be rigid and not bend with the limbs during the draw because if it does the bow will 'kick' when the stave returns to rest. The handle of the Yrzi bow has a scarfed construction designed to stop it from curving. The Qum-Darya bow and at least some in Roman use, as evidenced by the Caerleon finds, had a lath attached to the grip for this purpose. Hunnic and Avar bows went further with the addition of laths to three or even four faces of the grip. If the bow kicks it can be uncomfortable for the archer's hand and impart inaccuracy to the arrow at the last moment of leaving the string.[125]

Ear laths performed a specifically mechanical function only partially intimated by the term 'bow-stiffeners'. The stored energy of a bow, and from it the force of impact and distance of cast, depends upon the archer's strength and length of draw, thus the weight of the bow he can use. The weight and draw-length of two bows with different constituents, but the same weight and draw-length, can be plotted on a graph as a 'force-draw curve'.[126] This demonstrates that when an English longbow, for example, is drawn the weight experienced by the archer builds up

uniformly over the draw but increases markedly, or 'stacks', towards the end. However, with a stiff-eared composite the weight builds up quickly for the first half of the draw but in the second half the rate of increase slows appreciably. This is because the stiff ears act as levers pulling the flexible dustārs back mechanically.[127] Paterson comments that "When shooting this bow it feels, as the shoulder and back muscles come into exerting their power, that the pull on the bowstring reduces, though this is not, in fact the case".[128] For a given exertion the composite stores more energy and with the addition of stiff ears avoids 'stacking'. The latter makes it difficult to hold the string at full draw with the hand tending to 'creep' forward or 'shake' under the strain. It is crucial that the last part of the draw be perfectly executed in order to hit the target with consistent accuracy. The Housesteads Archer's bow and some weapons in Sassanid use seem to have had ears angled forward at rest (Figs.27 & 40). The main advantage of this during release is that at the moment the string hits the knees of the stave it is effectively shortened and the arrow is given a final 'push' before leaving the string.[129] Avar bows reconstructed by Fabian working from the angle of ear laths in relation to grip laths as found in undisturbed graves, also have such forward ears.[130] It might be suggested that the additional ear laths were designed to protect the ear from the impact of the string which could adversely affect the cohesion of the components. The addition of ear laths to wooden bows would be unnecessary and might even lead to damage of the limbs by the lever action.[131] Thus the incidence of ear laths in Roman contexts is in itself an indication of composite bow use.

The occurrence of pairs of ear laths of differing lengths on the Yrzi and Qum-Darya bows, and from Hunnic and Avar weapons, leads to the conclusion that such bows had asymmetrical limbs. This is clearly seen in artistic representations discussed above, notably of Scythian and Sassanid bows. Surviving Middle Eastern bows have symmetrical limbs and could be used either way up in the heat of battle but Taybugha's Mamluk Syrian bow had an upper limb and ear slightly longer than the lower as did the bows recommended in the 15th century Moroccan treatise.[132] This is logical because the arrow passes above the hand on the grip, not along the grip's mid-point. The comparative properties of the limbs had to be carefully adjusted to compensate but this is not a problem as the Japanese longbow most clearly demonstrates. This was held with two-thirds of its length above the hand to enable it to be shot from horseback (not done with the English longbow) or whilst the archer was kneeling.[133]

The longest Roman laths and those with rivets for suspension may thus be attributed to upper limbs. However, Alfoldi positioned the longer ear laths on the lower ear of his Hunnic

bow reconstructions.[134] He reasoned that the string was permanently affixed to the lower ear and when the bow was strung it was slipped over the upper. He thought that the upper limb was the one pulled back during stringing so it had to be more flexible than the lower which was stiffened for a greater length by his longer lath positioning. Brown followed this reasoning for the Yrzi bow.[135] Against this it must be said that there is no need to permanently tie the string to one ear. On the contrary it would be far more convenient to remove it altogether when the bow is not in use. The risk to the string from damp would be obviated by storing it in a pouch with spares. Although Alfoldi was quite correct in supposing that the string was slipped into the lower nock first, especially on horseback, performance after release was the governing factor in limb-design, not ease of bracing.

The very longest Roman ear laths all have rounded upper ends as do both sets of the Yrzi bow laths. The ends of the longer Qum-Darya laths are missing but the shorter ones are square-ended and it might be suggested that the lower ears of some bows were so treated. The shorter delineated Jacuszowicze golden 'laths' accord with this. However, there is no consistency amongst Roman (or Hunnic) laths, short examples with rounded ends surviving complete in large numbers. Moreover, it is obvious from the variety of Roman lath lengths that there was a great variety of bow lengths and proportions in use. This is unsurprising considering the temporal and geographical distribution of these finds and the variety seen in artistic depictions.

The positioning of the longest laths on the longer, upper limb of the bows used by Roman forces aids in the estimation of the minimum number of bows represented by a given assemblage (Lath Catalogue). Two non-matching laths could come from two different bows or just two ears of the same bow. Ten non-matching laths constitute a minimum of five bows, and so on.

In Hunnic and Avar funerary contexts very few complete weapons were deposited, defective weapons being substituted.[136] A custom-made bow could, with care, last an archer for his entire life and indeed 18th century Ottoman bows may still be shot today. Neglect resulting in damage from damp and insects considerably shortens the working life.

6. THE COMPOSITE BOW: CONSTRUCTION

The construction of a really good composite bow demanded the utmost skill and craftsmanship as the major sources of comparative information stress throughout. The basic properties of the materials are unchanging, as are the best methods of

treating them.[137] Consequently the constructional processes described in the surviving 14th to 19th centuries AD archery manuals are remarkably similar. Likewise methods and tools applied in the Ch'engtu bow industry in China are closely comparable. The design, proportions and choices of materials for the stave vary with availability, geography, climate and function (for war, hunting, target shooting or flight shooting). Climate may have been very important judging from the Moroccan treatise which specified adjustments in limb-widths, core thickness and amount of sinew applied according to local conditions.[138] Weight, draw-length, amount of recurve, presence of a set back handle and inclining forward of the ears are other variables. The exact choices of materials made by Roman arcuarii cannot in many cases be proven but the recommendations of more modern experts and the conclusions drawn from modern reconstruction work may be taken into account, subject to availability to Roman craftsmen.

According to Taybughā "the fashioning of a bow calls for more competence than anything else if a truly good weapon is to be obtained. Its manufacture also calls for more patience, since it cannot be properly completed in less than a full year. Autumn must be devoted to the carving and preparation of the wooden core on the one hand, and to the sawing and fitting of the horn on the other. Winter is the season for binding and reflexing, and the at the beginning of the spring the sinew is applied. Next, in summer, the bow, as yet unfinished, is strung and rounded to the curvature required. It is then veneered and painted".[139] The four seasons are used to obtain optimum conditions for glue-setting.

For a good bow a full year was the minimum time period. Inferior staves could be produced over a shorter time dependent on the glue drying sufficiently. The physical work of fashioning and glueing the components may take as little as eight full days.[140] Luschan quoted a period of five to ten years for Turkish bows and those produced at Ch'engtu each took three years' work.[141] These longer periods were partially dictated by careful gathering of materials at the right seasons but treatises often recorded practices in periods of marked decline in customer demand.[142] Paradoxically high levels of craftsmanship and pure virtuoso work were being exercised as a result. It is true that Taybughā was writing in a period when archery and bow-construction had been developed to unequal levels of skill but he was an expert horse-archer himself writing a practical manual for warriors. Thus, his full year is a good framework on which to base a discussion of construction, given the undoubted contemporary demand for bows and the logical use of seasons for glue-drying. Taybughā stated that the best bows were made in Syria, so his remarks on climate and materials must be seen in

this context.[143]

The first task in composite bow manufacture is the construction of the wooded core (Fig.5.1). Maple, cornus and mulberry woods were preferred in the Levant.[144] The handle should be oval in section, the limbs elliptical, rectangular or 'D'-shaped, a few millimetres thick, and the ears triangular or 'D'-shaped. The belly is usually flat or slightly convex (Figs.2 & 4).[145] The choice of pieces demands great working experience if irregularities of grain patterns are to be accounted for. The actual component make-up can vary widely from region to region. The most complex forms have a hardwood grip section, two dustārs,, two ears and two ear inserts with nocks, making a total of seven sections.[146] Fewer are seen on Medieval-Islamic bows with the whole siyah in one piece. These are all joined by 'V'-form splices and glued.[147] The Yrzi bow has four sections, two for the limbs and two laterally applied grip sections scarfed together (Fig.2). Only the wood of the latter, oak and elm, was identified by Brown.[148] The Qum-Darya bow was not examined before the grip area was lost. Both ears, however, seemed to have additional wooden strips attached to the back of the core. From published drawings (Fig.4) it is not clear how these pieces were related to each other but they may have served to deepen the ear profile ('stacking' them).[149] The resultant rectangular section, quite different from that of the dustārs, contributed to the lever function of the ears. The evidence indicates that the cores of the bows used by Roman forces might have had continuous cores from ear to grip with a separate piece(s) for a stiff handle. Fish-tail splicing was employed by Islamic craftsmen to achieve the necessary core curvature in preference to shaping with heat.[150] A combination of spliced grip section and heat-curved limbs may have been the Roman period practice judging from the occurrence of Roman grip laths. These would have been made redundant by the Yrzi scarfed method. The wood must absorb glue well and the core must be very carefully assembled and shaped to prevent lateral twisting and fracture during the draw.[151]

Glueing is the method used throughout the construction for attaching the components to the core. These would have been bound together during the setting process but neither binding nor other methods such as nailing play a part in the final stave cohesion. The glue itself is produced from tendons simmered in rainwater. The liquid is strained off and then evaporated to a viscous solution then cooled and gelled so it may be stored indefinitely. In this viscous state it is clearly visible between the laths on the back on the Belmesa ear (Fig.16). It only has to be heated through again for use. Variants of fish glue were preferred in the Ch'engtu workshop and for slower setting Turkish bowyers favoured glue made from the roof of the

mouth of the Danubian sturgeon. Heating at all stages of construction is done over charcoal braziers.[152]

Judging from the Belmesa ear and the longest Bar Hill lath the tips of the core should be extremely fine and triangular. Von Groller calculated that the Carnuntum lath with a nail formed a pair enclosing something no more than 3mm in width and the longest Bar Hill lath had an even finer tip inserted into it.[153] As already remarked, the rivets had no constructional role.

Both bone and antler materials were employed for ear laths but antler is much the tougher of the two. It is less likely to break under sudden loads and less vulnerable to weakening by small notches and nicks cut into it or accidentally incurred in use. Several Caerleon bone laths broke along lines made by non-functional knife-cuts. There is evidence to suggest a preference for antler over bone in some Roman contexts for these reasons.[154] However, it is often very difficult to distinguish the two materials in Roman laths. Most reports assume bone, but both were used at Caerleon and Carnuntum. The Bar Hill and London examples are all antler and their waterlogged contexts have given them a characteristic staining not present in the Caerleon deposit. Only when the cellular structure is visible can definite conclusions be drawn because bone laths may be cut from the thick, outer material of long bones avoiding the weak, springy inner cells. In the finished bow the choice of material might not have been very significant but if it was dropped or given a hard nock the laths might be more easily chipped or cracked if made of bone.

It is likely that the ear laths were applied to the ears of the core before the other materials. The Belmesa laths are overlain by the belly-horn and the sinew backing. Most unusually they do not have a back zone of scoring up to the nock but with nearly all the other Roman laths this feature is probably designed to give a better purchase to the sinew material. The zone of belly scoring near the lower end of the longest Bar Hill lath and one of the Caerleon pieces strongly suggests they were overlain by horn. The laterally sawn sections on the convex faces of the other Bar Hill laths may have been intended simply to present an unstepped surface for the sinew on the sides of the stave. The position of the grip laths in the constructional sequence is less clear. Those with splayed ends may have been applied directly to the core with the laterally sawn sections overlaid by the belly-horn, the sawn sections making a less broken surface for the overall binding (Fig.1). The steep long edges of some of these laths appears to be scored so the sinew backing on the sides of the stave probably abutted against them. Thus the grip lath would be glued on after the horn but before the sinew. The Yrzi bow's grip had horn along its length (Fig.2)

as do more modern bows.[155] Most of the Roman ear and grip laths, like those in position on the Yrzi bow, are heavily scored on the flat face in order to improve glue adhesion.

Filing and smoothing of the core in addition to heat-shaping is carried out before the next constructional stage. The cooler weather and higher humidity of autumn in Taybughā's scheme allows for a slower glue setting rate, imparting superior adhesion to that possible in hot, dry weather.[156] During this process the horn for the belly must be prepared. It must only curve on one plane, not twist and must be long enough to serve most of, if not the entire length of one limb. Experimentation has shown that horn from Western domestic animals tends to be too friable and splits into thin layers when subjected to stress.[157] In Roman contexts the Celtic shorthorn (Bos longifrons) would have been quite unsuitable. In the Levant the long-horned caraboa or Indian Buffalo (Arni, Bos bubalis) was available together with the Armenian Wild Sheep, or Asiatic Mouflon (Ovis orientalis typica) and wild or domestic goats.[158] Two strips from each animal horn, on the outer and inner curves could be used. It is unclear how the horn was laid on the Yrzi bow because so little survives. On fragment B of the Qum-Darya bow (Fig.4) two strips of horn are present, the piece on the ear underlying that on the dustār. Perhaps longer horn was not available to the bowyer. The horn on the Yrzi bow is only 2.5 to 3mm thick. The outer keratin layer is employed so the horn is perishable, prone to insect damage and semi-translucent.[159] Horn on the Belmesa ear is a light brown in colour. On Turkish and Sino-Tatar bows it is black or dark grey.[160] The short dustārs associated with bows on Sassanid silver dishes may indicate the use of Mouflon horn which is shorter than Buffalo.[161]

For the horn to adhere to the core both surfaces are heavily scored as seen on the Yrzi bow and which may be assumed for all bows in Roman use. Scoring is visible on more modern bows and was also practised in the Ch'engtu workshop.[162] When the horn is applied the core is strung in a reversed, squared 'C' shape (Fig.5.2). Turkish bows with siyāt had 'false nocks' cut in the belly edge of the ears for this reversed stringing. It is not impossible that these nocks were employed on bone ear laths, especially as the ends were butting bone without other materials between them. It is unlikely that this was the case, however, because of the absence of false nocks on the Caerleon laths which were in all probability never applied to bows. One piece, assembled by Nash-Williams, appeared to have a nock on the belly but this may either have been wrongly put together or may have been another feature of the low level of competence exhibited in the assemblage.[163] This piece is in any case shorter than would be expected because later in the constructional process the end with the false nock was cut away and a 'true' nock fashioned

(Fig.5.4).[164]

When the stave is increasingly reflexed for the sinew application the horn strips butting at the grip are inevitably pulled apart. The resultant gap must be plugged to prevent harmful shearing stresses when the bow is later strung and drawn. A bone, ivory or hardwood piece is inserted (Fig.1) on Turkish and other Oriental bows (Arabic ibranjak; Turkish çelik)[165] and if made of wood it would not survive in Roman archaeological contexts. It may also contribute to the stiffness of the handle. The Chinese bowyers bound the horn to the core for a day and a night then removed the binding and left the glue to set for four to five months before polishing and rubbing the horn surface.[166] They insisted on June for the binding and a setting period extending to November which roughly corresponds with Taybughā's autumn stipulation.

These two sources are at variance, however, on the season for sinew application. For Taybughā, working on a one-year timetable, the sinew was best applied in early spring but the Chinese chose winter with an obligatory commencement in October. They spread their glueing over three years using the first and second autumns' for glue-setting, the last winter and spring for sinew laying and setting.[167] The sinew application is the most important stage of the whole process, this substance determining the final recurve. Sinew is also the material most affected by temperature and humidity variations. Defects in the wood and horn could be rectified to some extent at this stage. Spring was chosen by Taybughā for its warmer conditions, inferior elasticity resulting from application on a cold day.[168]

Practical experience demonstrates that the best sinews come from cattle or deer leg tendons.[169] The Ch'engtu craftsmen used cattle back tendons deeming it important to remove them just after slaughter to facilitate the separation of flesh before it cools.[170] The sinews are dried, combed out, pounded with a wooden mallet into separate flax-like fibres, and graded by length. At this stage they are hard, translucent and stiff. They are then soaked in warm glue. The bow is heated and the sinew is applied onto the back of the wooden core by hand and combed into a homogeneous layer. The core must be deeply scored for adhesion beforehand. When the first layer is dry a second and even a third is laid on. These are applied to the back of the dustārs, the back and sides of the grip and more or less 'stacked' on the ears. With each layer the stave is increasingly recurved in order to elicit the maximum stretch when the bow is strung. Only with the final layer is the full-reflex achieved (Fig.5.3).[171] With small weapons, such as the Scythian bow, the ears would probably touch and even overlap, as with a Turkish flight bow in the Pitt Rivers Museum, Oxford.[172]

The back zone of scoring on Roman ear laths may be intended for the adhesion of sinew. The Qum-Darya fragment A has sinew on the back and sides of the ear up to approximately 3cm from the upper end (Fig.4). The Belmesa ear has traces of oozed glue on the back of the laths but the sinew only extended up as far as the point where the laths straighten out, level with the termination of the horn. On both laths knife scorings appear on the convex face (Fig.3) suggesting a trimming or tidying up of the sinew at that level. This explains the lack of back edge scoring. Traces of sinew overlaying the edges of the horn on the belly and at the lower end of the laths confirm that sinew was applied to the sides as well as the back of the ear.

After two to six months or more the sinew is hard enough to be filed and the exuded glue removed.[173] Shaping continues during the 'tillering' process as the bow is gradually bent, using heat to increase flexibility, and eventually the stave is strung (Fig.5.4). Careful study and adjustment accompanies the slow drawing of the bow and experimentation with the comparative physical performance of the limbs. Once the stave has been strung the true 'C' of the constructional reflex is lost as the sinew partially adjusts to the stretch. The bow is drawn on a 'tiller', a wooden beam which holds the handle at one end and takes the string in notches at intervals along its length. Filing and adjustment commences after the bow has been on the tiller for a few hours and after it has been sun-dried or brazier-warmed for hours to expel moisture.[174] Thus the stave can be monitored at measured stages and the draw-weight is estimated. This process may be carried out in consultation with the archer if the bow is custom-made.

Work on the ears would be completed before stringing. False nocks would be cut away from the tips. If the ears of a bow are designed to angle forward at rest, as was the case with Avar weapons, 'string bridges' are necessary to prevent the bow 'capsizing'.[175] The 'string guide' on the Mainz lath and other Hunnic examples might also be cut at this stage. Roman, Parthian and Sassanid bows do not seem for the most part to have had such ears, a point suggested by the Belmesa ear which has a leather-covered sinew binding above the nock (Fig.3). This was probably intended to bind the ear assemblage more firmly together preventing it from coming apart with the string's impact. Where the binding has come away scoring for additional purchase on the polished bone is visible. A Sassanid silver dish may depict a bow similarly bound below the nock (Fig.44). On Medieval bows this binding was termed the 'aqab' and a leather-covered example survives on an 18th century Bashkir bow.[176]

Islamic and Chinese sources recommend strings of silk or sinew for cold and humid climates, intestine strings only for hot conditions because they stretch when damp. For all weathers the best are hide strings, especially from a young emaciated camel, followed by wild ass and deer. Goat hide is only good in warm climates because it also stretches. Vegetable fibres could also be employed. A thick string increases accuracy and on a powerful bow it must be strong enough to withstand the tremendous strain of checking the forward movement of the limbs. A wide safety margin was allowed for war bows.[177]

Next, the stave is bound. Back edge scoring on Roman laths (and the scoring all over the convex face of one of the Caerleon grip laths) may in fact be for the adhesion of binding rather than exclusively for the sinew backing. The Yrzi bow has a sinew binding surviving particularly around the grip (Fig.2). Neck tendon could be used for this and it is also used as additional siyah stacking on more modern bows.[178] Sinew binding appears on fragment B of the Qum-Darya bow and it may have retained the surviving ear lath fragment (Fig.4). Over this, or instead of it, a binding of glued birch bark was universally popular in the Levant and China. This substance does not stretch during the draw and is laid spirally, taking glue as well.[179] Sinew and bark may bind the whole surface as with Persian and Indian bows, or the horn belly may be left exposed as with Mamluk, Sino-Tartar and Ottoman flight bows.[180] Sassanid bows are depicted as covered up to the knees but not it seems on the laths (Fig.44). The bow in Scene CVIII of Trajan's Column curiously does not appear to be bound at all, nor perhaps are those seen in the Syrian hunting mosaics (Figs.23, 36, & 37).

Lastly, several coats or sandarac of lacquer were applied to the binding, perhaps with painted designs to taste. For what little it is worth the bow held by both attendants in the S. M. Capua Veteres (Italy) mithraeum tauroctony fresco has a convincing profile and is browny-yellow in colour. This suggests an unpainted binding.[181] The onager hunting fresco from Dura-Europos has an unpainted bow as do the Kizil and Pendzhikent Early Medieval paintings.[182] Apart from the aesthetic reasons, the binding and varnishing is carried out to protect the stave from moisture damage. Western European climatic conditions may have caused problems in this respect.

The tools involved in the construction process were very similar in widely different contexts. Turkish implements described by Kani bear close comparison with those employed in Ch'engtu.[183] The core work demanded a saw for cutting components, a knife for shaping them, a glue pot and brush, a small adze for smoothing surfaces, a wood file, a scoring tool and a brazier for drying and shaping. A horn working tool for

polishing, a rasp, a scraping knife, a binding tightening tool and a pressing horse were needed for the belly application. For the sinew a mortar and pestle, a sinew comb and a glueing knife for scraping were necessary. For the general shaping of the limbs curved 'formers' may be bound to the dustārs. These also prevent the stave from twisting during the tillering process. The Turkish tepelik was very similar to the Chinese 'movement tool'.[184] Likewise, the slotted destagh frame, used in conjunction with the tepelik for curving the limbs, performed the same function as the Chinese 'big board bench' which was a work-bench with a slotted top also generally used for sawing, cutting and filing the stave at various stages (Fig.6.E).[185] The Japanese yumidame was of a similar design.[186] Drying frames, drying boxes, storage cabinets and charcoal braziers were used in common.[187]

In the Ch'engtu shop the horn binding demanded the hands of four people: a heater of glue, bow, and horn; a glue-spreader; a binder to apply the binding-cord; and a press-horse operator.[188] Application of the sinew would perhaps require three: a heater, an applier and a spreader to comb and mould. The workshop's staff of four consisted of owner-manager, the skilled artisan, the apprentice and the labourer. The owner helped during important stages such as horn-binding and the labourer performed unskilled tasks such as tending braziers and peeling birch bark. The shop itself (Fig.6) was 4.94m by 3.88m fronting onto a street with a shuttered front. The workbench (E) extended out the front with plenty of room to work. A storage cabinet (A) had a brazier burning in it in all weathers so that components could be dried out and valuable, completed bows be safely stored. A work table (B) was used for the general cutting and shaping of components. Tools and materials hung on the walls, materials and partly completed bows hung from the rafters, and materials were also piled on the floor in empty spaces (F).[189]

A workshop of course produced more than one bow per one, three, five or ten years. The materials could be stored and the physical work was intensive but not very time consuming, so bows could be made in large, staggered batches. With a staff of four the Ch'engtu shop was producing bows in batches of 50 during the 1940s. In the past, presumably with a larger staff, it had produced 500-600 bows in a batch.[190] Even when, latterly, there were very few customers the shop was busy every day with the preparation of materials. Klopsteg commented that if a bowyer newly started up worked on 100 bows in one year he would need 500 bows in preparation before he could do business.[191] This represented a large investment of materials and time, a high cost product and, in urban centres at least, a stable industry. What this meant in terms of nomadic steppe peoples moving around in wagons and living in felt tents can only be guessed at, although

the itinerant nature of such societies can be over-emphasised.

A distinction must always be drawn between bowyer and archer beyond that of producer and customer. Whilst the bowyer might be skilled in shooting, particularly for stave-testing, most archers were technicians in the use of the bow, rather than its construction. The archer was capable of minor repairs and maintenance with regard to the string, the stave's binding and producing and repairing arrow stele and fletchings.

Before the establishment of large, centrally organised fabricae three levels of Roman equipment production might be rather simplistically postulated for the East. The production of large items such as bladed weapons and armour would have been done in areas of 'civilian' industry, particularly in the cities of Syria. These products would then be moved through negotiatores to the legionary fortresses on the second level where large fabricae would make supplementary pieces and artillery, plus shields, shafted weapons, missiles etc. in bulk. These would be distributed to the smaller forts on the third production level, the fabricae of which might be capable of making large items from scratch but would specialise in smaller scale manufacture (arrow-heads, spear-heads, caltrops, mail rings, scales etc.) and running repairs. On this level the scrupulous recycling of materials from broken pieces would be an important feature. In the West the fortresses were the first level though civilian manufacture may have played a part as urban development increased. Obviously these levels blur together, particularly with troops stationed within Eastern cities and once a unit had been raised and equipped further production would consist of repairs and topping up the equipment pool. The vici also had a role in manufacture and most likely in the decoration of pieces to individual order.[192]

The secure identification of bow manufacturing sites is difficult. Nothing of the Ch'engtu workshop would survive in the archaeological record, except an anonymous shop groundplan and perhaps some iron tools. The latter were not particularly diagnostic and could be mistaken for textile industry or wood-cutting implements. In the case of Sino-Tartar bows bone laths were not used so nothing of the workshop products would give a clue.

The rather ineptly worked and often unfinished Roman laths from Caerleon suggest a manufacturing context rather than just a weapon-store. The finds associated with other legionary fortresses suggest by analogy that such sites were generally producing bows. By the time of Commodus, and probably much earlier, the legionary immunes included arcuarii and sagittarii, bow- and arrow-workers.[193] Vegetius included bows and arrows in

the production activities presided over by the legionary praefectus fabrorum.[194] Unfortunately none of the Corbridge laths were found in association with the legionary workshops of the Severan campaign supply base. One piece was in course of manufacture, however, when rejected. For campaign purposes some construction of spare bows would have been necessary though bow workshops might have had stocks of completed weapons already. The mass-production of arrows would have been far more important and this is exactly what the Corbridge fabricae were engaged in.[195]

The construction of bows was a specialised task but the possibility of general legionary production plus the state of the Caerleon laths excites the suspicion that the level of skill and competence involved here was not of the highest order. The situation may have been very different in the context of specialist alae, cohortes and numeri sagittariorum (Calibre below). The construction and maintenance of c. 480 or c. 800 composite bows would have been a major undertaking. It is reasonable to assume the existence of specialised fabricae centred round master-bowyers, with their apprentices and assistants, in the forts housing such archer-units. The evidence for bow construction at Intercisa is important but the late antler-working industry and possible Hunnic associations makes a link with a series of known Roman units of sagittarii problematical.[196] The competent excavation of Carvoran (Northumberland) on Hadrian's Wall, repeatedly occupied by cohors I Hamiorum sag., might be informative in this respect. It is not impossible that when such units were originally raised in the Levant the tirones brought their personal weapons with them because eastern recruitment in itself supposed prior skill and a cultural background of archery.

The general commercial and manufacturing industries in the Walbrook area of Roman London might suggest that the laths here were associated with on-site bow construction, though the pieces themselves exhibit every sign of completion.[197] The Mainz laths may partly be associated with the Mainz-Weisenau fort garrisons but the 3rd century canabae antler-working industry suggests either civilian bow construction or the extension of production work outside the fortress to gain additional space.[198]

The areas most active in bow construction in the East would have been Syria, Arabia, Palestine and the client states. Bows were a major hunting weapon throughout the region to judge from the pictorial record (Roman Representations and Comparative Evidence, above). Developments in tactics, armour and fortifications were all dominated by archery. Cities such as Palmyra and Hatra were more than capable of producing bows for mural defence and the equipping of the horse-archers.[199] Within

the Parthian Empire bow workshops have been identified at Merv (Ferghana)[200] and Toprak Kala (Transoxiana).[201] As in China and in the Medieval Levant the bow manufacturing industry was urban-based.[202]

In the Western provinces bow construction is likely to have been carried out in the legionary fortresses for general training and mural defence for legionary and auxiliary troops (Bow-Armed Units, below). The fabricae of specialist sagittarii would have met the needs of such units except, perhaps, the mass supply of arrows for campaign purposes. All the materials for composite bow staves would have been available except the belly horn, there being perhaps no suitable supply from wild or domestic Western animals. This reason, plus the climatic conditions was put forward by Paterson to explain the failure of medieval Western peoples to adopt composite archery when faced with its effective use by invading steppe peoples.[203] Composite bows do appear in Frankish, Alammanic and Lombard graves and there is evidence for Carolingian use but no suggestion that these peoples either manufactured their own composite bows or that they adopted them widely from the Huns, Avars and Magyars.[204] This is in contrast with the effects of contemporary Asiatic archery on Byzantine and Islamic states having direct access to horn materials. It is true that composite cross-bows were in Western use from the 9th to 14th centuries A.D. and that some suitable horn was found in the Baltic region, but the most common belly material was whale-bone acting, it may be said, as a horn substitute.[205]

The establishment of the centralised fabricae, itemised in the Notitia Dignitatum, may have been an extra production level superimposed upon the earlier situation rather than replacing it. These would have supplied the needs of mobile field-army units, especially for bulk orders and the larger classes or armour. None of the eastern fabricae are specifically designated as bow and arrow producers but in the West Ticinum (Pavia) is labelled 'arcuaria' and both Concordia (Concordia) and Matisco (Maçon) are 'sagittaria'.[206] Possibly Ticinum acted as an inlet for horn materials from the Levant and the two arrow-producers supplied arrows in bulk for the field-army and built up campaign reserves. The appearance of three such fabricae in the West but none in the East must be entirely due to the long Levantine cultural tradition of military and hunting archery. Significantly large elements of the fabricenses of the Ticinum and Concordia workshops were of oriental origin.[207]

7. ROMAN CROSS-BOWS

The bows so far discussed are 'hand-bows' as distinguished from 'foot-bows' which are more commonly referred to as

'cross-bows'. The foot-bow is so called because the stave is held down on the ground by the archer's two feet (Medieval Latin arbalista ad duos pedes; Arabic qaws ar-rijl) or one (arbilista ad unum pedem; qaws ar-rikāb) whilst he pulls back the string using his arm and back muscles. The former type is more primitive involving placing the stave actually on the ground whilst the latter employs a stirrup. The stirrup method was a later medieval development with advantages of avoiding stave contact with potentially damp ground and of allowing use in the saddle. The stave is lashed onto and set into the end of a wooden stock or 'tiller'. The string is pulled back along the tiller and locked on a trigger nut mechanism.[208]

The direct evidence for the Roman use of cross-bows amounts to two clear sculptural representations of 3rd century AD date, references by Vegetius and possible mentions in Byzantine military manuals. Comparative evidence from later periods to some extent illuminates this material.

A Gallo-Roman relief from Salignac-sur-Loire, in the museum at Puy, Haute Loire, depicts a hunting dog, a knife, a quiver and a clearly represented cross-bow hanging up.[209] The stave is unstrung with reversed limbs strongly suggesting a composite structure. The tiller is grooved with an eliptical stock at one end and possibly a delineated trigger nut. It is likely that the tiller is foreshortened to fit into the restricted panel space so no conclusions may be drawn with relation to the type or length of projectile used with the weapon.

A second relief, from a Gallo-Roman villa at Espály, also in the Puy Museum, depicts a hunting party with two pack animals (?), two men and a dog.[210] The sinister man rather awkwardly carries under his arm a long quiver and a cross-bow. The tiller is similar to the Salignac example except that it is of a larger scale and the trigger area is obscured by drapery. Although strung, the recurving of the surviving limb again denotes composite construction. The quiver is approximately the length of the tiller minus the eliptical stock, and this would imply the use of normal projectiles, not of short heavy quarrels.[211]

The gastraphetes of Heron of Alexandria was similarly a very large bow attached to a tiller but with a curved stock.[212] The latter fitted the archer's middle and a 'slider' was employed to push back the string until it could be locked by the trigger mechanism. The operator would prop the end of the slider firmly against a wall or the ground and exert his weight against the stock pushing with his stomach (hence 'belly-bow'). The weapon would have been heavy and unwieldy but would have needed only one operator and no stand. The major drawback inherent in the stave's composite construction would have been the extreme length

of the horn belly materials needed. Extra layers of sinew on the back would have given the desired increase in strength. The paucity of evidence for the gastraphetes apart from Heron's description might suggest that light torsion bolt-throwers were preferred to this weapon. The period in which it was used, if ever, is unclear because Heron drew from Hellenistic sources and probably wrote in the Late Roman period.[213]

The small-scale fittings from bolt-shooters found at Orsova and Gornea on the Danube, dating from the late 4th century A.D. have been equated with Heron's cheiroballistra, effectively a torsion artillery version of the gastraphetes.[214] The differences between the two sets of finds suggest a contemporary variety of models in use. Like the belly-bow these demanded a solid surface against which to push back the slider and would be heavy and difficult to handle. Their forte would have been in mural defence with a parapet on which to rest the weapon for aiming and shooting.[215]

Several times Vegetius refers to a 'manuballista' which may be equated with the Danubian finds and with the cheiroballista in scale and name.[216] In a passage discussing the legionary order of battle Vegetius describes a support line of tragularii, grouping together arrow-shooting manuballistae and archuballistae.[217] 'Arcuballista', etymologically similar to 'manuballista', with its bow element may be compared to the Gallo-Roman weapons. A trigger nut was found at Carnuntum (Austria), although a Roman date for it is not secure.[218]

The Late Roman units designated 'ballistariorum' were suggested by Marsden to have consisted of large numbers of carroballistae accompanying mobile field-armies.[219] This view was partly based on the assumption that they were formed by pooling legionary artillery and represented the only available engines, at least in the West. This scenario is unlikely because it would not make for 'mobile' units, moving as they would with carts as slowly as baggage trains. One possibility is that such units were equipped with the whole range of artillery types, the heavier pieces being detached to important bases for mural defence. The light variants would have served in the field. An 'artillery legion' would have been of little use as a block of men and heavy machines on the battle field and would demand parcelling out along the battle-line. A unit of cross-bowmen would have been a different proposition. Julian's oft-quoted journey with an escort of catafracti and ballistarii is readily understandable if the latter were arcuballistarii giving the necessary mobility.[220] A lack of post-conflict pursuit might be put down to tired, slow-moving cataphracts and a desire not to throw forward unsupported missile-troops. With regard to manuballistae, Vegetius' line would have demanded the lightest

weapons of the Gornea type and firm ground for slider movement.

The arcuballista would, however, have been most effectively deployed in mural defence, except on the eastern frontiers where enemy cavalry was heavily armoured. Interestingly Taybughā commented of cross-bows that "my own view is that in the manoeuvres of combat, in the desert, and on expeditions the hand-bow is a better and more serviceable weapon whereas in fortresses, sieges and ships greater power and advantage will be derived from the cross-bow".[221] The possibility that not all ballistarii were creamed off from the Legiones to the field-armies, and that some remained is suggested both by Vegetius' order of battle and by the provision of combined legionary artillery units in Danubian bridgehead forts.[222] In the latter static garrisoning by long-range missile troops commanding the areas around river crossing, as specifically recommended by Vegetius, would have made great tactical sense.

Maurikios' Strategikon (later 6th century AD) refers to solenaria which go with small quivers and arrows and have a long range. Similarly, Leo's Taktika and Problemata (end of 10th century AD), and the anonymous Sylloge Taktikorum (10th century AD) mention solenaria with small arrows.[223] These all suggest the field-use of a weapon most suitably interpreted as a cross-bow. As such, the solenarion might represent a continuous use of the arcuballista right through into the 10th century AD.

Whether or not cross-bows had a history of use by the Romans prior to the 3rd century AD cannot be determined on the present evidence but they were not necessarily derived from the gastraphetes. As a hunting weapon the cross-bow had distinct advantages over the hand-bow. It could be shot and cocked (by the archer lying on his back) from a concealed, lying position. It could be held cocked thus ready for use immediately game appeared. It delivered an arrow or quarrel over a greater distance, with heavier impact and with more accuracy (at least without demanding skilled marksmanship from a novice) than a hand-bow and was especially useful for fowling.[224]

In warfare cross-bows were most useful in marine-conflict and in mural defence where advantage could be taken of their greater range. The latter feature would not compensate for their slow rate of shooting in a direct field confrontation with infantry handbow-men but might very well do in exchanges with horse-archers. The penetrative qualities of cross-bow missiles hitting armour would have been most useful in the Parthian and Persian wars.

If a tiller was widely used in bow construction (Construction above) the cross-bow development would not have

been a huge innovatory leap of imagination. The main prerequisite was the provision of a trigger mechanism and hints for this may have been provided by contemporary artillery practices or, more likely, such a device represented a new approach. A trigger nut remarkably similar to Medieval European examples had been developed in China by the late 3rd century B.C.[225] The Chinese cross-bow had a composite stave and a variety of strength classifications. It was an exclusively infantry weapon developed for frontier defence as an answer to Asiatic horse-archer adversaries. This is not to suggest any technological link between Roman and Chinese empires, but simply to draw attention to an interestingly parallel development.

From the Gallo-Roman representations it may be inferred that cross-bows in Roman and Byzantine use had composite structures. The necessary stave length was shorter than for hand-bows and the increased power would have been provided by additional sinew backing, say up to five layers. In the West cross-bows appear on 9th and 10th century A.D. Pictish stones and were in continental use by the late 10th century.[226] Subsequent cross-bows were generally of composite structure employing whale-bone on the belly as a horn substitute, at least until the 14th century introduction of steel staves.[227] Wooden staves were also in use, the Pictish examples presumably being of thus material. Taybughā discussed composite cross-bows but recommended yew staves for ship-board use because of the detrimental effects of moisture on glue and sinew.[228]

II. OTHER EQUIPMENT

1. ARROWS

Arrows vary in their dimensions, weight, shape of fletchings and type of head according to the size of the archer, the use of the bow and the vulnerability of the target. The metal heads are the commonest archaeological finds providing some information about these factors. Very occasionally the organic materials making up the stele, nock and fletchings (Fig.8) survive in arid contexts. Artistic representations are usually of little use because of scale or the omission of fletchings which might obscure an archer's face (Fig.44). A few literary mentions provide evidence for types of wood employed.

Detailed examination of arrow-head types in this study is rendered unnecessary by the work of Erdmann and Davies.[1] The British material does repay review because of its geographical distribution with relation to known *sagittarii* and the incidence of laths. Arrows are easily lost and likely to appear in the archaeological record wherever archery was practised. The arrow-heads which appear in British contexts are all of iron and may be grouped in seven broad categories.

1. *Trilobate tanged*: Characterised by three vanes, barbed or otherwise, *c.*3-3.5cm long without the pointed tang. Davies suggested an early Scythian introduction of the type into the eastern Mediterranean region.[2] The employment of oriental *sagittarii* from an early date ensured its ubiquity in use by archers of whatever origin in the Imperial period. Although Scythian arrow-heads were characteristically of cast bronze and socketed, the tanged trilobate (or quadruple-vaned) iron head was of Central Asiatic origin spreading eastwards into China and southwards into Achaemenid Persian, Parthian and Syrian use. Tanged trilobate heads appear in Sarmatian, Hunnic and Avar contexts.[3] Within the Roman East many examples occur on Palestinian sites associated with the two Jewish Revolts (Fig.46).[4]

   Davies lists British provenances: Ham Hill (Dorset), Hod Hill (Dorset), Kingsholm (Gloucs.), Richborough (Kent), Margidunum (Notts.), Wall (Staffs.), Wilderspool (Cheshire), Corbridge (Northumb.), Turret 25b on Hadrian's Wall (Northumb.), Newstead (Roxs.), Bar Hill (Strathclyde).[5] To these must be added Gloucester (Gloucs.), Maumbury Rings (Dorset), Walbrook (London), Brecon Gaer (Brecon), Chichester (Sussex), Watercrook (Cumbria), Ebchester (Durham), Godmanchester (Hunts.), Carlisle (Cumbria), York (Yorks.), Caernarvon (Caerns.), Burnswark (Dumfries) and several

examples from Housesteads (Northumb.).[6] This list has no pretensions of completeness but demonstrates that these heads are a very common find on military sites.

Post-Antonine pieces from dated British contexts are few as seems to be the case on the German-Raetian limes.[7] In the East the type continued in use as the finds from Dura-Europos demonstrate, and it may perhaps be seen in Dura graffiti and on Sassanid dishes.[8]

2. Socketed, vaned: A socketed head with three or four barbed vanes c.10cm overall. This represents a socketed variant of the trilobate, tanged and probably replaced it in Britain by the early 3rd century A.D. In the Severan workshop III at Corbridge three tanged, quadruple-vaned heads were found with five socketed examples.[9] Hearths and tempering tanks suggest production on-site and a total of seventeen heads were found with javelin-heads, pilum-heads and spear-heads. The predominance of the socketed type is suggested by the late 3rd century deposit in the rampart-back building at Caerleon which included twenty-two examples with three or four vanes.[10]

3. Tanged, 'bodkin': A type with a square or triangular cross-section, c.4cm long. Erdmann lists British examples from Newstead (Roxs.), Corbridge (Northumb.), Poltross Burn (Northumb.), Kirkby Thore (Westmoreland) and Richborough (Kent).[11] This type of arrow may have been shot against ox-skull targets found at Corbridge and Chesterholm (Northumb.) but it occurs much more frequently on the Continent (Calibre below).

4. Socketed, 'bodkin': A long, slim head, square or rhomboid in section, c.5cm long. Few occur in Britain, rather more on the German limes. An example comes from Richborough (Kent).[12]

5. Socketed, flat-bladed: Much simpler in construction than the foregoing types, an example from Watercrook (Cumbria), c.5.1cm long, has a flat, triangular blade and was affixed to the stele with a pin. At Dura-Europos similar heads were used alongside the trilobate tanged but the latter were in the majority.[13] Sockets were glued to the stele, not pinned.

6. Tanged, flat-bladed: The blade of this type varies from triangular to leaf-shaped and may be barbed. This category might in many instances best be termed 'improvised'. Some 800 were found in room 12 of the Housesteads (Northumb.) principia in a 4th century context.[14] Some still had wood enclosing their tangs and had been arranged in bundles.

Scrap-metal suggests hammering into shape on the spot and they are very crude compared with the trilobate, tanged heads found elsewhere in the fort. Similar examples occur at Richborough (Kent).[15] The later date, simple design and local manufacture at Housesteads suggest improvisation for mural defence.

Quite different is a group of 44 tanged heads from Bearsden (Dumb.) on the Scottish wall, dating to the Antonine period.[16] They are characterised by a tang, square in section and a flat head with a triangular blade. The only approximate contemporary parallel is a head from Vindolanda (Northumb.).[17] They are reminiscent of the triangular point on the Dura-Europos incendiary ballista-bolt head.[18] The writer can only suggest that the Bearsden group was either locally produced for mural defence or was manufactured simply for hunting purposes. When sharpened this type would accord with heads recommended for soft-skinned targets.

7. Fire-arrows: Five examples were found at Bar Hill (Strathclyde) on the Antonine Wall, 5.2 - 6cm, and one at Wroxeter (Shrops.), 7.6cm long.[19] They consist of a tang joined to a short point by three outwardly curving bars. There is no doubt that these are fire-arrow-heads, of a type described by Ammianus and Vegetius, termed malleoli.[20] Davies' suggestion that they were constructed to reduce the time and skill needed for trilobate, tanged heads is mistaken because the bars are not sharpened, would hinder penetration and would buckle on impact.[21] The real problem with these projectiles is the tendency to be extinguished when shot.[22] The British examples are closely related to the Dura incendiary ballista-head in structure.[23]

Shades of local variation in dimensions and proportions are to be expected within these types.

The Elder Pliny remarked upon the use of reed for arrow stele: "The people of the East employ reeds in making war; by means of reeds with a feather added to them they hasten the approach of death, and to reeds they add points which deal wounds with their barbs that cannot be extracted... And if anybody should make a rather careful reckoning on the Ethiopians, Egyptians, Arabs, Indians, Scythians and Bactrians, and the realms of the Parthians, almost half of mankind in the whole world lives subject to the reed."[24]

During the sixth season of work at Dura-Europos three posterior ends of reed or cane arrows were found, 27.5cm, 21.5cm and 21cm in length (Fig.45).[25] The stele are without taper towards either end, the first two being 1cm in diameter, the

third 0.95cm. The longest has a nock 0.95cm deep with the tips and sides rounded off. The end was first bound with glue-soaked sinew for 2.5cm, then the nock was cut so that its sides and base were strengthened by this binding against this thrust of the bow-string. Three slightly ballooned vanes, 15cm long, 1.1cm high, fletched the arrow with the cock feather aligned with the string. A sinew whipping extends along the waist to give a glue purchase on the reed for these fletchings. A red line encircles the stele on the waist. On the second stele the fletching are badly damaged but in other respects it is similar to the first, with the addition of black painted lines and red circles on the waist. The vanes are 14.3cm in length. The third piece has lost its fletchings, which were 15cm in length, but has white-rimmed red circles, red dots, and black and red bands. These markings were presumably intended to identify ownership and/or an equally matched set of arrows.

Reed or cane stele presuppose tanged heads. However, for the socketed heads at Dura wooden piles were used (Fig.45). Two identical examples were found with the three stele discussed above, cut from tamarisk shoots.[26] One was intact, 17cm long, 1.1cm in diameter at its widest point. A dowel, 0.5cm long and 0.2cm in diameter acts as a 'tang' to be inserted into the reed stele. The remainder of the length from the stepped stele tapered to a 0.6cm diameter end onto which a socketed arrow-head would have been placed. The last 2.5cm has traces of glue remaining and there is no evidence for pinning.

At Masada (Palestine) Yadin found "hundreds of arrows in such places as the middle terrace of the palace-villa, the western palace and elsewhere, literally in heaps where they had been piled and intentionally set on fire. Only very few weapons for hand-to-hand fighting like the sword and spear, were found at Masada; the most effective defence weapon on the walls of the summit was of course the bow and arrow."[27] Roman troops would have removed any metallic weapons that they found, accounting for their absence. Some stele were found made of wood and some heads had very long tangs, presumably to distribute the shock of impact and to increase the purchase within the stele (Fig.46). Shafts from the Second Jewish Revolt have also survived in arid conditions. These exhibit an unusual two-part construction; the half of the stele with the head was wooden, the half with the fletchings was of reed (Fig.8).[28] An arrow from the Cave of Letters has only its wooden half and with it a small, trilobate, tanged head, the vanes of which are flush with the sides of the stele leaving in effect no barbs. The remains of a gut binding are in place at the other end and this would leave attached the reed section with fletchings as seen on better-preserved examples from Nahal Se'elim and Wadi Muraba'at. The wood is of the Tamarix species and was sharpened to a point so as to be driven

into the reed. The wooden section was clearly intended to lessen the possibility of the tang splitting the stele on impact. In both Jewish Revolts the Roman targets would have been metal-armoured.

In comparison a number of tamarisk stele, 70cm long, were found in the same cemetery as the Qum-Darya bow. Lighter, reed examples, 56 - 65.5cm long, were also discovered. Both tanged and socketed heads were present and some painted stele decoration.[29] These and the Dura stele indicate the use of thin bow-strings in contrast to some Sarmatian and later Islamic nocks which were more bulbous to accommodate thick string.[30]

In the Roman West stele do not survive so well but probably less use was made of reed than in the East. The Sarmatians used cornel-wood arrows, the Germans employed pine and hazel.[31] Fabian used heat-straightened reed for his Magyar reconstructions and birch was common in Medieval Europe.[32] Ammianus mentioned reed for malleoli.[33] Taybughā recommended vulture feathers as the best material for fletchings, followed by eagle.[34] The Ch'engtu workshop used vulture or eagle feathers, and white poplar for the stele.[35] Head and fletchings were attached to the stele using glue-soak d sinew-whipping.

Wood still adheres to the tangs of some of the Housesteads 'improvised' heads and inside the sockets of some of the Caerleon and Corbridge vaned examples.

The most efficient war arrow was a heavy one which would absorb all of the bow-string's thrust. This arrow would not have a great range, but if the head was of an appropriate type it would impact hard and penetratingly.[36] Hunting arrows had a maximum of sharpened edge for use against soft targets which would be hit with very little shocking power but deep penetration. They did not drop large animals but caused heavy haemorrhaging.[37] The Bearsden arrows would have been effective in this way. Bone heads were apparently employed by the Scythians, Sarmatians, Huns and Germans and these could have inflicted very messy wounds.[38]

War-arrows had quite different heads unless they were shot at unarmoured targets.[39] According to Taybughā "the most reliable and effective arrow-heads are those which are either triangular or square (in section). These are used in battle and for piercing all kinds of armour."[40] The penetrative qualities of various heads were laid out in the Moroccan treatise with reference to helmets, body-armour, shields, unarmoured man and game. Barbed heads were recommended for the last categories.[41] The barbed, trilobate form in Roman use might not be thought of as the best type for armoured targets. The tanged 'bodkin' was

an improvement but developmental impetus was not really present in the West where most of the barbarian adversaries were unarmoured.

The Elder Pliny, quoted above, remarked upon the difficulty of extracting eastern barbed heads from flesh. The barbed arrows shot by Parthian horse-archers at Crassus' legionarii were credited by Plutarch as having good armour (presumably mail in this case) penetration and they pinned hands to shields and feet to the ground.[42] Procopius described the removal of a barbed Gothic arrow from a face-wound, it being necessary to cut off the fletchings and pull the shaft out through the exit wound.[43] Procopius also states that Sassanid arrows "hitting a corselet, perhaps, or helmet or shield of a Roman warrior, were broken off and had no power to hurt the man who was hit." Although Persian bows were said to be weak, the Roman bows shot with such force "as to kill whoever stands in the way, shield or corselet alike having no power to check its force."[44] Without experimental reconstructions it would be dangerous to make inferences about arrow-types in use here.

The tang attachment method had the disadvantage of the stele tending to split on hitting a hard target. On the other hand a socket could snap off at the point where the collar ends. The Moroccan treatise was heavily in favour of the tang method.[45] The wooden piles from Dura and the wooden stele from Palestine lessen the incidence of both types of damage. Reed would be especially problematic and sinew-whipping was applied with this in mind. The Islamic sources speak of wooden stele and Taybughā also approved of tang attachment. "It (the head) must be so made that it is perfectly straight from the point to the end of the tang (sīlān), the end of the tang being narrower than its base. The wood of the shaft should be bored right in the centre to a distance that is less than the length of the tang of the arrow-head so that its end can be inserted into unbored wood in its natural state."[46]

Presumably, units of auxiliary sagittarii would have had specialist fabricae producing arrows for their needs. With the exception of the heads this work could have been done on a personal basis to make matching sets of arrows appropriate to an archer's draw-length. Mass-production is most likely within the Roman army, but more personal specification would have been possible in the Levantine 'private sector' of urban workshops. Legionary fortresses produced arrows for training and mural defence and most forts probably had a small supply for these purposes. The imperial fabricae at Concordia and Matisco (Maçon) in the Notitia must have produced them in bulk.[47] Garrisons under prolonged siege would have been constantly manufacturing projectile-heads in addition to using up prepared stocks and

returning enemy missiles. Some of the cruder Dura-Europos finds may fall within the hastily-fabricated category.[48] Metallurgical analysis of one of the tanged, trilobate heads from Masada revealed no evidence of quenching or tempering, and manufacture was done from a piece of bloom iron with an uneven carbon content. "This arrow-head, hence, would be effective against animals, or humans protected by leather armour, but ineffective against other iron or bronze armour."[49] In the field the archer might be expected to have his quiver full of arrows made to his specifications. Thereafter he would have relied on mass-produced supplies from the baggage train. Surena's horse-archers pursuing Crassus were constantly resupplied from a train of 1000 arrow-bearing camels.[50]

2. BOW-CASES AND QUIVERS

Whenever a composite bow is out of use it must be unstrung to preserve the elastic qualities of the sinew. Thus when Surena met Crassus he unstrung his bow as a sign of peace. When Parthian horse-archers fraternised with Antonius' troops they pointed to their unstrung bows and when they eventually gave up pursuit they unstrung their bows and left the Romans unmolested.[51] Dampness is extremely detrimental to the glue binding the constituents of the composite stave. The sinew backing is very sensitive to moisture and temperature changes. Likewise the bow-string suffers especially if it is made of leather or gut. In sedentary conditions unstrung bows may have been hung up in a drying cabinet, as at Ch'engtu, or kept in a bow-case. In the field a bow-case of some kind was vitally important.[52]

There are numerous instances of horse-archers being rendered ineffective by sudden downpours. Frontinus recorded that rain demoralised Antiochus' forces facing Publius Scipio in Lydia and made their bow-strings damp and useless. Likewise bows used by Varus' troops were rendered useless by continuous rainfall. In A.D.624 the Eastern Turks were decisively defeated in battle by Li Shih-min (later T'ang T'ai-tsung) because of a rainstorm. In 838 Theophilus escaped capture by the Turks at Dazimon when a sudden shower neutralised his pursuers' bows. There is a tradition that the Ottonian victory over the Magyars at Lechfeld in A.D.955 was partly attributable to rain before the battle.[53]

Similarly, the glue attaching head and fletchings to the arrow stele may be adversely affected by dampness and in any case the fletchings are delicate and easily damaged by mishandling. Many forms of quivers enclosing part of all of the arrows have been developed by various cultures. In Borneo, for example, fletched darts were kept safe from the high rainfall by cases

with wooden lids.[54]

Bow-cases and quivers would, therefore, have been very necessary items in the equipment of archers in Roman service, probably joining the numerous leather cases and covers needed for such items as musical instruments, artillery torsion frames, parade helmets, standards and shields.[55] Nothing survives archaeologically of these objects, Roman quivers apparently were lacking the metal fittings of some Avar and Magyar equipment (below). A number of Roman, Parthian and Sassanid pictorial representations of archers allow a reasonable estimate of the types of quivers and bow-cases in use by Roman forces.

The gorytus, a combined bow-case and quiver, was suspended from a waist-belt on the archer's left hip. It was developed by the Scythians, was primarily for cavalry use and took the small unstrung Scythicus arcus.[56] A quiver was attached to the outer face of the bow-case but the withdrawal of arrows with the right hand was very inconvenient because the top was angled backwards. In the later Medieval period Turkish horse-bows and arrows were of similar proportions to the Scythian but in spite of the use of cases for strung bows the Turkish quivers were always separate, hanging from the right hip, with the tops angled backwards.[57]

Judging from the Crimean frescoes and funerary reliefs the Sarmatians probably used the gorytus.[58] Therefore this is likely to have been employed by Bosporan sagittarii, by units of Sarmatian dediticii in the Roman forces and by Thracian archers.

Bow-cases do not appear in Roman military representations, a visible bow making a more interesting subject. All the military quivers are of a cylindrical type with parallel sides and round mouth. Generally this is worn on the archer's back on a balteus, with the mouth projecting above his right shoulder for ease of arrow withdrawal. This is a form useful for infantry, avoiding the danger of entangling quiver and legs possible with hip suspension. Archers in Scenes LXX and CVIII on Trajan's Column display this type of quiver and method of carriage. In Scene LXX conical caps cover the mouths as with the Housesteads archer's quiver. Presumably this is a measure to protect the fletchings from rain. Some form of lid may also be seen on the ala Scubulorum tombstone from Walbersdorf, an unusual instance of balteus suspension on a cavalryman. No quivers appear on the Marcus Column. The lid is commonly shown with deities and personifications with archery attributes.

The usual cavalry suspension-method of the cylindrical quiver was from the right side of the saddle behind the rider. The Mainz eques singularis Augusti has a quiver hanging vertically with no cap and the fletchings entirely visible above

the mouth (Fig.29). The ala I Augusta Ituraeorum stone at Gÿor depicts a quiver, conceivably with a cap, with the mouth angled backwards in the later Medieval manner (Fig.30). This would demand two vertical suspension straps.

Eastern quiver practices went with eastern bow types in Roman employment as suggested by the Mainz ala Parthorum et Araborum tombstone which displays a curious, curved object where the quiver usually hangs (Fig.31). The sculptor's grasp of archery details was not good (Roman Representations above) and the object's profile may have been badly depicted. However, it corresponds most closely to the combined quiver and bow-case used by Crimean, Parthian and Palmyrene horse-archers. This was quite different from the gorytus because it served a longer bow, unstrung for storage, and comprised a cylindrical quiver hung vertically behind the saddle, with a 'sheath' bow-case attached to its side. Numerous Palmyrene caravan god reliefs of 1st to 3rd century A.D. date depict this type with varying degrees of decoration and stylisation (Fig.33). Sometimes the case is curved, sometimes straight, with angled ends for unstrung, angled forward bow ears. It always appears behind the saddle on the rider's right side.[59]

Palmyrene funerary banquet reliefs often depict pages with a cylindrical quiver hanging over one shoulder from a strap held in the hand. This gives the appearance of a quiver removed from the usual saddle attachment, not suspension from a balteus. When a horse is present a quiver is seen behind the saddle.[60] The pages normally bear the hunting equipment of the deceased who would have hunted on horseback with the bow.

Quiver and bow-case combinations appear on late Crimean tombstones, though it is unclear whether they are similar but independent development to the Palmyrene type, or whether there is some direct, possibly Parthian connection between the regions. Some proportionally very long bows are depicted with angled ears.[61] It is possible that late Sarmatian peoples were using this form of quiver-case instead of the gorytus. The Parthian horseman carving at Tang-i-Sarvak seems to depict a type very similar to the Palmyrene combination.[62]

Variants of the quiver and bow-case appear in two Palmyrene reliefs. One may represent a case on the rider's right side, for a strung bow but this is not clear because of the damage.[63] The other is for an unstrung bow but does not seem to have the clearly defined separate bow-sheath.[64] Another variant, most clearly seen on the Mordechai and Esther fresco in the Dura synagogue (mid 3rd century A.D.) incorporates the usual bow-sheath alongside a tapering quiver.[65]

This type points to Sassanid developments. At some point in the 3rd century A.D. a tapering quiver came into use which bunched the arrow-heads at the lower end and perhaps giving the fletchings greater space. This is seen on the early Sassanid rock reliefs at Bishāpūr, Naqsh-i-Rustam and Fīrūzābād suspended on the rider's right side from a hip-belt, not behind him from the saddle.[66] The Dura-Europos graffiti provide numerous additional examples as do the the Sassanid silver dishes.[67] Curiously when the rider and horse on the latter are viewed from the rider's left side no attempt is made to depict a bow-case. This is most regrettable because there is no definite indication as to the exact form of this early separate bow-case which, by later analogy, would have been suspended on the rider's left side from a belt. The separation of bow-case and quiver, and the respective sides for suspension, is an important innovation which continued right through into modern times, despite later reversion to cases for strung bows. Forces on both sides of the Roman-Sassanid frontier are likely to have influenced each other's equipment.

A completely different type of quiver appears on the Tāq-i-Bustān armoured horseman sculpture which probably depicts Chosroes II (AD590-628).[68] It is a waisted 'hour-glass' quiver, so-called because the foot and mouth are usually wider than the body, suspended on the rider's right side by two vertical straps from a hip belt (Fig.41). It hangs diagonally with the open mouth uppermost and pointing forward. The lower end is much wider than the upper where the arrow stele are visible.

This quiver-type was developed in Central Asia, and was in use in China from at least the T'ang period when the Chinese were influenced by Turkish equipment. The 6th-8th century AD Turkish petroglyphs from the Minusinsk region exhibit hourglass quivers and many are seen on frescoes depicting Iranian and Turkish armoured cavalry from Pendzhikent (7th century AD), Kizil (mid 8th century), Chotscho (8th-9th century) and other sites.[69]

When the open quiver is depicted in detail it is clear that the arrow-heads are positioned at the mouth with the fletchings inside the lower end. This situation is reflected in western Avar graves where a concentration of arrow-heads is found in close proximity to the hip of the deceased in association with decorated belt-plates and pendants. The quivers themselves do not seem to have had a metal mouth or 'chape' but may have been decorated with worked bone strips.[70] Metal fittings at mouth, foot and long edges do appear on Magyar quivers, however. An entirely preserved mouth with seven arrow-heads attached to it by corrosion was found at Magyarhomorog (Hungary).[71]

The Sassanids may have adopted the hourglass quiver in the

mid 4th century AD from the neighbouring Chionitae. Late Roman horse-archers almost certainly would have acquired it from the Avars if they did not possess it already. The question arises as to whether the Huns introduced the hourglass quiver to the Roman army. Unfortunately, concentrations of arrows do not occur in Hunnic funerary contexts similar to those in Avar graves. The 6th century AD mosaic horse-archer from the Great Palace at Constantinople although viewed from the man's left, has the top of a quiver appearing in front of him (Fig.38).[72] From its profile and angle of suspension this is very probably of the hourglass type. Regrettably this mosaic is not dated closely enough to distinguish between Hunnic or Avar influence. On the other hand a rather crudely executed horse-archer in the church of St George at Khirbet el-Mekhayyat (Jordan) depicting a quiver slung diagonally with the open upper end forward dates by inscription to the 530s AD.[73] This may point to a Hunnic introduction although little weight can be placed on it. The Syrian hunt mosaics do not depict quivers.

No separate bow-cases appear in Roman art. A 3rd-2nd century BC Bactrian bowl suggests an early date for the sheath type which is depicted both containing a bow and empty.[74] An object suspended on the left side of the Tāq-i-Bustān horseman looks very much like the upper 'ear' of a sheath quiver.[75] This type is most clearly seen in Central Asian frescoes at Pendzhikent and Kizil and in the Jenissei petroglyphs. Again it was adopted in China, suggesting an Asian origin.[76] A sheath quiver occurs on a post-Sassanid silver dish with a curved profile and angled ears for an unstrung bow.[77] Sassanid period dishes do not depict bow-cases. Non-perishable fittings do not appear in Hunnic funerary contexts but Magyar bow-cases had decorated bone plates attached to the mouth of the sheath to enclose the bow's upper ear.[78] With the 'Sassanid' and hourglass types of quivers sheath bow-cases would have been necessary and presumably widely used on both sides of the Roman-Sassanid frontier. Citing Maurikios' Strategikon, Haldon comments that bow-cases of 'the Persian type' were in Roman use, as opposed to steppe sheath type bow-cases.[79] However, this seems to be a false distinction because the Persian type very probably was a sheath bow-case.

A variety of quiver and bow-case types may have been in contemporary use but the evidence discussed above allows the following conclusions about Roman usage. Infantry archers employed cylindrical quivers, with caps in wet conditions at least, suspended on the back and they probably carried a sheath bow-case. There is no evidence for the latter supposition but some such form of bow-case must have been used. Sarmatian and Bosphoran troops probably used the gorytus suspended from the left hip for a short Scythian bow. The majority of oriental

horse-archers in the 1st-3rd centuries AD would have had the quiver and bow-case combination suspended from the right side on the rear of the saddle, for longer unstrung bow. This type spread also to the Crimea.

During the first half of the 3rd century AD the quiver and bow-case elements were separated. A tapering quiver with a narrow foot remained on the archer's right but was now suspended vertically from his hip. The necessary bow-case must have been carried on the left side hanging from the same belt as the quiver, probably diagonally with the upper ear rearwards. Again there is no direct evidence for this except for temporally wide analogies.

At an indeterminate point both Roman and Sassanid forces adopted the Central Asiatic hourglass quiver suspended horizontally with the mouth towards the front and the arrow-heads uppermost. Dated representations are scarce from both areas but if the Huns did not introduce it into Roman use, the Avars almost certainly did. The sheath bow-case would have been unaffected by this new quiver type.

3. BRACERS AND THUMB-RINGS

Bracers and thumb-rings are mutually exclusive pieces of equipment associated with bow-string release in shooting. Their use is dictated by the method of release, 'Mediterranean' or 'Mongolian'.

The Mediterranean release is the drawing and loosing of the string using two or more fingers with the back of the hand vertical.[80] This is the most common release used by modern archers. As the hand is opened the string springs away to the archer's left (presuming he is holding the bow in his left hand) and takes a curved course to the position at rest. The acceleration and force of the string presses the arrow rightwards so that with this release the arrow has to be laid on the left side of the stave (the 'inside') or it would fly off uncontrollably.[81] The path of the string runs close to the archer's left forearm and may actually contact it resulting in a painful burn or bruise. A leather band, the bracer, is employed to protect the arm.

The Mongolian release involves the use of the thumb to hold the string 'locked' by the index finger, with the back of the hand horizontal or sloping downwards (Fig.43).[82] When the string is released it springs rightwards bending the arrow around the right of the stave. The arrow is laid on the 'outside' and the

string does not go near the left forearm, thus a bracer is unnecessary. To protect the thumb, to make the holding of the string more comfortable and to aid consistent accuracy a leather 'thumb-stall' or a bone 'thumb-ring' is slipped over the thumb.[83] The ring is characterised by a flange positioned on the inside of the thumb to take the string.

The question of the type of release employed by Roman period archers has important ramifications for shooting performance and the use of other equipment. The advantages of the Mongolian over the Mediterranean release are many. Firstly, the string-path and 'out-side' placing of the stele of the Mongolian allows a small shield to be strapped to the left forearm, the straps of which could be caught by the string in the Mediterranean release.[84] A baggy left sleeve must be bound up but a bracer is unnecessary.[85] This is an important advantage for horse-archers who were particularly vulnerable to melee attack by other skirmishing cavalry if they were shieldless. The smaller angle made by the string at the thumb alone, compared with that when held by several fingers, enables an archer to use shorter bow with a greater draw-length in comfort. An archer may draw to the right shoulder with a thumb-ring imparting greater power to the arrow for increased distance or penetration. Alternatively a large bow may be used with a commensurately longer draw.

Robinson suggested that archers in the Roman forces used the Mongolian release, citing a bone ring from Chesters (Northumberland) as a thumb-ring.[86] This object in fact does not have the characteristic flange. To the writer's knowledge no clear examples of bone thumb-rings have been found in securely dated Roman contexts, although leather thumb-stalls would not have survived. One ring was found at Dura-Europos but the context of the find was unrecorded and it could easily be a Late Roman or Medieval stray-find.[87]

Artists might be expected to be lax in portraying such details as fingers on a bow-string but a few representations prove to be of use for the discussion.

Parthian terracottas rarely depict archers at full draw. The Berlin figure is seen from the wrong side (Fig.39), but a plaque on display in the British Museum, London, has such an archer with a hound which may be executing a Mediterranean release.[88] The clearest depiction is a piece of mother-of-pearl box inlay, 2nd-1st century BC in date, from Shami (Iran).[89] The bow is lost but the back of the archer's hand is clearly vertical and the string is held by the two middle fingers. The index and little fingers are extended. Fragments of a terracotta frieze was recovered from the small palace at Khalchayan (Transoxiana) dating to c. 50BC-50AD. One drawing arm and hand survived from a

light horse-archer figure. Despite Pugachenkova's reconstruction drawing with Mongolian releases, the back of the hand is vertical and the string appears to be held by the index and second fingers.[90]

The Dura-Europos Parthian-Sassanid horse-archer graffiti are of little help because of their small scale and often crude execution. Sassanian silver dishes depicting kings hunting on horseback clearly depict what might be termed the 'Sassanid release' which is really a continuation of that seen on the Shami piece. This was a Mediterranean variant by which the middle two fingers hold the string and the index and little fingers are extended paralleled with the stele (Fig.44). Only on evidently post-Sassanian dishes does the Mongolian release appear. The Moroccan treatise described a similar 'Slav release' with just the index finger extended.[91] It might be suggested that some of the advantages of the Mongolian thumb-lock might be gained by holding the string with only the two middle fingers. The angle of the string at the hand would be more comfortable with a long draw though a shield could not be worn simultaneously on the left forearm. This may account for Ammianus' description of Sassanid archers drawing to the right side of their chest.[92]

The Scythians and presumably the Sarmatians used the Mediterranean release.[93] On the above evidence eastern archers in Roman service would also have used this release. All the archers on Trajan's Column draw with their fingers and those in Scene LXX are clearly depicted with bracers. There are no shields associated with archers on military tombstones, though these do not show bracers, mainly because of lack of detail.

The Mongolian release was another steppe development, as the name suggests, and is seen in Asiatic frescoes.[94] There are no thumb-rings in Hunnic funerary contexts known to the writer though this does not preclude the use of thumb-stalls. However, some decorated bone thumb-rings do survive in association with Avar material.[95] Late Roman forces would almost certainly have adopted the Mongolian release by the later 6th century A.D. and Bivar suggested that Roman archery at Callinicum was so penetrative because the Hunnic bow and the Mongolian release were being employed. The Sassanid opponents by this token would have used their Mediterranean variant with the smaller Sassanid bow. The silver dishes may of course be stylised and conservative in this respect, and the contemporaneous use of both releases is not impossible. Bivar further implied that the Arabs adopted the Mongolian release from the Romans not from the Sassanids but there is no contemporary evidence to prove it. The Umayyad Khasr el-Hayr el-Gharbī fresco which he cites in support (Fig.43) is too late to be relevant and the archer represented is probably from Khurasan or Transoxiana anyway.[96] The distinction between

'Roman' and 'Persian' shooting in the anonymous 6th century archery treatise may perhaps be interpreted as referring to Mongolian and Sassanid releases.[97]

It would be surprising if the Sassanids were slow in absorbing the Mongolian release, considering their longstanding steppe contacts. The late use of the hourglass quiver demonstrates that Asiatic practices were influential. A Kidarite Hun dish of late 4th century date depicts horse-archers employing thumb-locks (no bow-cases or quivers are represented) proving the steppe use of this method at this time.[98] Another relief at Tāq-i-Bustān, the aquatic hunt scene, depicts Chosroes II in a boat with a bow held at full-draw.[99] The king's right hand seems to be bent downwards, a common artistic convention to denote a thumb-lock (Fig.40). Moreover, with only one exception, all depictions of Parthian, Palmyrene, Sassanid and other oriental horse-archers include no shields. The predictable exception is the armoured Chosroes II at Tāq-i-Bustān which has shield, bow and contus (Fig.41).[100]

There is no evidence that the eastern foot- and horse-archers in Roman service in the auxilia, numeri or irregular bodies of troops employed anything but the Mediterranean release which required a bracer. With the arrival of the Huns in the later 4th century it is likely that the use of Mongolian release, requiring a thumb-ring, spread at least to the best bow-armed Roman cavalry. Other archers may have continued to use the Mediterranean or Sassanid releases. Some evidence supports a Sassanid use of the Mongolian method, again adopted from Hunnic peoples, by the late 6th century A.D. at the latest.

4. GENERAL EQUIPMENT

The soldiers' general requirements of mill-stones, tents, pack-animals etc. would have been the same for all classes of troops but it might be expected that eastern archers exhibited oriental features in their clothing and armour. On the contrary the tombstones of auxiliary sagittarii suggest that they differed not at all from other auxiliarii except in the carrying of archery equipment. The two archers of cohors I sagittariorum are dressed in the normal sagum and tunica as seen on the very similar stone of Annaius Daverzus from cohors IV Delmatarum, a unit equipped with shields and hastae.[101] The gladius, pugio and two cingula are identical. The Mainz archer of cohors I Ituraeorum wears a paenula and a tunica (Fig.28). A tubicen of the same cohors is depicted on another tombstone in Roman civilian dress.[102]

These figures all date to the first half of the 1st century

A.D. whereas the Housesteads archer must be Hadrianic or later in date (Fig.26). The man wears a long-sleeved tunic[103] which may be an oriental feature if the stone is 2nd century in date and the man came from cohors I Hamiorum stationed at Carvoran, two forts along Hadrian's Wall to the west. Alternatively it may be a 3rd century feature. No body armour appears to be present, even considering the weathered state of the stone. A conical projection on the head has been interpreted as a conical helmet or as a normal helmet with crest.[104] A large knife with bird-headed pommel hangs from a cingulum. In his right hand the archer holds a bill-hook, not an axe. This combination of bow and bill-hook is also found on a Gallic-Roman statue of a forest deity from Mont-Saint-Jean (Oise).[105] The funerary nature of the Housesteads relief, rather than a deity depiction, is indicated mainly be the debased rosettes and pine-cones flanking the aedicula.[106]

The horsearcher from the ala Ituraeorum at Tipasa appears to wear knee-breeches and tunica. The Gÿor and Walbersdorf reliefs suggest the same attire with the latter adding a helmet with neck flange and a normal cavalry spatha (Figs.30). Similarly the eques singularis Augusti at Mainz has short, tight breeches and a tunica. He appears to be bare-headed. Lastly, the member of the ala Parthorum et Araborum is badly damaged but provides very important details of clothing (Fig.31). The servant is clad in the usual short-sleeved tunica but the deceased appears to have a long-sleeved tunic with a cuff appearing on his left arm. Most importantly the profile of his eroded leg looks as though he is wearing baggy Parthian anaxyrides. On the back of the damaged head appears a helmet neck-flange.

On Trajan's Column an archer appears in the background of Scene XXIV dressed in the same fashion as other auxiliarii but substituting a bow for shield and shafted weapon (Fig.19). The other archers appear in the well-known ankle-length robes, with conical 'spangenhelme' and either loricae squamatae or hamatae (LXX, CVIII, CXV). The helmets are similar to one variant seen on the Column's pedestal and may denote Sarmatian origin for the men (Fig.20). The archers in Scene LXVI wear helmets identical to those worn by Sarmatian cavalry in Scenes XXXI and XXXVII. The writer would see the archer in XXIV as typical of members of cohortes sagittariorum. The long robes of the other archers probably denote Sarmatian origin rather than Levantine dress (Fig.20 & 22). In Scene C the Sarmatian envoys wear long, asiatic kaftans. The sculptors have misinterpreted their subject as they did elsewhere in depicting horses with scale-armoured legs. No dress in Parthian, Palmyrene or Syrian art suggests that such long robes were common Levantine wear. The Conon fresco at Dura is the closest approximation but these robes are priestly in character.[107] Conceivably the sculptors could have

misrepresented the anaxyrides by running the baggy legs together, or the 'sarongs' worn by rider-gods. Definitely the archers in LXVI and possibly those in CXV were intended to be Sarmatian Iazyges who may have provided the Romans with contingents for the Dacian wars. The archers in CVIII may be the same (hamatae are seen on the pedestal reliefs) or badly depicted Levantines (Fig.22). Cichorius favoured such a dual interpretation.[108]

On the Marcus Column the horse-archer in Scene LVII (Fig.25) is dressed like any other mounted auxiliarius with lorica hamata, substituting bow for shield and hasta. The infantry in Scenes XV, XXVII, XXXIX and LXXVIII all wear long-sleeved tunics, tight, long trousers and Phrygian caps (Fig.24). These men are clearly orientals, stylised but not out of place in Levantine art.

From these representations, funerary and monumental, it appears that the alae and cohortes sagittariorum were dressed and armoured in the same manner as other auxiliary units. The ala Parthorum et Araborum may have been an exception to this because of its unusual origins. The Dura Terentius fresco, depicting officers and men of cohors XX Palmyrenorum sag. mill. eq., supports this conclusion. All the figures wear normal 3rd century military dress and belt-fittings.[109] The horse-archer graffiti from the town probably depict irregular Palmyrenes or Sassanids, not equites cohortales.[110]

Some other elements of equipment may have displayed oriental characteristics.[111] The putative conical helmet worn by the Housesteads archer corresponds roughly with two actual helmets in the Archaeological Museums of Zagreb and Sofia which also accord with some helmets on Trajan's Column (notably in Scene VIII).[112] It is possible, however, that the two surviving helmets, one very ornately decorated, were purely for parade use or belonged to officers. Normal auxiliary helmet types may have been everyday wear. Ethnic variation in military equipment is a vexed subject but units might be expected to gradually lose initial characteristics by moving away from their areas of recruitment, by a slow process of equipment replacement and by becoming inbedded in new supply systems. Moreover, surviving equipment from the Eastern Provinces does not differ markedly from pieces found in the West. The Zagreb and Sofia helmets are decorated with typically Roman mythological figures and the Housesteads archer's helmet may be crested rather than conical.

The bill-hook held by the Housesteads archer is unparalleled in military depictions and may be a specialist tool for the collection of arrow materials. Had it been an axe it would have been understandable as a side-arm because the man is otherwise only armed with a long knife. Axes are mentioned by Arrian in use by cavalry and in 6th century A.D. and later manuals they

were associated with light troops.[113] Robertson suggested that for mural defence of their forts auxiliary sagittarii would have been equipped with shields and shafted weapons.[114]

There is no evidence for the use of shields by sagittarii in the first three centuries A.D. Vegetius specifically said that archers were unable to use them so should have had body armour.[115] The Mediterranean release would have precluded use whilst shooting. No weapons would have outranged foot-archers except artillery, against which shields would have been useless. In the event of a unit of archers being shot at it would reply in kind rather than use shields for protection. Some Palmyrene horsemen carried shields and bows but shafted weapons are also in evidence suggesting a melee role. Parthian horse-archers definitely did not use shields.[116]

Were later Roman sagittarii equipped with shields? In the Notitia Dignitatum 15 units of archers and 4 of ballistarii have shield-patterns. Grigg has demonstrated the arbitrary formulation of these emblems in the manuscripts and it is doubtful whether any weight may be placed on them.[117] It is true that the scola scutariorum sagittariorum has a shield and archer title but in the same chapter an equally unique scola scutariorum clibanariorum occurs.[118] Since all the ethnically designated clibanarii in the Notitia were 'Parthian' or 'Persian' they were very likely contus-armed, another weapon with which shields could not be used simultaneously. The small shield mentioned by Procopius, born by lance-armed and bow-armed cavalry, was to protect the face.[119] This has no bearing on the release question but is connected with the double-handed use of the contus. Even after the Avar introduction of stirrups Central Asian cavalry still used both hands rather than couching the lance.[120]

III. ARCHERS AND ARCHERY EQUIPMENT

1. BOW-ARMED UNITS

It would be an exaggeration to suggest that virtually all soldiers in the Roman Army could have practised archery at some point in their careers. However, archery equipment was much more widely employed than might be expected judging solely by regimental titles. Battlefield archery, siege-work and general military training presented a range of circumstances in which bows might have been used.

The archaeological material is the most informative source of information. The distribution of laths and arrow-heads in Britannia and along the Northern limites is important because in only a few cases may a direct connection be made between finds and known garrisons of sagittarii.

Laths from the Augustan legionary bases at Dangstetten (Catalogue No. 12) and Oberaden (Catalogue No. 13) may be explained by the recorded employment of equites and pedites sagittarii by Germanicus.[1] At Bar Hill (No. 1) the cohors I Hamiorum sag. was in residence at some point during the Antonine period and Ctraubing (No. 23) was garrisoned by the cohors I Flavia Canathenorum mill. (eq.?). Depending upon their date the late laths from Intercisa (No. 25) might be attributed to the equites sagittarii of the Notitia. However, Bobertson has cautioned against a simple identification for the Bar Hill pieces and points to literary evidence (discussed below) suggesting archery practice outside units entitled sagittariorum. She suggested that the other unit in residence, cohors I Baetasiorum c. R., could have been responsible for the laths and arrow-heads, thus the archery equipment is of no use in elucidating the garrison sequence.[2] Walke, on the other hand, takes the laths and heads from Straubing to indicate the presence of the cohors sagittariorum.[3] The difficulty in distinguishing 'Hunnic' laths from those found in indubitably Roman contexts makes any attributions for the Intercisa material quite insecure (No. 25).

All other laths in the Catalogue have no definite correlation with known sagittarii. At South Shields, Chesters, Chesterholm, Zugmantel, Heddernheim, Stockstadt and Buch none of the known garrisons were sagittarii (No. 2, 5, 15, 16, 17, 22). However, at Heddernheim the presence of elements of cohors I Flavia Damascenorum mill. eq. from Friedberg might offer an explanation.[4] Rißtissen (No. 21) had a mixed legionary-auxiliary garrison to judge from the lorica segmentata fittings and no known specialist sagittarii.[5] Garrisons of other forts in the Catalogue are unknown. Lath-finds in London (No.7) could be accounted for by this site being the provincial capital with

military presence of singulares and administrators. At Silchester (No. 8) other small-finds suggest military presence of an unknown nature.[6]

Laths associated with the legionary fortresses of Mainz, Windisch and Carnuntum (Nos. 14, 20, 24) may be explained by analogy with the bow manufacture material at Caerleon (No. 9) and the presence of arcuarii as legionary immunes (Bow Construction above). Likewise the arrow-heads at Corbridge (No. 3) were produced in legionary Fabricae, presumably for campaign stocks. The laths may also have been of legionary manufacture.

In Britain the only known unit of sagittarii was the cohors I Hamiorum on the two walls.[7] Davies suggested that some Thracian units of the conquest period may have had bows but there is no proof of this.[8] Arrow-heads are very common on military sites with a wide distribution across the province. With a tolerably well-known auxiliary garrison and no Central Asian element in the archaeological record two logical explanations present themselves. Either the Hamii toured the province extensively discarding their bows and losing their arrows, or archery was widely practised by auxiliary units. The latter possibility seems preferable. The wide distribution of archery equipment on the German and Raetian limites led Erdmann to a similar conclusion for continental practice.[9]

Ox-skulls discovered at Chesterholm and Corbridge (Cat. No. 3, 5) were perforated with many punched holes made by an object which was square in section.[10] The smallness and multiplicity of these holes precludes association with animal slaughter. It seems most likely that the heads were mounted and used as targets for arrows or hand-hurled weapons. Square-sectioned ballista-bolts or pila would have either gone right through the skull or smashed it. Light javelins with appropriate head-sections would still have been too large. The neat, multiple holes are most likely to have been made by the 'bodkin' type of arrow-head (Arrows, types 3 - 4, above) found on Hadrian's Wall sites.[11] Neither Corbridge nor Chesterholm had known archer-garrisons.

The conclusion that archery may have played a part in general training for troops not in units entitled sagittariorum is quite reasonable on the archaeological evidence but has little to support it in the literary sources. Avidius Cassius is said to have exercised his troops in archery and the use of other weapons but this comes as no surprise in the Orient.[12] Arrian confines his detailed remarks on cavalry manoeuvres to javelin- and shield-armed cavalry.[13] Vegetius recommended mounted and foot practice for tirones shooting wooden bows at a palus target.[14] Elsewhere he says that other troops should also

exercise using straw targets over a range of 600 feet.[15]

One reference suggests the use of archery by some Late Republican legionarii.[16] The construction of bows at Caerleon and by extension in legionary fortresses in general, might suggest the meeting of a need for practice weapons. Alternatively the bows were constructed for mural defence of the fortress, a supply of weapons being in store should the need arise. This is not as unlikely as it at first seems, considering the collection of caltrops found in the same building as the laths at Caerleon.[17] Another possibility is that such bows were for training or mural defence use by non-sagittarii auxiliaries, assuming that specialist units of archers manufactured their own weapons (above Bow Construction). Robertson suggested that a cohors sagittariorum would need shields and shafted weapons for the defence of its fort.[18] The reverse may have been true for non-sagittarii, greatly aided in defence by having a small complement of bows in store with a supply of arrows. By this token laths and arrow-heads cannot be used to identify the garrison of a given fort as specialist sagittarii with any degree of certainty.

One cannot imagine the Guard units in Rome being bow-armed for mural defence but surprisingly there is evidence confirming archery training for them. General doctores appear in the epigraphic record with campidoctores perhaps of superior rank and with an equestrian emphasis.[19] For the praetoriani there was a position of doctor sagittariorum[20] and in the equites singulares Augusti a campidoctor sagittariorum is attested.[21] Two funerary reliefs depict members of the latter body as horse-archers, suggesting that an element was permanently bow-armed (Fig.29).[22] The emperor Commodus received archery tuition from a Parthian who may have been a singularis.[23]

With regard tc auxiliary regiments the title 'sagittariorum' is presumably a sure indication that a unit was bow-armed. Unfortunately the epithet is often omitted in inscriptions and on diplomata. Geographical titles without the epithet may be a guide and Davies suggested that all the cohortes Commagenorum, Petraeorum and Ituraeorum could have consisted of archers.[24] If most Eastern units were sagittarii then the Western units in the Orient assumed a greater tactical importance in providing spear- and shield-armed cavalry. Sometimes funerary reliefs provide the necessary information by depicting an archer, as with the ala Scubulorum or the ala Parthorum et Araborum discussed above.[25] Another problem is whether the cavalry of a cohors equitata sagittariorum were bow-armed. There are no definite depictions at Dura-Europos of equites cohortis XX Palmyrenorum[26] and no equites cohortales appear as tombstone figures. However, the cavalry element of cohors III Ulpia Petraeorum mill. sag. forming

a screen on Arrian's march to meet the Alani consisted of horse-archers and those shooting over the heads of the legionarii in the projected battle were presumably from the other cohortes sagittariorum present.[27] Alternatively, comments addressed by Hadrian to the equites of cohors VI Commagenorum would perhaps better suit men armed with javelins (though the unit is not definitely known to be sagittariorum).[28] The Straubing parade armour, presumably belonging to equites of cohors I Flavia Canathenorum mill., suggests exercises no different from those involving practice javelins described by Arrian.[29]

It is probable, judging from the archaeological evidence, that some auxiliary regiments of non-sagittarii were in part also bow-equipped for training and/or mural defence purposes. Indeed the finest recorded demonstration of archery skill was exhibited not by a member of an oriental cohors sagittariorum but by Soranus, an eques from a cohors Batavorum mill. eq.[30] He swam the Danube on horseback under the eye of Hadrian, shot an arrow in the air and hit it with another before it came to earth. No units of Batavian archers are known. In small-scale engagements bow-armed elements of non-archer auxiliary regiments might give useful missile support. The distribution of arrow-heads might thus be compared with the incidence of glandes, there being no auxiliary units of funditores.[31]

A number of oriental 'national' numeri were deployed, notably in Dacia, Africa and Mauritania. All may be assumed to have been composed of sagittarii (most have the title) because this class of unit was formed to take advantage of particular skills of archery, light cavalry combat, or skills in forest and mountain warfare (see Deployment below). Quite why 'numeri' of archers were employed rather than alae or cohortes from the same regions is unclear. The numeri seem to have been internally organised along similar lines to the auxiliary units, however, with centuriones, decuriones, optiones, librarii, signiferi, immunes etc. epigraphically attested.[32] Their overall size is unknown. It is probable that the numerus Palmyrenorum Porolissensium c. R. at least contained horsearchers because of the likely 3rd century formation of an ala and a cohors Palmyrenorum from it.[33] The numerus Syrorum at Lalla Marnia in Mauretania Caesariensis may have had a mounted element because of its far-flung position and patrolling role.[34] Perhaps the Palmyreni of 'Hyginus'' army were all infantry.[35]

Large numbers of irregular symmachiarii were supplied by the Eastern client-states, the majority being light horse- and foot-archers. These were probably present in every Roman campaign from the Late Republic onwards and were transferred on occasion to the Rhine and Danube (Deployment below).

The best bow-armed troops in the Late Roman Army were provided by the field-army units. There was a predictable East-West imbalance in numbers and mounted and oriental units (assuming Persian-style clibanarii to be bow-armed): 13 vexillationes to 7 auxilia and legiones in the East; 10 vexillationes to 4 auxilia in the West.[36] Additional horse-archers were provided by 32 units of equites sagittarii indigenae in the East, 8 in the West, numbers again reflecting the cultural background of the Eastern provinces.[37] Moreover, some alae and cohortes had sagittariorum in their titles or appropriate geographical designations, but it is unclear whether they were still bow-armed.[38] Vegetius' description of an order of battle envisaged archers integral to the legiones and a late legio pseudocomitatensis has an archery title.[39] Presumably irregular contingents were used on campaign whenever available.

The impacts of the Huns and the Avars on Roman military practices made armoured, bow-armed cavalry the primary tactical arm, overlaying developments in the Roman-Sassanid frontier region. Infantry units continued to be bow-armed fulfilling the conventional skirmishing, screening and support roles. Hunnic horse-archer allies were also employed in significant numbers[40]

Archery had some permanent role in the Imperial Guard units. Most auxiliary regiments could have had archery training. Mural defence and limited field use could be other factors explaining the distribution of archaeological finds. The alae and cohortes sagittariorum probably supplied their own specialist equipment as would the 'national' numeri and more ad hoc bodies of symmachiarii. The legiones may have had some archery training but most likely manufactured bows for their own mural defence or for supply of weapons to non-archer auxiliary units. Field-use by legionarii would seem quite out of the question, at least before the Late Imperial period.

2. CALIBRE

There is no practical reason why the skills exercised by the best bowyers in Roman service should have been inferior to those outlined in the Islamic and Chinese sources. Details of construction, decoration. Stave proportions and mechanical properties obviously differed but a high degree of craftsmanship is likely in some contexts. The urban bowyers and fletchers in the Eastern Roman provinces and in the neighbouring Iranian empires might work for their cities' general supply of bows and arrows but their commercial business would have been dictated by their level of skill. Wealthy and noble customers would demand weapons commensurate with their social positions, for hunting purposes as much as for warfare. Bows and arrows made to an

an individual's personal height and length of draw would be more expensive and given more skilful attention by the artisan than the bulk of the stock for general sale. The quality of the bowyer's work and his reputation might dictated price and demand.

Within the Roman forces such market factors might not have been applied except for the irregular symmachiarii and irregular units made up from noble exiles and their retainers already armed when they came into service.[41] The Levantine raising of auxiliary sagittarii and the continued recruitment of easterners to these units could, however, mean that the individuals would bring with them weapons that they already owned and which may have been manufactured to personal specifications. Moreover, the speculation that such regiments and the numeri sagittariorum would have specialised fabricae producing archery equipment (Bow Construction above) could also mean a high level of construction skill was exercised.

With regard to legionary bow construction the quality of the finished product would have depended upon the available personnel. If the arcuarii involved were easterners working with suitable materials then perfectly good composite bows could be produced. The laths from Mainz, Windisch and Carnuntum are not distinguished from other site-finds by inferior workmanship. The same cannot be said for the Caerleon laths which display ineptly cut nocks in sections of bone badly chosen with regard to curvature and coarseness of cellular structure.

Problems in constructing or obtaining good composite bows may be hinted at by Vegetius' mention of wooden practice bows. That composite bows were in wide use is demonstrated by the distribution of laths but wooden self-bows would have left no archaeological trace under normal western conditions. Arrow-types have no bearing on the types of bows which shot them. Self-bow archery was employed in Gaul and Free Germany,[42] but for Roman combat purposes the employment of orientals in the alae, cohortes and numeri indicates composite bow use. Physically the latter type is always superior to ancient or modern self-bows.

The practice of composite archery in the West was essentially a product of the political domination of the Mediterranean by one power. In Western climatic conditions the mechanical properties of the stave materials would have been more prone to the detrimental effects of cold and moisture than in the Levant. The time taken to construct bows and the stages of that process depended largely upon glue setting rates dictated by temperature. Moreover, the utmost care would be required in the storage of staves whilst out of use or in transit. Drying-frames and bow-cases would therefore have been extremely important,

especially during winter months. In the hands of specialist troops archery equipment need not have been too adversely affected by these conditions. The framework of the Roman Army allowed for the presence of such troops in the West but after the eclipse of Western Roman power composite archery ceased to be widely employed despite periodic violent contacts with Asiatic peoples. The Roman Army was also the medium by which suitable horn for composite bellies was passed to the West. Not before the 10th century A.D. did composite construction appear again and then it was for shorter cross-bow staves, often substituting whale-bone for horn (Cross-Bows above).

The employment of Levantine sagittarii was a basic fact of Roman military policy from the Late Republican to the Late Imperial period. This and the continued recruitment of Easterners after Levantine units had been raised and moved away led Cheesman to the logical conclusion that "the reason for the adoption of these exceptional methods in the recruiting of the oriental auxilia was probably the purely military one that good archers were born in Syria, and could not be made elsewhere."[43] Good archers were in fact 'made' elsewhere, principally in Thrace, Cyrenaica, Numidia and on Crete, but it is clear that the Levantine cultural background produced the best archers at least before the impact of the Huns.[44] Commentators have emphasised the 'Eastern' elements within cohortes sagittariorum by studying personal names, origines and the tenacity of oriental religious cults.[45] The natural tendency has been to emphasise oriental elements especially in samples of personal names. Whilst no-one would deny the continuing oriental nature of important archer-units, the degree of local recruitment must not be played down. Even oriental numeri recruited locally and were capable of being culturally influenced by their location.[46] However, it is important to examine what exactly Cheesman's statement meant with regard to the calibre of archers in Roman service.

Ancient and modern observers of proficient archers often made a point of mentioning that skills were acquired at an early age.[47] This applies especially to horse-archery which virtually required the archer to be 'born in the saddle'. It was partly for this reason that the waves of steppe horse-archers made such impacts on settled peoples around the Asiatic fringes. Development of specific musculature early in life was probably very important. This is not to say that in a Roman context recruits from Pannonia, for example, entering a cohors sagittariorum at eighteen could not be trained and exercised to make them good archers. The basics of archery may be learnt fairly quickly and a moderate level of proficiency can be attained with constant practice. However, the higher levels of marksmanship, bow maintenance, good arrow-construction and horsemanship require years of experience and dedicated exercise.

Release of the string in shooting must be smoothly executed, the minutest variations in draw-length and finger-disengagement will affect the flight of the arrow. The mark of a skilled archer is constant accuracy under difficult circumstances so that he can function well in confused battlefield conditions. A regiment raised de novo from a population with no cultural background of archery, even if trained by oriental doctores, would be far inferior to a unit of Easterners already proficient with the bow on enlistment. Local, western recruits brought into this unit would benefit from the presence of oriental principales, doctores and arcuarii, not to mention living and working alongside their Eastern fellows. Therefore gradual induction of local recruits might not necessarily or immediately affect the efficiency of an oriental regiment's archery. It is unlikely that the strategically important auxiliary regiments would have been allowed to decline in skill. The unusual homeland recruitment which apparently continued after the unit had moved away was intended precisely to prevent degeneration.[48] Coupled with the circulation of Eastern doctores high standards would have been ensured.

The career of Barsemius Abbei may be of relevance in the last respect. He originated in Carrhae, served in a numerus Hosroruorum then in the ala firma Katafractaria as a decurio, before becoming a magister cohortis in the cohors I Hemensenorum mill. sag. eq. at Intercisa.[49] To judge from this series of units Barsemius must have been an equestrian trainer and/or an archery expert. If the former then it is likely that the numerus was mounted or part-mounted. If he was an archery instructor then it would be likely that the ala Katafractaria was bow-armed. For the cohors Hemensenorum, a unit of great numerical and strategic importance, it is reasonable to suppose that Barsemius was a skilled horse-archery campidoctor.[50]

A representation of a member of the ala I Augusta Parthorum at Cherchel suggests that Eastern regiments could degenerate if isolated from a continuous supply of oriental recruits.[51] By comparison with the Mainz ala Parthorum et Araborum tombstone horse-archers might reasonably be expected for the ala Parthorum but the African figure carries a round shield and a javelin. None of the known personnel of the ala Parthorum were of oriental origin and perhaps nearly two centuries of isolation in Mauretania resulted in a change of weaponry.[52]

A similar process of degeneration in skills may have affected the alae and cohortes in the Late Roman limitanei. None of those in the Notitia were given the suffix 'sagittariorum' although they included suitable geographical or ethnic titles and some pre-Severan units are known to have consisted of archers.[53] This may simply be because the full titles are not given in the

Notitia and, as all of these units occur in the East, they may have continued to be bow-armed. Alternatively reliance may have been put on the field-army units for the best archers (as in the West) and the limitanei have degenerated to spear- and shield-armed troops. The numerous units of equites sagittarii indigenae may thus represent a measure to compensate for this putative decline, or may have been a regularisation of the earlier symmachiarii. Although the emphasis, even with the limitanei, was on mounted troops,[54] on occasion it was possible for troops to be down-graded to infantry as in the case of the equites sagittarii recorded by Synesius.[55]

Some oriental regiments of sagittarii (oriental at least when raised) served in the Western field-armies but it seems unlikely that a supply of new, eastern recruits could have been kept up to these units. What level of archery skill they exercised may only be guessed at and some units of western origins with Gallic epithets also appear.[56] These troops, being 'mobile', may have relied entirely upon the Ticinum fabrica for their equipment. In the Eastern half of the empire supplies of materials and proficient personnel would not have been a problem. Contacts with Hunnic and Avar horse-archers and the increasing Roman bias towards mounted troops meant that the resulting 'composite cavalryman' did not meet his match in archery in the West, fighting Ostrogoths, Vandals, Alamanni and the Franks, and in the East, against the Sassanid Persians. The archery of these Late Roman cavalry with their Hunnic allies was of the highest calibre.

3. PERFORMANCE

The ranges of composite bows have been much discussed but with little consensus.[57] Vegetius quoted a surprisingly long practice range of 600 feet (274m).[58] This would certainly have to be worked up to be a novice starting at 200 to 300 feet (61-91m). Islamic treatises expected consistent accuracy at a range of 60 bows. With a side measurement of 114cm this gave a range of 75 yards (69m). An archer was capable, after a few years of practice of hitting a target of 3 feet (0.9m) diameter with every shot.[59] Late Roman and Byzantine tactical manuals used the bow-shot as a measure of intervals between troop-formations drawn up in the field but estimation of this 'unit' is not possible.[60] Bivar quoted a maximum of 250 yards (229m) and an effective range of 100 yards (91m). Collingwood and Richmond gave a modern range of 250 yards (229m) and an effective killing range of about 150 yards (137m).[61] Jobey used the last two figures when discussing the arrow-heads from Burnswark (Dumfries).[62] Along with artillery stones and glandes these arrows may have been loosed during manoeuvres. At the end

of his very useful review of ancient literary sources McLeod concluded that the "Turkish target range of 160-190m, the Byzantine 'moderate bow-shot' and the Turkish extreme effective range of some 310m, and the sundry flight shots of 500m, and upwards all square with the ancient values postulated. They suggest that the ancient evidence, tenuous though it be, has not betrayed us".[63]

In fact many variables are at work within these figures. Range depended upon the type of bow involved. All figures pertaining to 'flight' bows must be discarded in a discussion of military practice because these bows were designed to shoot light arrows over a maximum distance without accuracy. As discussed above a bow designed for use on foot is likely to be more powerful than a horse-bow, thus infantry-archers would normally have outranged horse-archers. The introduction of new bow-types obviously meant variation (presumably improvement) in performance. McLeod put together figures from widely separated periods and contexts with the misguided belief that "the oriental bows used on the fringes of the Greco-Roman world underwent no startling improvement between 700 B.C. and A.D. 700".[64] If nothing else the present study demonstrates the erroneous nature of this statement.

The nature of the target, its size, vulnerability, rate of movement etc., also governs accuracy and effectiveness over various ranges. The Moroccan treatise gives instructions on how to shoot at still and moving targets, horsemen and lions.[65] More modern observers describe two target exercises carried out in common by various Asiatic nomads, the Ottoman Turks and the Egyptian Mamluks.[66] A tall mast was set up with a gourd (qabaq) or another suitable target on the top and horse-archers would shoot near-vertically at the target whilst galloping past. This exercise simulated the shooting of birds on the wing. A second target was a butt (qīghaj) at which the archer galloping by had to shoot downwards. Some of the most skilful shots could be practised from below the horse's neck and this was intended to simulate the archer coming across an unhorsed foe in battle and not having time to put his bow away and take up sword or mace. It developed accuracy at short range and at short notice. The Japanese still gallop past and shoot at targets in yabusame exercises. The exercises and targets of Roman auxiliaries, mentioned by Hadrian, Arrian and Vegetius, make it seem likely that targets similar to the qighaj at least were devised for archers in Roman service.

Quite different are the demands for accuracy made upon a body of archers shooting at a large troop-formation. Whilst it might be desirable to pick off chieftains/officers and standard-bearers, arrows dropping into the mass of troops need

not be more than generally aimed and will be more likely to hit a target over the greater distance.[67]

The greater the range the less effective is the arrow's penetration on impact. The weight of the arrow and type of head are other contributory factors. The development of catafracti/clibanarii in the East was a direct response to archery. On the Danube heavily armoured Sarmatian cavalry would demand penetrative Roman archery. Light-armed, loose-formation targets such as skirmishing Moorish cavalry would require greater accuracy than penetration. However, in the West close-order, unarmoured Celtic or Germanic warbands would have formed slow-moving, soft targets.[68] British chariots would need only one horse to be killed for the whole vehicle to be neutralised.[69] Vegetius recommended that Roman foot-archers should be armoured to protect them from Gothic (foot-) archery.[70] The Armenian Tiridates with 1000 horse-archers offered to meet Corbulo if he was escorted by an unlimited number of unarmoured Roman troops. Corbulo refused because any number of unarmoured infantry would be useless against mounted bowmen.[71]

Taybughā's Ghunyah is most important as a treatise on horse-archery skills and he described a variety of shots from the saddle over a field of almost 180 degrees.[72] Some of these shots may have been difficult if not impossible, before the introduction of stirrups by the Avars. However, the performance of ancient horse-archers demonstrates that they were not markedly inferior to medieval horsemen. Stirrups are advantageous principally in providing firmer support for downward sword-slashes and for the couching of the lance, but some of Taybughā's shots below and across the front of the horse's neck demanded that all the rider's weight be put on one stirrup.

It must be said that there is nothing inherently 'Parthian' about the 'Parthian Shot'. The ability to shoot back over the horse's rump, and indeed all around, especially whilst retiring, was common to all good horse-archers from the Scythians to the Crimean Tatars.[73] Close-order, armoured cavalry might have shot behind but the shooting arc forward and to the sides would have been restricted by their formation.[74] The reason for the modern association of shooting backwards with the Parthians is the fact that the 'Parthian Shot' and Parthian archery generally became a Leitmotif in Roman literature.[75]

4. DEPLOYMENT

Vegetius recommended the use of archers and light infantry as a screen for an army on the march in potentially hostile country.[76] This is seen in practice on both Vespasian's invasion

of Galilee and Arrian's projected advance to meet the Alani.[77] Arrian had horse-archers at the head of the column (from cohors III Petraeorum mill. sag. eq.) preceded by exploratores and backed by an ala.

In Roman battles foot-archers with javelinmen and slingers formed a screen to protect the close-order legionary infantry from enemy missiles. They served to provoke an enemy advance by skirmishing forward and retired through the main line as the enemy approached. They would then form up behind it or move to the flanks. Once the enemy was repulsed the light troops would move back through the line and pursue.[78] Archers might alternatively have been drawn up originally behind the legionary infantry, as Arrian, Vegetius and Julian stipulated giving missile support as the enemy charged in and during the ensuing melee.[79] The pedites sagittarii of Arrian's force were joined by horse-archers shooting over the heads of the legionarii.[80] Instead of, or in addition to this position, archers were often placed with the bulk of the cavalry on the flanks as in Caesar's North African battles or in Corbulo's order of battle in Armenia. Arrian placed his Armenian symmachiarii on his right flank. When Maximinus Thrax advanced to Emona his army was in a shallow square enclosing the baggage, with catafracti, Moors and bow-armed cavalry on the wings. Vegetius recommended light horse-archers be grouped on the wings. Julian placed catafracti and sagittarii on his flanks facing the Alamanni.[81] Arrian deepened his legionary formation to take the physical impact of the Alan cavalry charge but this impetus, it was hoped, would have been disrupted by an arrow storm projected from behind the line and from the flanks.[82]

In 6th century armies the armoured, bow-armed cavalry were the close-order battle-line. The tactics employed were intended to gain maximum effect of archery if the enemy was unable to reply in kind (in the West) or to fight an archery duel before charging in with the contus (in the East).[83] On one occasion Sarmatian cavalry with shorter-range bows attempted to lessen the effects of the enemy archery by discarding their bows, taking up contus and sword and charging in as soon as possible.[84] The greatest danger for an armoured, mounted army was to be drawn out and disordered by opposing light horse-archers. The Sassanid Peroz's army was fatally enticed by Ephthalites feigning flight and the main Byzantine line at Manzikert was stung into pursuing Selçuk horse-archers.[85] 'Feigned flight' was also employed by Roman horse-archers and on one occasion Ostrogothic cavalry were drawn forward by a horse-archer screen to make a fine, dense target.[86]

Unless armed with shafted-weapons and shields light horse-archers were at a great disadvantage if contacted by enemy

troops with melee weapons.[87] However, their mobility enabled them to skirmish with both enemy cavalry and infantry formations. Facing infantry without missile-support they were extremely effective in harassment. If caught and routed by such troops the horsemen could easily outdistance pursuit and ensure that the defeat was indecisive. Precisely these tactics led to the Carrhae debâcle and to the savage mauling of Antonius' humiliatingly unsuccessful expedition.[88] Antonius realised the need for more cavalry and archers after the event. In the Imperial period this lack was rectified by the regular auxilia and the wide use of client symmachiarii. Admittedly the invasions of Parthia by Trajan and Severus were aided by the weakness of the Arsacid monarchy[89] but Roman armies were well supplied with support troops and in no danger of suffering Crassus' fate on the battlefield. Even under Crassus the legionarii could only be defeated in combat if detachments could be lured out and isolated. The Parthian catafracti crushed the inferior Gallic cavalry but were too few to do more than hold the legionary front whilst horse-archers harassed the flanks.[90] Julian's advance down the Euphrates may have been ultimately disastrous but the Roman forces defeated the Sassanids in the major engagements, even when elephants were sent in to disorganise them. The Sassanids were superior in archers (horse, foot and elephant-mounted[91]) but the Roman troops were able to close with them quickly enough to lessen the effect of missiles.[92]

Infantry-archers were far more vulnerable than horsemen because they were more easily caught. At Idistaviso the Germans attempted to reach the pedites sagittarii but these were protected by Gallic and Germanic auxiliarii who repulsed the attack. Sabinus' archers in the Thracian war were effective at long range but were quickly routed by an unexpected barbarian attack.[93] Arrian protected his Armeni on a hill by posting a cohors Italica in front of and below them.[94] The auxiliary sagittarii, as in Vegetius' battle-order, were safe at the rear.

In less set-piece situations archers were used to support work-parties and river-crossings.[95] During sieges archery could be employed to drive the defenders from the parapets or archers with other missile troops could be put into siege-towers to support escalades.[96] The defensive value of archery is nicely demonstrated when an Ostrogothic, ox-drawn siege-tower being hauled up to the walls of Rome was neutralised by the simple expedient of shooting the oxen.[97] The mural provision of projecting stone towers, especially ones with cranellated tops, was primarily for archery, not the positioning of artillery-pieces, to give added range through height and command of the base of the curtain.[98]

Breeze has stated that Roman auxiliaries besieged in their forts were at a great disadvantage because they did not have suitable defensive weapons.[99] The wide distributions of laths and arrow-heads along the limites belies this view which is possibly a subconscious over-statement of the truism that the two British walls were not used as fighting platforms and that the army preferred to seek out the enemy in the field. Weapon-stores in forts must be envisaged as having had a few bows, bundles of arrows, bundles of light javelins, perhaps shaped stones for throwing and dropping, and a sack or two of caltrops to be scattered on causeways.

Caesar used ship-board archers, slingers and artillery to support troops making the contested landing of his first invasion of Britain. He had them in Africa also, and Antonius used archers at Actium. Vegetius recommended their employment and Belisarius hauled up archers to the tops of ships' masts.[100] A relief of two sagittarii from Koptos in Egypt demonstrates the use of Palmyrene archers on ships engaged in the Indian trade.[101] Fire-arrows would have been very useful in naval contexts, as in sieges.

Roman auxiliary archers were deployed all along the limites as an integral part of frontier armies. Units might be placed in positions of strategic importance, for example the cohors I Flavia Damascenorum mill. eq. at Friedberg in the neck of a frontier salient.[102] In more neutral positions regiments could support other troop formations with vexillationes in the field, as may have been the case with cohors I Hamiorum at corresponding medial positions on the British walls.[103] The cohors I Cilicum mill. certainly supplied a detachment to accompany Lower Moesian units in the Crimea, perhaps because of the Sarmatian enemy there.[104] However, concentrations of units of archers corresponded with areas where Roman armies faced peoples who were predominantly horsemen and/or archers.

In the Eastern theatre Armenian, Parthian, Jewish and Sassanid archery dictated that the Romans should raise units of oriental archers and employ local symmachiarii. Trajan's Parthian enterprises required the formation of specialist units of sagittarii and dromedarii, presumably aided by the annexation of Arabia.[105] The rump of the exercitus Cappadocicus on campaign with Arrian had a high proportion of archers amongst the auxilia, 5 out of 10 cohortes, and these were intended to play a very important part in the projected battle.[106] Knowledge of Cappadocia's entire auxiliary garrison is now fairly complete and out of 15 units 6 consisted of sagittarii with Armenian archers available in addition.[107] None of the alae were bow-armed and indeed Arrian's Techne Taktike only discusses Western cavalry in detail, mentioning horse-archers briefly.[108] With numerous

infantry-archers to outrange enemy mounted bowmen perhaps greater need was felt for cavalry armed with melee weapons.

In Syria the native archers had a policing function in protecting the trading caravans between the 'caravan cities' from attack by desert nomads. The importance of this role is manifest in Palmyrene sculptural depictions of 'Caravan gods' armed and attired as light horse-archers and dromedary-bowmen (Fig.33).[109] Apart from Roman employment of these archers they were of wider importance in the 3rd century and were able to maul Sassanid troops retiring after plundering Syria.[110] The stationing of cohors I Flavia Chalcidenorum sag. eq. at Palmyra and of cohors XX Palmyrenorum mill. sag. eq. at Dura-Europos, probably respectively in association with the wars of Verus and Severus, suggest functions in the maintenance of desert communications.[111] Bodies of irregular Palmyrene archers were probably always present at Dura.[112]

The defence of the Danubian provinces involved conflict with three tactical classes of enemies. The Sarmatian peoples fielded armoured, bow-armed cavalry.[113] The Germanic tribes fought in close-order warbands.[114] The 'Free Dacian' tribes were probably skilled in mountain warfare and practised composite archery under Sarmatian influence.[115]

From the mid 1st century A.D. the North-South river line of Eastern Pannonia had a high proportion of cavalry facing the Iazyges as compared with the frontier of Northern Pannonia facing Germanic tribes.[116] After the Marcommanic Wars of Marcus in particular there was a marked concentration of auxiliary sagittarii.[117] At Szentendre (Ulcisia Castra) the cohors I mill. Aurelia Antonina Surorum (later on the cohors mill. Nova Surorum) was in garrison;[118] Nagyteteny (Campona) probably held the ala I Thracum veterana sag.;[119] Dunaujvaros (Intercisa) was garrisoned by the cohors I mill. Hemesenorum sag. eq.[120] In addition to Syrian archers units of North African troops versed in cavalry warfare were brought in.[121]

The Roman forces in Dacia flanked by Sarmatians and with Dacians to the north, contained a large number of cohortes sagittariorum centrally located or on the limes Alutanus facing the Roxolani.[122] These were supplemented by numeri sagittariorum, three of Palmyreni (Porolissensium, Optatianensium, Tibiscensium) and one of Suri (Malvensium).[123] These consisted of both cavalry and infantry and were presumably located to counter enemy archery in addition to fulfilling their frontier policing role.

Along the Danube, facing the Germanic tribes, units of sagittarii were markedly fewer except towards the 'knee' where

Iazyges were nearby and the ala III Augusta Thracum sag. was located at Almasfuzito (Azaum).[124] However, here and on the Rhine, greater use of archers, especially mounted ones, was favoured for armies in the field. An inscription from Carnuntum, apparently associated with Vespasianic forces in the Civil War, mentions a miles who was ex vexil(latione) sagit(tariorum) exer(citus) Syriaci.[125] A body of archers made up from various Eastern units might have seemed an effective expedient to supplement the Danubian defences whilst the legiones were active elsewhere. The army itemised by 'Hyginus' included 500 Palmyreni and similar, probably contemporary, troops are represented on the Marcus Column (Fig.24) for use primarily against the Germans.[126] Interestingly the only Western troops in the Notitia corresponding to the Eastern equites sagittarii indigenae all appear in the Pannonian commands.[127]

Further West Severus Alexander included Osrhoenians, Armenians and Parthians in the army assembled for his German campaign together with Moorish cavalry. "This force Alexander began to train to use against the Germans. An army of this kind is particularly harassing to them because the Moors with their javelin-throwing used their tactics of light-armed attack and withdrawal, and the archers found the Germans' bare heads and huge bodies an easy target for their arrows".[128] These were further augmented by Maximinus Thrax for his German campaign and later brought into Italy.[129] The sagittarii Osrhoeni were prominent enough to pose a danger to Maximinus through revolt.[130]

North-west Africa was another region where alae and cohortes sagittariorum were employed in some numbers.[131] The barbarian enemies consisted of skirmishing javelin-armed light cavalry (themselves employed widely by the Romans) and presumably javelin- or bow-armed light infantry.[132] The high proportion of part-mounted cohortes, especially in Numidia, reflected the tactical response to an elusive enemy in the field and the need to patrol vast areas. The composition of the Pannonian reinforcements sent in for the Mauretanian war of Antoninus Pius suggests a well-considered reaction to tactical problems posed by the enemy. The whole of ala I Ulpia contariorum mill. was joined by vexillationes of six other alae.[133] Of the latter three were from alae sagittariorum (III Augusta Thracum, I Thracum veterana and I Ituraeorum) and one may have been contus-armed (I Cannenefatium).[134] Evidently the vexillationes had to be mounted and were chosen with regard to their specialised weaponry. Perhaps experience in dealing with mounted adversaries was also a determining factor.[135]

Oriental numeri sagittariorum were also employed in Mauretania and Africa. In Numidia during the late 2nd to early 3rd century A.D. a numerus Palmyrenorum had its headquarters at

El-Kantara (Calceus Herculis), vexillationes of it appearing elsewhere, and a numerus Hemesenorum was also present.[136] In Mauretania Caesariensis a numerus Osrhoenorum was present at Sidi Ali ben Yub (Kaputtasaccora) and the numerus Syrorum Malvensium was in an extended position at Lalla Marnia (Numerus Syrorum) from the Severan period.[137] The latter was transferred from the limes Alutanus, may have been of milliarial strength and probably was part-mounted. The numeri perhaps primarily performed a policing function (as on other frontiers) but with the climate and terrain conditions being similar to those in Syria. This area and Dacia were the only occidental regions in which numeri sagittariorum were deployed with consistency.[138]

ACKNOWLEDGEMENTS

A great many people have advised the writer over several years on specific points. In addition to those acknowledged in the notes, a more general debt is owed to Prof. E. Birley, Mr G.C. Boon, Mr C.M. Daniels, Mr J.P. Gillam and Prof. J.J. Wilkes. The writer is particularly grateful to Dr B. Zouhdi, Dr K. As'sad and Dr A. Taha for granting access to the Damascus and Palmyra museum collections, and to Prof. A. la Regina and Arch. G. Martines for their tremendous help for studying the sculptural monuments of Rome. Much of this work would have been impossible without generous grants from the British School at Rome, the British School at Jerusalem, and the British Institute at Amman. Several fellow members of the Society of Archer-Antiquaries have been very helpful indeed, in particular, Lt-Cdr W.F. Paterson, Mr E. McEwen and Mr M. Anderssohn. Mr M.C. Bishop, Mr D.B. Boyson and Dr H. Dodge very kindly read the text and made many helpful suggestions and corrections. Lastly, Mr W. Hubbard and Mrs A. Gibson drew up the figures. The opinions expressed and any errors contained in this paper are purely the writer's and not necessarily held by the many people gratefully acknowledged here.

ADDENDUM

Two possible ear lath fragments have been found at St. Albans, Hertfordshire (Britannia) in Insula XIV. They are broken at both ends (3.6cm and 2.4cm in length) and appear to have back zone scoring on the convex faces. Their presence at a town site is perhaps similar to finds from Colchester and Silchester (Cat. Nos. 6 and 8) in their supposed civilian context - cf. S.S. Frere, Verulamium Excavations, Vol.III, (Oxford 1984), 75 No.293.

NOTES

INTRODUCTION

1. RICHMOND, 1935, 16.

2. Cf. especially DARKO, 1935; DE WEERD & LAMBRECHTS, 1938; CALLIES, 1964; SADDINGTON, 1970.

3. JONES, 1964, 655, 661-2.

4. LATHAM & PATERSON, 1970; FARIS & ELMER, 1945; KLOPSTEG, 1947.

5. CHIUNG, 1981.

I. BOWS

1. See in general ARMITAGE & CLUTTON-BROCK, 1976. The writer is very grateful to Dr S. Greep for discussing many aspects of bone, antler and horn materials.

2. MACDONALD & PARK, 1905-6, 524; NASH-WILLIAMS, 1932, 94, 96.

3. Ibid., 96.

4. VON GROLLER, 1901, 132; MACDONALD & PARK, 1905-6, 527.

5. WERNER, 1932, for the best summary.

6. RAUSING, 1967, 22-6; MAENCHEN-HELFEN, 1973, 223-5. Also EMENEAU, 1953, 79.

7. VON FLESCHENBERG, 1941.

8. For example, RAUSING, 1967, throughout.

9. WERNER, 1932, 48; POLASCHEK, 1932, 240, 256-7; ALFÖLDI, 1932, 18; WERNER, 1956, 48, Map 4.

10. MACDONALD & PARK, 1905-6, 523-8, Fig.44; MACDONALD, 1934, 283-4, Fig.39; ROBERTSON et al., 1975, 56, Fig.18.8. Hunterian Museum, Glasgow, Inv. F.1936.117(8-10). Dr L.J.F. Keppie very kindly discussed these pieces and allowed the writer to examine them.

11. ALLASON-JONES & MIKET, 1984, 2.16, 2.18; Museum of Antiquities, Newcastle upon Tyne, Inv. 1972.31; South Shields Museum, Inv. 1900.44. The writer is very grateful

to Miss L. Allason-Jones and Mr R. Miket for access to these pieces.

12. Corbridge Museum, Inv. 75.1219-23, 75.3630, 75.3634. Study of these pieces was kindly arranged by Mr J. Dore.

13. Inv. 75.3563.

14. BUDGE, 1903, No.339-40; Clayton Museum Inv. No.633-4.

15. BIRLEY, 1977, Pl.60. The writer is obliged to Mrs P. Birley for allowing examination of this lath.

16. CRUMMY, 1983, 138, Fig.160, Inv. 4245.

17. WEBSTER, 1958, No.156; GREEP, 1983, Fig.2.1-2. Museum of London, Inv. 13942, 18208, 20077. Mrs J. Hall kindly arranged for the study of these pieces.

18. WEBSTER, 1958, No.192; BOON, 1974, 68, Fig.8.7.

19. NASH-WILLIAMS, 1932, 94-6, Fig.42.

20. Ibid., Fig.42.1; BOON, 1972, Fig.30.12.

21. NASH-WILLIAMS, 1931, 131-3.

22. WEBSTER, 1965, 149, No.21, Fig.7.21.

23. GRÜNEWALD, 1981, 23.

24. STADE, 1933, 113-4, Fig.2; WERNER, 1956, 47.

25. BEHRENS, 1913-14, 72, No.23, Fig.6.20; KLUMBACH, 1968, 73,40, Pl.5.4; 1971, 231-2, Pl.96.9.

26. WERNER, 1932, 35, 57-8, Figs.2, 10; POLASCHECK, 1932, 256-7; RAUSING, 1967, 65.

27. O.R.L. Abt.B, No.8, 182, Pl.XX.80; ECKINGER, 1933, 289 n.[1].

28. FISCHER, 1973, Fig.48, No.4.

29. O.R.L. Abt.A, Str.6, 44, Fig.7.3-4; STADE, 1933, 111-2, n.[6], Fig.1.

30. ECKINGER, 1933, 289, n.[9].

31. STADE, 1933, 113.

32. ECKINGER, 1933, 289-90, Fig.1.

33. GRÜNEWALD, 1981, 23.

34. ULBERT, 1970, No.253-6, Pl.13.

35. PLANCK, 1983, 47-9, Fig.24.

36. WALKE, 1965, 55, 152, No.25-31, Pl.105.

37. VON GROLLER, 1901, 132, Pl.XXIV.22-5; WERNER, 1932, 33-5, 39, Fig.1; POLASCHECK, 1932, 241-2.

38. GRÜNEWALD, 1981, 23-4, Pl.16, 17. Mr M.C. Bishop has kindly drawn the writer's attention to the fact that the Waffenmagazin material is all commensurate with a 1st-2nd century A.D. date, despite disturbance. Perhaps all the laths are of this period therefore.

39. SALAMON, 1976, 48-50, Pl.24-6; LENGYEL & RADAN, 1980, 400, Fig.70.

40. Pers. comm. Mr S. James, contra ROSTOVTZEFF, 1935, 221-2.

41. BALFOUR, 1921, 306-7, Fig.14. The writer is very grateful to Miss L. Cheethan for allowing examination and photography of this piece.

42. Scene numbering follows CICHORIUS, 1896-1900.

43. For example on the 4th century B.C. Kul Oba electrum vase, MINNS, 1913, Fig.93-4; ROSTOVTZEFF, 1922, Pl.XXII; PHILLIPS, 1965, Fig.61; RAUSING, 1967, Fig.54.

44. WEBSTER, 1969, Pl.XXI. These lines are definitely on the stone itself and are not a product of the casting technique.

45. ROBINSON, 1975, 7, 83, 183.

46. KIESERITZKY & WATZINGER, 1909, No.501; MINNS, 1913, Fig.223; ROSTOVTZEFF, 1922, Pl.XXVII. For other bows with curved ears see Quivers and Bow-Cases, below n.58.

47. Scene numbering follows PETERSEN et al., 1896.

48. ORANGE & VAN GERKAN, 1939, 45-7, Pl.8-11.

49. FRESHFIELD, 1921-2, Pl.XVII, XX, XXIII.

50. G.R. III, Pl.IV,1; ESPÉRANDIEU, 1907-66, No.6136-7.

51. Ibid., No.6125.

52. G.R. III, Pl.IV,1; ÉSPÉRANDIEU, 1907-66, No.5861 (Monimus).

53. SMITH, 1968, Pl.XVI; WEBSTER, 1969, 151, Pl.XVI. The writer is very grateful to Dr D.J. Smith for his advice and patient discussion of this sculpture.

54. TOYNBEE, 1962, No.93, Pl.94.

55. PFEFFER, 1957, 121; INSTINSKY, 1958, Fig.1; HOLDER, 1980, Pl.3.B.

56. SPEIDEL, 1965, 86, n.540.

57. HOFMANN, 1905, Fig.23.

58. BARADEZ, 1954, Fig.10; BENSEDDIK, 1979, Fig.5.

59. CUMONT, 1942, Fig.25; C.S.I.R., Ost., I,5, No.9.

60. SEYRIG, 1937, Pl.IV; GHIRSHMAN, 1962, Fig.4,90; COLLEDGE, 1967, Pl.4.

61. CAMPBELL, 1968, 183-4, 191-6, 250, Pl.III-IV, XXII, XXVI, XXX, XXXVI-VIII, XL-XLI; ROSTOVTZEFF et al., 1939, Pl.XIV. For other deities see ÉSPÉRANDIEU, 1907-66, No.3540, 4916, 5233, 7804.

62. A.R.B., 55, No.9, Pl.XX.

63. For cross-sections see VON LUSCHAN, 1899, Fig.7; BALFOUR, 1890, Pl.VI; 1921, Fig.4-5; STONE, 1934, Fig.170; BROWN, 1937, Fig.2; RAUSING, 1967, Fig.3; LATHAM & PATERSON, 1970, Fig.10.

64. LEVI, 1947, Pl.XCa.

65. BALTY, 1969, Pl.VII.2, IX, XXXIV, XXXIX.

66. BRETT et al., 1947, 82, Pl.39.

67. GUSMAN, 1914, Pl.140.

68. BROWN, 1937, 5; DARKO, 1946-8, 87-9; RUBIN, 1955, 273-8; KAEGI, 1964, 98-9; BIVAR, 1972, 281-6; MAENCHEN-HELFEN, 1973, 228.

69. LATHAM, 1970; BIVAR, 1972, 290; LATHAM & PATERSON, 1970,

37-40; 1979, 79-80.

70. Dio, XL, 15 says exactly this. Cf. Julian, 63,C-D.

71. MEDINGER, 1933; DEBEVOISE, 1938, 86-7; ROSTOVTZEFF, 1943, 184-5; RUBIN, 1955, 273-5; BIVAR, 1972, 273-6.

72. BROWN, 1937, 1-3.

73. Ibid., 2.

74. RAUSING, 1967, 68.

75. Ibid., 100-1, 105, 150.

76. POPE, 1938, Pl.134a; GHIRSHMAN, 1962, Fig.340.

77. ROSTOVTZEFF, 1943, Pl.XVIII-XIX.

78. MAENCHEN-HELFEN, 1973, 224.

79. RAUSING, 1967, 105, n.17.

80. RAUSING, 1967, 105; PATERSON, 1969a, 29, Fig.1.3; MAENCHEN-HELFEN, 1973, 228-32. This is another inexact term because this bow-type occurs outside the Sassanid Empire and period. See EMENEAU, 1953, 86, Fig.10-14 for 4th-6th century Indian coins depicting it.

81. POPE, 1938, Pl.163a, 209-11, 213-4, 229, 239; GHIRSHMAN, 1962, Fig.236-8, 248, 252-4, 247, 314; BIVAR, 1972, Fig.23; MAENCHEN-HELFEN, 1973, Fig.7-8; HERRMANN, 1977, 15, 119.

82. BIVAR, 1972, 282, Fig.20-22; LATHAM & PATERSON, 1979, Fig.93.

83. GHIRSHMAN, 1962, Fig.343; BELENITZKY, 1968, Pl.34; PATERSON, 1969a, 31.

84. GHIRSHMAN, 1962, Fig.236-8; HERRMANN, 1977, 17, 132-3. Bows in the Tāq-i-Bustān game-park relief have angled ears.

85. No laths appear in MINNS, 1913; ROSTOVTZEFF, 1922; RUDENKO, 1970.

86. SULIMIRSKI, 1970, 32, 120. Suggested by the curled ears in Crimean art, Bow-Cases and Quivers, below, n.58.

87. Arrian, Ektaxis, 3,18.

88. DAVIES, 1977, 269-70.

89. SYME, 1929, 130-3; EADIE, 1967, 165-8 (for the evidence but his conclusions are worthless); SULIMIRSKI, 1970, 29; BIVAR, 1972, 274; MAENCHEN-HELFEN, 1973, 238-9; WILKES, 1983, 258.

90. Tacitus, Annals, VI,35.

91. RAUSING, 1967, 68-9, Fig.57.

92. BERGMAN, 1939, 121-4, Fig.30, Pl.18.10; HEDIN, 1940, 76-9.

93. BERGMAN, 1939, 122, Pl.XIII,a; HEDIN, 1940, 78. Composite bow in right background.

94. BERGMAN, 1939, 123.

95. Disribution map and discussion WERNER, 1956, 46-50, Map 4. See BROWN, 1937, 5; BERGMAN, 1939, 123-4; WERNER, 1939, 194, Fig.2a; FIELD & PROSTOV, 1940, 417; LÁSZLÒ, 1951, 99; RAUSING, 1967, 67, 123; MAENCHEN-HELFEN, 1973, 222.

96. SEBESTYEN, 1930; WERNER, 1932; ALFÖLDI, 1932.

97. WERNER, 1956, 48.

98. POLASCHEK, 1932, 239-40; ALFÖLDI, 1932, 18-22, Fig.1.

99. POLASCHEK, 1932, 241-2; WERNER, 1932, 33-5, Fig.1; ALFÖLDI, 1932, 23-4.

100. MAENCHEN-HELFEN, 1973, 255-6.

101. ALFÖLDI, 1932, Fig.2.

102. ALFÖLDI, 1932, 18-20, Fig.2; RAUSING, 1967, 68-9, 143; MAENCHEN-HELFEN, 1973, 222.

103. WERNER, 1932, Fig.5; ALFÖLDI, 1932, Fig.1; LÁSZLÒ, 1951, 99; WERNER, 1956, Pl.25.

104. ALFÖLDI, 1932, Pl.II; LÁSZLÒ, 1951, 93-8, Pl.XXI-II; HARMATTA, 1951, 143-4, 148; WERNER, 1956, 49-50, Map 4, Pl.16, 51-2, 61; PHILLIPS, 1965, 125-6, Fig.139; RAUSING, 1967, Fig.55; SULIMIRSKI, 1970, 192, Fig.72; ELMY, 1981.

105. DARKO, 1935, 465-9; 1946-8, 87-9; KAEGI, 1964, 98-9; BIVAR, 1972, 283-6; MAENCHEN-HELFEN, 1973, 227; HALDON, 1975, 11-13.

106. Sidonius Apollinaris, Panegyric on Avitus, 23; Gregory of Tours, Historia Francorum, II,8.

107. Zosimus, Historia Nova, 27, 34, 50; Procopius, Wars, V,xxii,5-6.

108. Ibid., I,i,8-15; III,viii,27-8; ix,11; V,xxvii,26-8; VIII,xxxii,7-10. See Agathius, Historiae, II,9.

109. WERNER, 1956, 48, 53; RAUSING, 1967, 67.

110. Procopius, Wars, I,xviii,31-4; BIVAR, 1972, 286.

111. Maurikios, Strategikon, i,2,2; DARKO, 1937, 119-22, 129, 134-7; 1946-48, 95; BIVAR, 1955, 62-5; 1972, 287; GROUSSET, 1970, 171-6; HALDON, 1975, 15, 21-2, 24. Other cavalry and archery equipment developed and spread by steppe peoples included dracones, spangenhelme, double-handed lances, types of quivers and bow-cases, the use of ear laths, sabres, sabretaches, pellises, thumb-rings, scabbard-slides and felt armour.

112. FETTICH, 1926, 46, 60. Fig.11,18; SEBESTYÉN, 1930, 206-19, Fig.1-6; HORVÁTH, 1935, Pl.I, III-V, IX, XVII-XVIII, XXXVI; MAROSI & FETTICH, 1936, 12, 14-16, 19, 46, 53, Pl.II-III, V-VI, VIII; VETTERS, 1948, 239, Pl.XX.F; WERNER, 1956, 35-6, 43; RAUSING, 1967, 69, Fig.30; GARAM et al., 1975, 63, 130, 215, 290-1, 308-9, 317-8; LENGYEL & RADAN, 1980, 410, Fig.75-6.

113. SEBESTYÉN, 1930, Fig.2.4; HORVÁTH, 1935, Pl.XVIII.7; MAROSI & FETTICH, 1936, Pl.III.7; RAUSING, 1967, Fig.30; GARAM et al., 1975, 215, 290-1, 317-8.

114. The next steppe bow-type, introduced by the Magyars, had the nock an even greater distance from the ear-tip and a reduced total of 6 laths. Dr G. Fabian has built working reconstructions with a moderately set-back handle and very long, stiff ears which angle sharply forward when the stave is reversed. Length 152.5cm. See SEBESTYÉN, 1930, Fig.9; RAUSING, 1967, 70, Fig.31; FABIAN, 1970, 12-16, Fig.1-3; DIENES, 1972, 38, Fig.10, Pl.18.

115. SEBESTYÉN, 1930, 211-12, Fig.8 for the clearest explanation.

116. Ibid., 214; HORVÁTH, 1935, 14, Pl.IV.11-12.

117. The writer is very grateful to Lt-Cdr W.F. Paterson for making available much information about recent Avar finds and Dr G. Fabian's reconstructions. See now FABIAN, 1984.

118. MACDONALD & PARK, 1905-6, 527.

119. CHIUNG, 1981, 172. Lt-Cdr W.F. Paterson, pers. comm.

120. RAUSING, 1967, 19. The term 'composite' was coined by General Pitt-Rivers (BALFOUR, 1890, 220).

121. BALFOUR, 1890, 227; 1921, 295-302; VON LUSCHAN, 1899, 228-33; MEDINGER, 1933, 228-30; BROWN, 1937, 4-5; KLOPSTEG, 1943, 185; EMENEAU, 1953, 78; FARIS & ELMER, 1945, 11-12; RAUSING, 1967, 147; MARSDEN, 1969, 9-10, Fig.2-3; LATHAM & PATERSON, 1970, xxv-viii; 1979, 79; MAENCHEN-HELFEN, 1973, 222.

122. KLOPSTEG, 1943, 178; PATERSON, 1966a, 80-1; 1969a, 29; RAUSING, 1967, 19-20, 144, 146; LATHAM & PATERSON, 1970, xxvii-viii.

123. PATERSON, 1966a, 85.

124. Ibid., 81, 83-4.

125. BROWN, 1937, 2, 5; PATERSON, 1966a, 72-3; LATHAM & PATERSON, 1970, 11; MCEWEN, 1979, 92.

126. KLOPSTEG, 1947, Fig.43; PATERSON, 1966a, Fig.3; RAUSING, 1967, Fig.62.

127. KLOPSTEG, 1943, 178; 1947, 145-7; PATERSON, 1966a, 78-9; 1966b, 19; RAUSING, 1967, 146-7; LATHAM & PATERSON, 1970, xxviii-ix; MCEWEN, 1979, 81.

128. PATERSON, 1966a, 79.

129. RAUSING, 1967, 17; MCEWEN, 1979, 81.

130. FABIAN, 1984.

131. Mr E. McEwen, pers. comm. See BROWN, 1937, 5.

132. LATHAM & PATERSON, 1970, 6, 16-17; FARIS & ELMER, 1945, 14.

133. STONE, 1934, 131, 682; MAENCHEN-HELFEN, 1973, 227.

134. ALFÖLDI, 1932, 18-20, Fig.2. Reproduced in MACDONALD, 1934, Fig.40; LENGYEL & RADAN, 1980, Fig.70.

135. BROWN, 1937, 2.

136. MAENCHEN-HELFEN, 1973, 226-7.

137. FARIS & ELMER, 1945, 160-1; LATHAM & PATERSON, 1970, 11.

138. FARIS & ELMER, 1945, 86.

139. LATHAM & PATERSON, 1970, 8.

140. MAENCHEN-HELFEN, 1973, 226.

141. VON LUSCHAN, 1899, 233; RAUSING, 1967, 157; LATHAM & PATERSON, 1970, 15-16; CHIUNG, 1981, 159-60.

142. FARIS & ELMER, 1945, 5; KLOPSTEG, 1947, 10; CHIUNG, 1981, 160.

143. LATHAM & PATERSON, 1970, 6-7.

144. FARIS & ELMER, 1945, 161; KLOPSTEG, 1947, 41-2, 121; PATERSON, 1966a, 70-1; RAUSING, 1967, 155; LATHAM & PATERSON, 1970, 11.

145. BALFOUR, 1890, Pl.VI; 1921, Fig.4-5; VON LUSCHAN, 1899, Fig.2,7-8; BROWN, 1937, Fig.2; PATERSON, 1966a, Fig.2; 1966b, 19; RAUSING, 1967, Fig.3; LATHAM & PATERSON, 1970, Fig.10; MCEWEN, 1979, 90.

146. MCEWEN, 1979, 91.

147. PATERSON, 1966a, 72, Fig.1; LATHAM & PATERSON, 1970, 11-12, Fig.12.

148. BROWN, 1937, 2.

149. MCEWEN, 1979, 92.

150. PATERSON, 1966a, 72.

151. Ibid., 70; MCEWEN, 1979, 91.

152. KLOPSTEG, 1947, 40-1; RAUSING, 1967, 155; CHIUNG, 1981, 165-6, 174.

153. VON GROLLER, 1901, 132; MACDONALD & PARK, 1905-6, 527.

154. MACGREGOR & CURREY, 1983, 75-6.

155. BALFOUR, 1879, Pl.IX; BROWN, 1937, 2; PATERSON, 1966a, Fig.1; LATHAM & PATERSON, 1970, Fig.9; CHIUNG, 1981, 177.

156. PATERSON, 1966a, 74.

157. RAUSING, 1967, 155.

158. BALFOUR, 1890, 229-30; 1897, 212; 1921, 291-301; ADLER, 1905, 12; FARIS & ELMER, 1945, 86, 161, 167-70; KLOPSTEG, 1947, 42, 121; EMENEAU, 1953, 79; PATERSON, 1966a, 81-2; RAUSING, 1967, 155; FABIAN, 1970, 12; LATHAM & PATERSON, 1970, 13; MCEWEN, 1979, 91.

159. BALFOUR, 1921, 292, Fig.1; BROWN, 1937, 1; MCLEOD, 1958, 401; 1962, 18.

160. Pers. obs.

161. PATERSON, 1969a, 30.

162. BALFOUR, 1897, 212; PATERSON, 1966a, Fig.2; RAUSING, 1967, Fig.3; CHIUNG, 1981, 183-4.

163. NASH-WILLIAMS, 1932, Fig.42.

164. PATERSON, 1966a, 74, Fig.1; LATHAM & PATERSON, 1970, Fig.7-8.

165. FARIS & ELMER, 1947, 162; KLOPSTEG, 1946, 46; PATERSON, 1966a, 75-6, Fig.1; LATHAM & PATERSON, 1970, 14-15, Fig.9.

166. CHIUNG, 1981, 185.

167. Ibid., 159-60.

168. PATERSON, 1966a, 75; LATHAM & PATERSON, 1970, 14-15.

169. KLOPSTEG, 1947, 42; PATERSON, 1966a, 74-5; LATHAM & PATERSON, 1970, 14; FABIAN, 1970, 12; MCEWEN, 1979, 91-2. These are based on experimentation disproving the neck tendon identification of PAYNE-GALLWEY, 1907, 4; BROWN, 1937, 2; FARIS & ELMER, 1945, 186.

170. CHIUNG, 1981, 186.

171. KLOPSTEG, 1947, 47-9; PATERSON, 1966a, 75, Fig.1; RAUSING, 1967, 156; LATHAM & PATERSON, 1970.

172. Ibid., Pl.2 and pers. obs.

173. PATERSON, 1966a, 76; RAUSING, 1967, 156; CHIUNG, 1981, 189.

174. KLOPSTEG, 1947, 50-1, Fig.21; PATERSON, 1966a, 77-8;

RAUSING, 1947, 156-7; LATHAM & PATERSON, 1970, 15, 177, Pl.18.3.

175. FABIAN, 1984, 30-1.

176. LATHAM & PATERSON, 1970, Fig.10.

177. FARIS & ELMER, 1945, 94-5; KLOPSTEG, 1947, 54-5; POPE, 1962, 35-6; LATHAM & PATERSON, 1970, xxix-xxxi; CHIUNG, 1981, 175, 192-3.

178. LATHAM & PATERSON, 1970, 14; MCEWEN, 1979, 92.

179. BALFOUR, 1890, 227-31; 1897, 212-3; 1921, 297; MCLEOD, 1958, 400; PATERSON, 1966b, 20; LATHAM & PATERSON, 1970, 15, Fig.2b-c; MCEWEN, 1979, 92. For leather and parchment see CHIUNG, 1981, 174, 191-2, Pl.IV,6-8. For other stave and grip materials see KLOPSTEG, 1947, 52; RAUSING, 1967, 157; FABIAN, 1970, 12; CHIUNG, 1981, 175.

180. EMENEAU, 1953, 79; PATERSON, 1966a, 77.

181. VERMASEREN, 1971, 7-8, Pl.III-V. For stave painting see BALFOUR, 1890, 232; ADLER, 1905, 15-16; KLOPSTEG, 1947, 52; EMENEAU, 1953, 79; NCLEOD, 1958, 400; PATERSON, 1966a, 77; MCEWEN, 1979, 92; CHIUNG, 1981, 175, 191.

182. GHIRSHMAN, 1962, Fig.62, 429; BELENITZKY, 1968, Pl.136-8; 1980, Pl.32.

183. KLOPSTEG, 1947, 47-51, Fig.13; CHIUNG, 1981, 162-73, Pl.I.

184. KLOPSTEG, 1947, 45, 51; RAUSING, 1967, 156-7; CHIUNG, 1981, 171, Pl.I.11.

185. KLOPSTEG, 1947, 45; CHIUNG, 1981, 162-3.

186. STONE, 1934, 678, Fig.868.

187. KLOPSTEG, 1947, 40-2, 53; CHIUNG, 1981, 162, 165-6, 172-3, 184-5, 188.

188. Ibid., 158-9, 161-2, 184-5.

189. Ibid., 173-5; KLOPSTEG, 1947, 40-2.

190. CHIUNG, 1981, 160.

191. KLOPSTEG, 1947, 52.

192. See MACMULLEN, 1960, 25-9; ROBINSON, 1975, 8; MANNING, 1976a, 152-3.

193. Digest, 50,6,7; WATSON, 1969, 181.

194. Vegetius, Epitoma rei militaris, II,11. A 2nd-3rd century A.D. papyrus includes arcus peracti amongst the products of a legionary fabrica (BRUCKNER & MARICHAL, 1979, No.409, Col.II,14). Mr M.C. Bishop kindly brought this reference to the writer's attention.

195. In addition to heads from pila, spears and javelins: RICHMOND & BIRLEY, 1940, 106, 112-3, Pl.XI. See CREDLAND, 1982, 16-18, for widely scattered suppliers of cross-bow quarrels for the Welsh wars of Henry III and Edward I.

196. SALAMON, 1976, 53-4.

197. MERRIFIELD, 1962, 38-9.

198. KLUMBACH, 1968, 36-7, Fig.1; 1971, 231-2.

199. Scriptores Historiae Augustae, Claudius, VII,5; Herodian, III,9,4.

200. MAENCHEN-HELFEN, 1973, 225.

201. BELENITZKY, 1968, 101.

202. CHIUNG, 1981, 156-7. In addition to blades Damascus was noted for its bows, FARIS & ELMER, 1945, 92.

203. PATERSON, 1966a, 81-2.

204. WERNER, 1932, 53; 1956, 48, 53; RAUSING, 1967, 67. Grave 86 in the Lombardic Nocera Umbra cemetery yielded ear and grip laths of Avar form (Museo dell'Alto Medio Evo, E.U.R., pers. obs.). An ivory plaque depicting Carolingian period cavalry suggests Avar or Magyar influence, see SCHINDLER, 1977, Fig.264.

205. STONE, 1934, 11; CREDLAND, 1981, 9; 1983, 12.

206. Notitia Dignitatum, Oc., IX,24, 28, 32.

207. HOFMANN, 1969, 63-5, 80, 112-13, 115.

208. PAYNE-GALLWEY, 1907, 60; STONE, 1934, 11-12; LATHAM & PATERSON, 1970, xxxi-ii, 18-19, Fig.3,a-b; CREDLAND, 1981, 9, 11; 1982, 17.

209. ESPÉRANDIEU, 1907-66, No.1679; MACGREGOR, 1975-6, 319.

210. ESPÉRANDIEU, 1907-66, No.1683; AYMARD, 1951, 334-5, Pl.XX.A.

211. STONE, 1934, 125.

212. MARSDEN, 1969, 7-8, 10-11, Fig.1,4.

213. BAATZ, 1978, 14, 16, contra MARSDEN, 1971, 209-10.

214. GUDEA & BAATZ, 1974, 66-7; BAATZ, 1978, 14-16.

215. BAATZ, 1983, Fig.123.

216. Vegetius, II,15; IV,21.

217. II,15; IV,21-2.

218. R.L.O., 10, 1909, 64, Fig.22; MACGREGOR, 1975-6, 319.

219. N.D., Or., VII,43, 57; VIII,46-7; IX,47; Oc., VII,97; XLI,23. MARSDEN, 1969, 196-7.

220. Ammianus Marcellinus, XVI,2, 5-6; WEBSTER, 1983, 118.

221. LATHAM & PATERSON, 1970, 9.

222. Vegetius, IV,9; BRENNEN, 1980.

223. Literary evidence collected by HALDON, 1970.

224. STONE, 1934, 13; CREDLAND, 1983, 15-16.

225. BERGMAN, 1939, 163-4, Pl.29.18.

226. GILBERT, 1975-6, MACGREGOR, 1975-6, 320.

227. STONE, 1934, 11; CREDLAND, 1983, 13-14; This is presumably what lies behind WEBSTER, 1969, 153.

228. LATHAM & PATERSON, 1970, 19.

II. OTHER EQUIPMENT

1. ERDMANN, 1976; 1982; DAVIES, 1977.

2. Ibid., 260.

3. For Asiatic heads see LE COQ, 1925, Fig.115; FETTICH, 1926,

Fig.12; WERNER, 1932, 42; POLASCHEK, 1932, 239; ALFÖLDI, 1932, 18, Pl.I,1-4, XXII.27; BERGMAN, 1939, 164, Pl.28, 42, 30.16; WERNER, 1956, 49, Pl.8, 11,46, 51, 53, 57; SULIMIRSKI, 1970, Fig.14, 16, 25, 42, 45, 49, 52, 60, 75; GARAM et al., 1975, 308-9, 317. GHIRSHMAN, 1946, Pl.XVI.17, XXI.13-19, XXXVI, XLVIII for Begram (Afghanistan) finds; OATES, 1959, 236, No.8, Pl.LIX, for examples from Ain Sinu and Hatra (Iraq). Mr J. Stewart and Mr A. Killick have kindly shown the writer heads from recent excavations at Jerash and Udruh (Jordan). See ROSTOVTZEFF et al., 1946, 57, 86, Pl.LI for Dura finds.

4. YADIN, 1963, 91, Fig.38-40; 1966, 57. Recent finds also from Gamala (Galilee).

5. DAVIES, 1977, 262-3.

6. WEBSTER, 1958, 86, No.94, 198; REED et al., 1964, 185; JOBEY, 1977-8, 89-90; POTTER, 1979, 223; pers. obs.

7. DAVIES, 1977, 264; ERDMANN, 1976, 78, except Krefeld-Gellep perhaps.

8. ROSTOVTZEFF, 1935, Fig.85; BAUR et al., 1932, Pl.XXXIV.4, XXXV.3-4; GHIRSHMAN, 1962, Fig.247, 252, 314.

9. RICHMOND & BIRLEY, 1940, 106, 112-13, Pl.XI.

10. NASH-WILLIAMS, 1932, 70, Fig.9; BOON, 1972, Fig.30.6.

11. ERDMANN, 1982, 9.

12. Ibid., 9-10; BUSHE-FOX, 1949, Pl.LIX.301.

13. POTTER, 1979, 222-3, Fig.88.105; ROSTOVTZEFF, 1936, 454. These do appear on the northern continental frontiers, e.g., WALKE, 1965, Pl.105.2-3.

14. BOSANQUET, 1904, 224-5, 290-1, Fig.16,27; MANNING, 1976b, 22-3, Fig.14.

15. BUSHE-FOX, 1949, Pl.LIX.294, 302.

16. Brit. X, 1979, 276, from the middle of the west ditch. The writer is very grateful to Dr D.J. Breeze for information about these heads.

17. Pers. obs., thanks to Mrs P. Birley.

18. JAMES, 1983, Fig.2-3.

19. MACDONALD & PARK, 1905-6, Fig.42; ROBERTSON et al., 1975, Fig.32.13; ATKINSON, 1942, 225, Pl.55. B.1.

20. Ammianus Marcellinus, XXIII,4,14-15; Vegetius, IV,18. The literary sources are well reviewed by BROK, 1978.

21. DAVIES, 1977, 262.

22. LATHAM & PATERSON, 1970, 144; COLLINS, 1975, 262.

23. JAMES, 1983, 142-3, Fig.2-4.

24. Pliny, Natural History, XVI,65,160.

25. ROSTOVTZEFF, 1936, 453, Pl.XXIV,1. See also BAUR & ROSTOVTZEFF, 1929, 18 and ROSTOVTZEFF, 1934, 166. Wooden ballista-bolts are repeatedly mistaken for arrows in the Dura reports starting with CUMONT, 1926.

26. ROSTOVTZEFF, 1936, 453-4, Pl.XXIV.1. For Egyptian dynastic reed stele with wooden fore-shafts see BALFOUR, 1897, 215-6, Pl.X.

27. YADIN, 1966, 96.

28. YADIN, 1963, 91, Fig.32, 40.

29. BERGMAN, 1939, 70, 79-82, 95, 102, 116, 164, Pl.7, 18, 28, 30. For painted Scythian stele with sinew whipping for the fletchings see RUDENKO, 1970, 143, 217-8.

30. BULANDA, 1913, Fig.41; SULIMIRSKI, 1970, Fig.42 from the Lower Volga region; LATHAM & PATERSON, 1970, xxix, Fig.55.

31. Pausanias, I,xxi,5-6; TODD, 1975, 175.

32. FABIAN, 1970, 16.

33. Ammianus Marcellinus, XXIII,4,14.

34. LATHAM & PATERSON, 1970, 26.

35. CHIUNG, 1981, 203-7.

36. PATERSON, 1966a, 80.

37. BALFOUR, 1897, 216; KLOPSTEG, 1943, 190. See POPE, 1938, Pl.229 for a crescent hunting arrow-head blade on a Sassanid dish.

38. MINNS, 1913, 68; RUDENKO, 1970, 143; TODD, 1975, 176; Pausanias, I,xxi,5-6; Ammianus Marcellinus, XXXI,2,9.

39. For experiments in penetration see POPE, 1962, 51, 54, 57-8, Pl.17; COLES, 1973, 123-8.

40. LATHAM & PATERSON, 1970, 25-6.

41. FARIS & ELMER, 1945, 107-9.

42. Plutarch, Crassus, 24-5.

43. Procopius, Wars, VI,ii,28. Cf. Celsus, de Medecina, VII,5,1-2 for the extraction of barbed missiles in this way.

44. I,i,12-15; xviii,32-5.

45. FARIS & ELMER, 1970, 109-10.

46. LATHAM & PATERSON, 1970, 25.

47. N.D., Oc., IX,24, 28, 32.

48. Such as ballista-bolts, ROSTOVTZEFF, 1936, Pl.XXIV.3.

49. KNOX et al., 1984, 99-100, Pl.11.A-B.

50. Plutarch, Crassus, 21, 25.

51. Ibid., 30; Marcus Antonius, 46, 49.

52. LÁSZLÒ, 1957, 158. See also Pliny N.H., XVI,65,159.

53. Frontinus, Strategems, IV,7,30; Dio, LVI,21,3; GROUSSET, 1970, 90; KAEGI, 1964, 100; LEYSER, 1965, 12. Dio comments that the Parthian lands were climatically good for bow-strings except in Winter (XL,15,4).

54. STONE, 1934, 619-21, Fig.793. For Chinese use on quivers 521, Fig.667. For Roman deities with caps see ÉSPÉRANDIEU, 1907-66, No.243, 3367, 3540, 4916, 5233, 5994, 6063, 6125, 6161, 6329, 7804, 8370, 9245.3.

55. See, for example, Dio, LVI,21,3 for soaked shields.

56. MINNS, 1913, 66-8, Fig.49, 53, 75, 93-4.

57. LATHAM & PATERSON, 1970, Fig.27, Pl.12; BIVAR, 1972, Fig.29.

58. KIESERITZKY & WATZINGER, 1909, No.559, 575, 587, 591, 593-4, 597, 599-600, 604, 606, 609, 618-9, 622, 624-5, 630, 633-5, 639-40, 642, 647, 650-52, 655, 657, 662, 664, 666, 669-71, 675, 680-1, 683, 686, 693, 703, 718; MINNS, 1913, Fig.213-6, 223; ROSTOVTZEFF, 1913, Pl.LI.6, LXXXIV.1-2, 4, XCIII.1-2; 1922, Pl.XXX.2, XXVIII.1.

59. ROSTOVTZEFF et al., 1935, Fig.40-1; ROSTOVTZEFF et al., 1936, Pl.XXX; GHIRSHMAN, 1962, Fig.13,86; COLLEDGE, 1976, Fig.26, Pl.33, 42-3.

60. SEYRIG, 1937, Pl.IV; GHIRSHMAN, 1962, Fig.4,90-1; COLLEDGE, 1967, Pl.4.

61. KIESERITZKY & WATZINGER, 1909, No.574, 626-7, 650; MAENCHEN-HELFEN, 1973, Fig.2; PHILLIPS, 1965, Fig.105 on a Sarmatian gold plaque.

62. GHIRSHMAN, 1962, Pl.69; COLLEDGE, 1977, Pl.20a.

63. SEYRIG, 1937, Pl.III.4; TAHA, 1982, Fig.V.

64. COLLEDGE, 1977, Pl.22; cf. Parthian terracotta on display in the British Museum, London, Inv.135684.

65. KRAELING, 1956, Pl.LXIV.

66. GHIRSHMAN, 1962, Fig.196-7, 220; BIVAR, 1972, Fig.10-11, 19, 21; HERRMANN, 1977, 88-9, 92-3, 100.

67. CUMONT, 1926, Pl.LIV; BAUR & ROSTOVTZEFF, 1931, Pl.XLIII.2; ROSTOVTZEFF, 1934, Pl.XXXV.4; ROSTOVTZEFF et al., 1939, Pl.LVI.2-3, XV; POPE, 1938, Pl.209-11, 213-4; GHIRSHMAN, 1962, Fig.223, 247, 253.

68. GHIRSHMAN, 1962, Fig.223-4; BIVAR, 1972, Fig.28; FUKAI & HORIUCHI, 1972, Pl.XLIX; HERRMANN, 1977, 135.

69. LE COQ, 1925, 21, Fig.33-24, 66, 94-100, 109; APPELGREN-KIVALO, 1931, Fig.82-3, 211, 307; GHIRSHMAN, 1962, Fig.363, 429; BELENITZKY, 1968, Pl.68, 74, 136-8; BIVAR, 1972, Fig.27; MAENCHEN-HELFEN, 1973, Fig.12A; BRINKER & GOEPPER, 1980, 258-62, Fig.157, 172-3; BELENITZKY, 1980, Pl.25, 30-1, 34.

70. FETTICH, 1926, Fig.18; MAROSI & FETTICH, 1936, 49, Pl.III.14; LENGYEL & RADAN, 1980, 410, Fig.75-6.

71. LÁSZLÒ, 1957, Fig.6; DIENES, 1972, Fig.5, Pl.20.

72. BRETT et al., 1947, Pl.39.

73. SADLER & BAGATTI, 1949, 71, Pl.25.1.

74. GHIRSHMAN, 1962, Fig.343; BELENITZKY, 1968, Pl.34.

75. FUKAI & HORIUCHI, 1972, Pl.XL.

76. LE COQ, 1925, 21, Fig.32-3, 65, 93, 100-2; LÁSZLÒ, 1957, Fig.8; BELENITZKY, 1968, Pl.74, 110, 136-8; 1980, 11, 83, Pl.26-8, 30-1, 41, 44; BRINKER & GOEPPER, 1980, Fig.157, 172-3.

77. BULANDA, 1913, Fig.40; MAENCHEN-HELFEN, 1973, Fig.9.

78. LÁSZLÒ, 1957, 172-82, Fig.3-7.

79. HALDON, 1975, 21.

80. MORSE, 1886, 12-16, Fig.8-9; FARIS & ELMER, 1945, 43-4: "This is indeed a corrupt draw used by the ignorant" according to the Moroccan treatise!

81. Freeze-frame photography revealed the arrow's path, KLOPSTEG, 1943, 185-6, Fig.12-13; 1947, 161-2.

82. MORSE, 1886, 17, Fig.11-12; BULANDA, 1913, 40, Fig.25; FARIS & ELMER, 1945, 45-6; LATHAM & PATERSON, 1970, xxv, 34-6, 51-3, Fig.1, 17, 22.a-e; BIVAR, 1972, 284-5.

83. MORSE, 1886, 17-20, Fig.3,18; STONE, 1934, 14-17, Fig.22-3; PATERSON, 1963; LATHAM & PATERSON, 1970, Pl.8; WIGGINS, 1973.

84. PATERSON, 1969b, 28.

85. MORSE, 1886, 4. Japanese archers, especially in the Heian and Kamakura periods, often had a tight left sleeve and a baggy right one. For a bound Mongolian sleeve see WEBB, 1982, Fig.

86. ROBINSON, 1976, 29, 39; BUDGE, 1903, No.146; Clayton Museum Inv. No.474.

87. BAUR & ROSTOVTZEFF, 1931, 73-4.

88. British Museum, London, Inv.135684.

89. GHIRSHMAN, 1962, Fig.125; HERRMANN, 1977, Frontispiece.

90. PUGACHENKOVA, 1971, 70-1.

91. FARIS & ELMER, 1945, 43-5. Cf. PATERSON, 1966, 30, Fig.2; LATHAM & PATERSON, 1970, 53, Fig.23; BIVAR, 1972, 285-6.

92. Ammianus Marcellinus, XXV,1,13. For points of draw see FARIS & ELMER, 1945, 49-52. For the angle of the string at the hand see RAUSING, 1967, 143, 146-7; PATERSON, 1966a, 78; 1966b, 19; 1969, 30.

93. No thumb-rings occur in funerary contexts or artistic representations of Mongolian releases.

94. LE COQ, 1925, Fig.107; BELENITZKY, 1980, 80, Pl.34 (?). Cf. LATHAM & PATERSON, 1970, Pl.8, 12-13.

95. ERDÉLYI, 1966, 44.

96. BIVAR, 1972, 286, Fig.29.

97. Ibid., 284-5.

98. Ibid., 282, Fig.20-2; LATHAM & PATERSON, 1979, Fig.93.

99. POPE, 1938, Pl.163A; GHIRSHMAN, 1962, Fig.236-8; HERRMANN, 1977, 17, 132-3.

100. FUKAI & HORIUCHI, 1972, Pl.XL; HERRMANN, 1977, 135.

101. ÉSPÉRANDIEU, 1907-66, No.6125.

102. No.5801.

103. SMITH, 1968, 286.

104. ROBINSON, 1975, 29; TOYNBEE, 1964, 189; SMITH, 1968, 286.

105. ÉSPÉRANDIEU, 1907-66, No.3001.

106. SMITH, 1968, 286.

107. GHIRSHMAN, 1962, Fig.59.

108. CICHORIUS, 1896-1900, II, 310, 328-9; III, 189, 238.

109. CUMONT, 1926, Pl.XLIX-L.

110. ROSTOVTZEFF, 1935, 264.

111. WEBSTER, 1969, 153-4 evidently thought so.

112. ROBINSON, 1975, 85, Pl.237; 1976, 29.

113. Arrian, Ektaxis, 31; HALDON, 1975, 33.

114. ROBERTSON et al., 1975, 25.

115. Vegetius, I,20; II,15. See Julian, 57, C-D, partly contradictory, but in accord over lack of shields.

116. Dio, XL,15,2.

117. GRIGG, 1979, 111-12; 1983, 140-1.

118. N.D., Or., XI,7-8.

119. Procopius, Wars, I,i,13; HALDON, 1975, 18, n.33.

120. BELENITZKY, 1968, Pl.132, 136-8; 1980, 54, 80, 83, 116, Pl.23-4.

III. ARCHERS AND ARCHERY EQUIPMENT

1. Tacitus, Annals, I,56; II,16.

2. ROBERTSON et al., 1975, 26. The writer is very grateful to Dr L.J.F. Keppie for discussing this question.

3. WALKE, 1965, 85.

4. SCHÖNBERGER, 1973.

5. ULBERT, 1970, 12-16. It is difficult to imagine auxiliary troops wearing this type of armour.

6. BOON, 1974, 66-70, Fig.8, mixed garrison presence.

7. ROBERTSON et al., 1975, 24-6.

8. DAVIES, 1977, 265. See Dio, LXII,12,3-4 and JARRETT, 1969, 224.

9. ERDMANN, 1976, 10.

10. FORSTER & KNOWLES, 1911, 51, Fig.40; BIRLEY, 1977, Pl.58.

11. ERDMANN, 1982, 9.

12. S.H.A., Avidius Cassius, VI,3.

13. Arrian, Techne Taktike, 43,1.

14. Vegetius, I,15.

15. Ibid., II,23; III,4.

16. Suetonius, Divus Iulius, 68, surely unreliable.

17. NASH-WILLIAMS, 1932, 71, Fig.22. Legionary weapons such as pila and ballista-bolts suggest that the deposit was intended for legionary use, not to be sent out to auxiliary units.

18. ROBERTSON et al., 1975, 25.

19. DOMASZEWSKI, 1908, 26, No.39-40.

20. Ibid., No.41.

21. SPEIDEL, 1965, 45.

22. Ibid., 86, n.540. The second is perhaps identical with a fragmentary tombstone relief seen by the writer in the catacombs of SS Marcellino e Pietro.

23. Herodian, I,15,2. See SPEIDEL, 1975, 212, n.39.

24. DAVIES, 1977, 270.

25. WAGNER, 1938, 64-5; DAVIES, 1977, 269.

26. ROSTOVTZEFF, 1938, 96.

27. Arrian, Ektaxis, 1,21; DAVIES, 1977, 754.

28. C.I.L., VIII, 18042 = I.L.S., 2487.

29. GARBSCH, 1978, 33-4; cf. Arrian, T.T., 34,1-8.

30. C.I.L., III, 3672 = I.L.S., 2558. Cf. Dio, LXIX,9,6.

31. JOBEY, 1977-78, 87-9; WATSON, 1969, 60-1; KORFMANN, 1972, 6. See Arrian, T.T., 43,1; C.I.L., VIII, 18042 = I.L.S., 2487; Vegetius, II,23. Scenes, LXVI, LXX, LXXII, CVIII and CXIII on Trajan's Column depict irregular slingers. See N.D., Or., VII, 52 for late funditores.

32. DOMASZEWSKI, 1908, 59-61; R.E.[1], XVII, s.v. 'numerus', cols 1327-41; MANN, 1954; CALLIES, 1964, 182-209.

33. WAGNER, 1938, 56, 174-5, 212.

34. SPEIDEL, 1973, 170-1; BENSEDDIK, 1979, 75-8.

35. Liber de munitionibus castrorum, 29-30.

36. N.D., Or., V, 29-30, 40, 54-6; VI, 31-2, 40, 54-6; VII, 31-4, 56; VIII, 30-1; IX, 19; Oc., V, 170, 174, 193, 211; VI, 67-73, 77, 83-4.

37. N.D., Or., XXXI, 25-9; XXXII, 22-6, 29; XXXIII, 18-22; XXXIV, 25-9; XXXV, 20-3; XXXVI, 25-8; XXXVII, 20; XXXVIII, 11-12; HOFMANN, 1969, 240-1, 255, 264-5.

38. N.D., Or., XXVIII, 40, 44, 46; XXXI, 49, 60; XXXII, 33, 38, 44; XXXIV, 32, 46-7; XXXV, 30, 33; XXXVI, 34-5; XXXVII, 34; XXXVIII, 27-8.

39. Vegetius, III,14; N.D., Or., VII, 56.

40. DARKO, 1935, 461-9; 1937, 119-25; KAEGI, 1964, 98-9; BIVAR, 1972, 281-6; HALDON, 1975, 11-25.

41. KENNEDY, 1977, 527-30.

42. Caesar, de Bello Gallico, VII, 31, 36, 80; TODD, 1975, 175.

43. CHEESMAN, 1914, 84.

44. For lists of oriental units see CHEESMAN, 1914, 178, 180-3; DE WEERD & LAMBRECHTS, 1938, 230-4; DAVIES, 1977, 269-70; HOLDER, 1980, 227-8, 230-2; R.E.[1], I, s.v. 'ala', cols 1223-70; IV, 'cohors', cols 231-56; R.E.[2], I.A, s.v. sagittarius, cols 1743-57 (esp. 1744-6).

45. CHEESMAN, 1914, 82-4; CATACUZÈNE, 1927, 159-71; DE WEERD & LAMBRECHTS, 1938, 234-9; FITZ, 1972, 149-58.

46. MANN, 1974, 260; SPEIDEL, 1973, 171, 176-7; BENSEDDIK, 1979, 73, 75-8.

47. For example, Herodotus, I,136 of the Achaemenid Persians; Dio, XL,15,3 of the Parthians; Ammianus Marcellinus, XXV,1,13 of the Sassanids; Strabo, VII,4,6 of Sarmatian horsemanship. Cf. LATHAM & PATERSON, 1970, xxv, 78.

48. CHEESMAN, 1914, 82-4; CATACUZÈNE, 1927, 171; DE WEERD & LAMBRECHTS, 1938, 237; CALLIES, 1964, 206; MÓCSY, 1974, 154, 195; ROXAN, 1976, 59, n.1; HOLDER, 1980, 115.

49. C.I.L., III, 10307 = I.L.S., 2540; DOMASZEWSKI, 1908, 59; CATACUZÈNE, 1927, 165, 169; WAGNER, 1938, 145-6, 211; CALLIES, 1964, 193; FITZ, 1972, 127; SPEIDEL, 1975, 228-9.

50. Cf. Vegetius, I,15; II,15.

51. BENSEDDIK, 1979, 38-40, Fig.11.

52. KENNEDY, 1977, 526-7; BENSEDDIK, 1979, 40.

53. Especially N.D., Or., XXXVIII. XXVIII, 40 is a partial exception.

54. ROXAN, 1976, 61.

55. Synesius, Epistulae, 131, quoted by JONES, 1964, 646.

56. N.D., Oc., V, 170, 174, 211.

57. For good summaries see MCLEOD, 1965; RAUSING, 1967, 31; KORFMANN, 1972, 17-19.

58. Vegetius, II,23.

59. PATERSON, 1966a, 83-4, 86; FARIS & ELMER, 1945, 77, 167.

60. MCLEOD, 1965, 9-12.

61. BIVAR, 1972, 283; COLLINGWOOD & RICHMOND, 1969, 306. See also MARSDEN, 1969, 12, c.150-200 yards (137-83m).

62. JOBEY, 1977-78, 89-91.

63. MCLEOD, 1965, 13.

64. Ibid., 3.

65. FARIS & ELMER, 1945, 145-9.

66. PATERSON, 1966a, 84; LATHAM & PATERSON, 1970, 73-9, Pl.13-15.

67. PATERSON, 1966a, 83. See Plutarch, Crassus, 24.

68. Herodian, VI,7,8; Procopius, Wars, VIII,xxix,17; Agathius, II,9.

69. Dio, LXII,12,3.

70. Vegetius, I,20.

71. Tacitus, Annals, XIII,38.

72. LATHAM & PATERSON, 1970, 71-5, 80-2, Fig.28.

73. Plutarch, Crassus, 24; Trajan's Column, Scene XXXVII; ESPERANDIEU, 1907-66, No.5270; Procopius, Wars, I,i,14; Anna Comnena, Alexiad, XV,3; MINNS, 1913, Fig.9; DARKO, 1935, 450; ROSTOVTZEFF, 1943, 180-7; BRETT et al., 1947, Pl.39; SULIMIRSKI, 1952, 455-9, Pl.I; GHIRSHMAN, 1962, Fig.248, 285, 289, 363, 422, 437, 444-5, 449; COLLINS, 1965, 264; BALTY, 1969, Pl.IX, XII, XXXIV; LATHAM & PATERSON, 1970, 74, 82, Fig.27, Pl.15; BRINKER & GOEPPER, 1980, Fig.127; BELENITZKY, 1980, Pl.71.

74. Cf. Procopius, Wars, V,xxix,47.

75. DEBEVOISE, 1938, 209.

76. Vegetius, III,6.

77. Josephus, Jewish War, III,116; Arrian, Ektaxis, 1. Also Josephus, V,47 in Titus' advance to Jerusalem.

78. Onasander, Strategos, XVII; Vegetius, III,14; Arrian, Ektaxis, 29. See Plutarch, Marcus Antonius, 41-2.

79. Arrian, Ektaxis, 18; Vegetius, III,14; Julian, 57D. See Tacitus, Annals, II,16 and Josephus, Jewish War, V,131.

80. Arrian, Ektaxis, 21.

81. Caesar, de bello Africano, 60, 81; Tacitus, Annals, XIII,38, 40; Arrian, Ektaxis, 12, 14; Herodian, VIII,1,3; Vegetius, III,16; Ammianus Marcellinus, XVI,12,7. Also see Julian, 57B-C, for Constantius II's army similarly arrayed.

82. Arrian, Ektaxis, 26. See Dio LXXV,7,2 for Niger's deployment at Issos.

83. Procopius, Wars, V,xxvii,27-9; I,xviii,32-5.

84. Tacitus, Annals, VI,35.

85. Procopius, Wars, I,iv,8-14; KAEGI, 1964, 102, 104-7.

86. Procopius, Wars, V,xxvii,5.

87. Plutarch, Marcus Antonius, 44; Dio, XLIX, 29; Herodian,

IV,15,2-3.

88. Crassus had some archers but they were lost with Publius (Plutarch, Crassus, 25). Antonius had light infantry who did much to save his army from Crassus' fate (Marcus Antonius, 41-2).

89. DEBEVOISE, 1938, 218, 258-9.

90. Plutarch, Crassus, 24-5, 27-8. See Tacitus, Annals, XIII,40 for the refusal of Corbulo's troops to be drawn out. See COLLINS, 1975, 271 for Tatar ineffectiveness against formed infantry.

91. Ammianus Marcellinus, XXIV,2,5; XXV,1,13; Julian, 63B, 65B; Vegetius, III,24.

92. Ammianus Marcellinus, XXIV,6,9; XXV,1,16.

93. Tacitus, Annals, II,17; IV,47.

94. Arrian, Ektaxis, 13.

95. Caesar, de bello Gallico, II,19; Tacitus, Annals, I,56; Dio, LXVIII,21,2; LXXI,3.

96. Caesar, de bello Gallico, VIII,40; Josephus, Jewish War, II,535-6; III,168, 258, 285, 486; V,263, 281, 296; Vegetius, IV,6, 17, 21.

97. Procopius, Wars, V,xxii,7-9. See Vegetius, IV,9.

98. Vegetius, IV,29; BAATZ, 1983, 137-8.

99. BREEZE, 1982, 84-5.

100. Caesar, de bello Gallico, IV,25; de bello Africano, 20; Plutarch, Marcus Antonius, 64; Vegetius, IV,44; Procopius, Wars, V,v,13.

101. INGOLT, 1970-71, 198-9, Pl.VI.1.

102. BAATZ, 1975, 135-6; SCHÖNBERGER, 1973; WELLES et al., 1959, 25.

103. ROBERTSON et al., 1975, 24-6.

104. WAGNER, 1938, 119-20.

105. CALLIES, 1964, 164-5; BIRLEY, 1966, 56. For the title Ulpia

in Syrian diplomata see HOLDER, 1980, 206.

106. Arrian, Ektaxis, 26.

107. RITTERLING, 1902, 361-72; PELHAM, 1911, 227-30; CHEESMAN, 1914, 159-60; HOLDER, 1980, 201; SPEIDEL, 1983, 16-17.

108. Arrian, T.T., 44,1.

109. ROSTOVTZEFF, 1932a, 805-8; 1932b, 112; SEYRIG, 1941. See Bow-Cases and Quivers, above, n.59.

110. Zosimus, Historia Nova, I,39.

111. SEYRIG, 1933, 167; WELLES et al., 1959, 25.

112. Ibid., 24.

113. Trajan's Column scenes XXXI and XXXVII; KIESERITZKY & WATZINGER, 1909, No.650; ROSTOVTZEFF, 1913, Pl.LXIV.1, LXXIX, LXXVIII.1, LXXXVIII.2, CXXXIV.3; 1922, 169; SULIMIRSKI, 1970, 28-9; WILKES, 1983, 258.

114. Tacitus, Germania, 6; TODD, 1975, 174, 178.

115. Trajan's Column, scenes XXIV, XXXII, CXIII, CXXXIV. RICHMOND, 1935, 38 was mistaken in seeing an arrow held by Trajan in XXV. It is the lower half of a spear, depicted in both stone and bronze.

116. SZILAGYI, 1952, 191.

117. FITZ, 1972, 59; MÓCSY, 1974, 194.

118. SZILÁGYI, 1952, 196; FITZ, 1976, 77.

119. WAGNER, 1938, 69-71; FITZ, 1976, 93.

120. WAGNER, 1938, 142-6; FITZ, 1971, 46-52; 1976, 101; MÓCSY, 1974, 195.

121. SAXER, 1967, No.74; MÓCSY, 1974, 194.

122. WAGNER, 1938, 123-8, 157-9, 173-4, 182-3; GUDEA, 1979, 84-5.

123. MANN, 1954, 502, 504, 506-7; CALLIES, 1964, 182-3, 185, 205, 207; MACREA, 1964, 155; SPEIDEL, 1973, 1-2; 1975, 207.

124. SZILÁGYI, 1952, 200; FITZ, 1972, 39.

125. C.I.L., III, 13483a = I.L.S., 9168; SAXER, 1967, 119, No.33; MANN, 1954, 502. See also SAXER, 1967, No.43, possibly also sagittarii (?).

126. 'Hyginus', Liber de munitionibus castrorum, 29-30.

127. N.D., Oc., XXXII, 32, 35; XXXIII, 38, 44; XXXIV, 17, 21, 32-3.

128. Herodian, VI,7,8. Also S.H.A., Alexander Severus, LXI,8.

129. S.H.A., Maximini Duo, XI; Herodian, VII,2,1-5; VIII,1,3.

130. S.H.A., Maximini Duo, XI; Herodian, VII,1,9-11. See also S.H.A., Tyranni Triginti, 32 and C.I.L., XIII, 6677a (for a possible damnatio memoriae following revolt). Osrhoeni were also employed by Caracalla, Dio LXXVIII,14,1.

131. BENSEDDIK, 1979, 51-3, 65-6; HOLDER, 1980, 210-14.

132. Trajan's Column scene LXIV; SPEIDEL, 1975, Pl.2; HORN & DE RUGER, 1979, Pl.107.

133. BARADEZ, 1956; SPEIDEL, 1977; BENSEDDIK, 1979, 27-30, 35-6, 43, 47.

134. From a funerary relief, BARADEZ, 1954, Fig.12; 1956, Pl.II.5; BENSEDDIK, 1979, Fig.2. However, this is so similar to the ala contariorum tombstone figure that they are most likely the products of the same sculptor, thus an unreliable guide to the armament of the Canenafates.

135. BARADEZ, 1956, 8, 11.

136. CAGNAT, 1913, 205-6; CHEESMAN, 1914, 88, 165; CARCOPINO, 1925, 43-4, 119-34; SAXER, 1967, No.328-31; FENTRESS, 1979, 87-8, 91, 116-7.

137. CAGNAT, 1913, 251; WAGNER, 1938, 214-5; SPEIDEL, 1973, 170-1; BENSEDDIK, 1979, 73, 75-8.

138. See WAGNER, 1938, 216, for another numerus Syrorum, in Moesia Inferior. The writer is very grateful to Mr A. Rushworth for discussing the North African dispositions.

FIGURE CAPTIONS

Unless otherwise acknowledged the photographs are from the writer's collection.

Fig.1: Bow terminology. The key is the same for all the drawings.

Fig.2: Yrzi bow (after BROWN, 1937).

Fig.3: Belmesa bow ear.

Fig.4: Qum Darya bow fragments. Left Piece A, right Piece B (after BERGMAN, 1937)

Fig.5: Stages of stave construction.

Fig.6: Ch'engtu workshop plan. A = drying cabinet with brazier; B = work table and two benches; E = 'big board bench'; F = areas for the storage of materials which are also hung from the rafters above (after CHIUNG, 1981).

Fig.7: Stave positions - I Yrzi bow; II 'Sassanid' bow: a = full draw, b = strung or braced, at rest, c = unstrung and reversed (after BROWN, 1937 and PATERSON, 1969a).

Fig.8: Arrow terminology. A = general arrow, B = Dura type with wooden pile, C = Bar Kochva Cave of Letters with two part, wood and reed stele.

Fig.9: Bar Hill ear laths. Convex faces (by permission of the Hunterian Museum, Glasgow).

Fig.10: Bar Hill ear laths. Flat faces (by permission of the Hunterian Museum, Glasgow).

Fig.11: Caerleon ear laths. Concave faces of the more complete examples (by permission of the National Museum of Wales).

Fig.12: Caerleon ear laths. Flat faces, note cellular structure (by permission of the National Museum of Wales).

Fig.13: Caerleon grip laths. Convex faces (by permission of the National Museum of Wales).

Fig.14: Caerleon grip laths. Flat faces (by permission of the National Museum of Wales).

Fig.15: Belmesa bow ear. Sinister face, note score lines (by permission of the Pitt Rivers Museum, Oxford).

Fig.16: Belmesa bow ear. Back face, note glue between diverging laths (by permission of the Pitt Rivers Museum, Oxford).

Fig.17: Belmesa bow ear. Dexter face (by permission of the Pitt Rivers Museum, Oxford).

Fig.18: Belmesa bow ear. Belly face, note score line above horn (by permission of the Pitt Rivers Museum, Oxford).

Fig.19: Trajan's Column. Archer in Scene XXIV.

Fig.20: Trajan's Column. Archers in Scene CXV.

Fig.21: Trajan's Column. Barbarian bow on the north-east face of the pedestal.

Fig.22: Trajan's Column. Archer in Scene CVIII.

Fig.23: Trajan's Column. Detail of bow in Scene CVIII.

Fig.24: Marcus Column. Archer in Scene LXXVIII.

Fig.25: Marcus Column. Horse-archer in Scene LVII.

Fig.26: Archer's tombstone from Housesteads, Northumberland (photograph Mr P. Moffat).

Fig.27: Detail of Housesteads archer's bow (photograph Mr P. Moffat).

Fig.28: Tombstone of Monimus, cohors I Ituraeorum, Mainz, West Germany.

Fig.29: Tombstone of an eques singularis Augusti, Mainz, West Germany.

Fig.30: Tombstone from Gÿor, Hungary, ala I Augusta Ituraeorum.

Fig.31: Tombstone from Mainz, West Germany, ala Parthorum et Araborum.

Fig.32: Tombstone from Tipasa, Algeria, ala I Augusta Ituraeorum (after BENSEDDIK, 1979).

Fig.33: Relief of Palmyrene rider-gods, Abgal and Ašar, from Palmyra. National Museum in Damascus, dated to A.D.154 (after GHIRSHMAN, 1962).

Fig.34: Detail of bow on a Palmyrene page relief. Located

south-east of the 'Funerary Temple', Palmyra.

Fig.35: Detail of statue of Atys. London, British Museum.

Fig.36: 'Worcester Hunt' mosaic from Daphne, Syria (after LEVI, 1947).

Fig.37: Detail of 'Triclinos', hunt mosaic. Apamea Syriae, Musées Royaux, Brussels.

Fig.38: Hunt mosaic detail, Great Palace, Istanbul (after BRETT et al., 1947).

Fig.39: Parthian terracotta horse-archer. Berlin Museum (after GHIRSHMAN, 1962).

Fig.40: Aquatic hunt scene, Tāq-i-Bustān, Iran (after GHIRSHMAN, 1962).

Fig.41: Mounted Sassanid king (Chosroes II?), Tāq-i-Bustān, Iran (after GHIRSHMAN, 1962).

Fig.42: Sven Hedin with finds from Mass Grave 1, beside Lop Nor. Complete Qum Darya bow in bottom right (after BERGMAN, 1939).

Fig.43: Detail of horse-archer fresco from Khasr el-Hayr el-Gharbi, National Museum in Damascus.

Fig.44: Detail of Sassanid Persian silver dish (after GHIRSHMAN, 1962).

Fig.45: Stele with fletchings and wooden piles from Dura-Europos, Syria (after ROSTOVTZEFF et al., 1936).

Fig.46: Tanged, trilobate arrow-heads and stele from Masada, Palestine (after YADIN, 1966).

Fig.47: Barbed, flat, tanged arrow-heads from Bearsden, Dumb. (by permission of the Scottish Development Department, Ancient Monuments).

BOW TERMINOLOGY

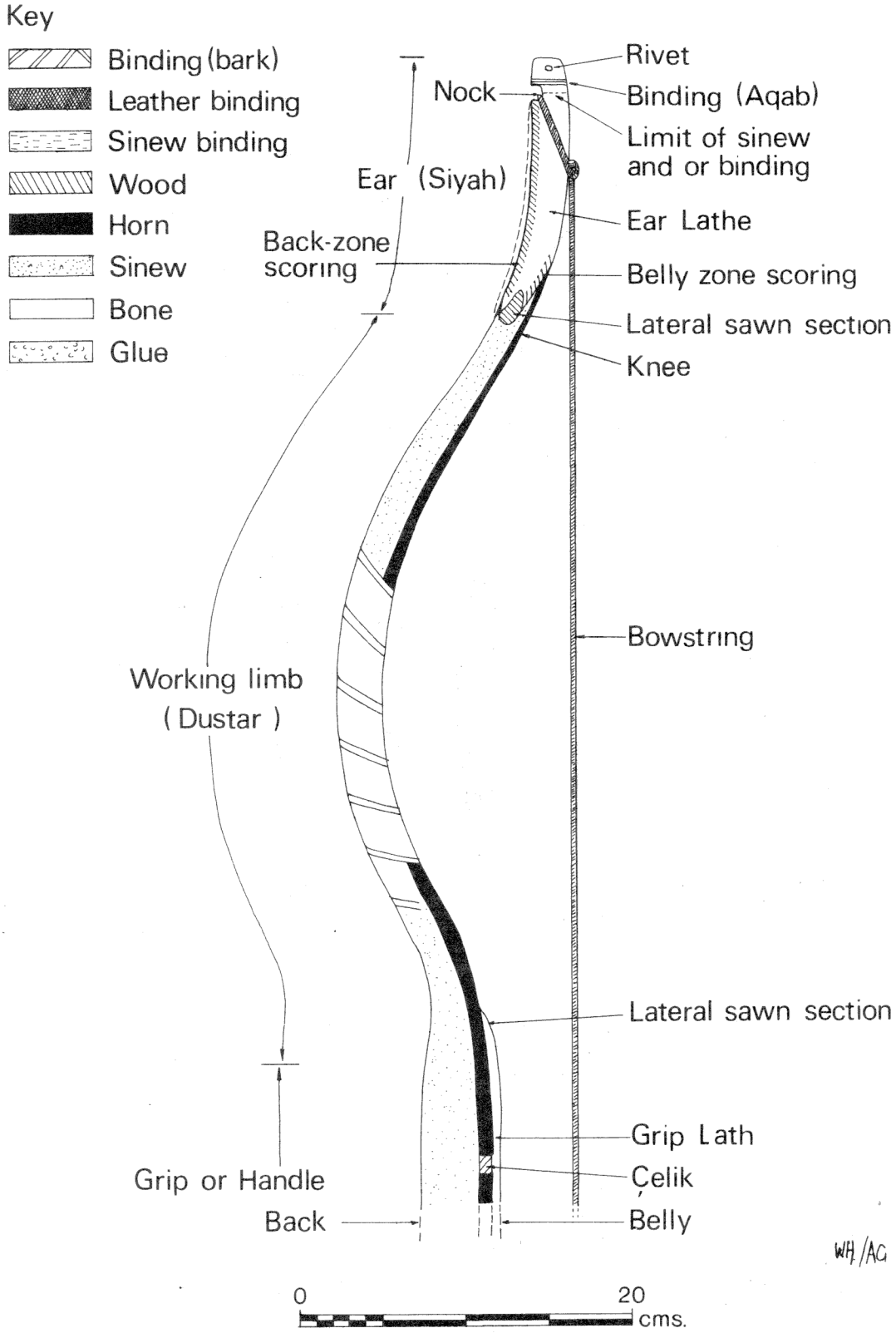


Fig.1

YRZI BOW

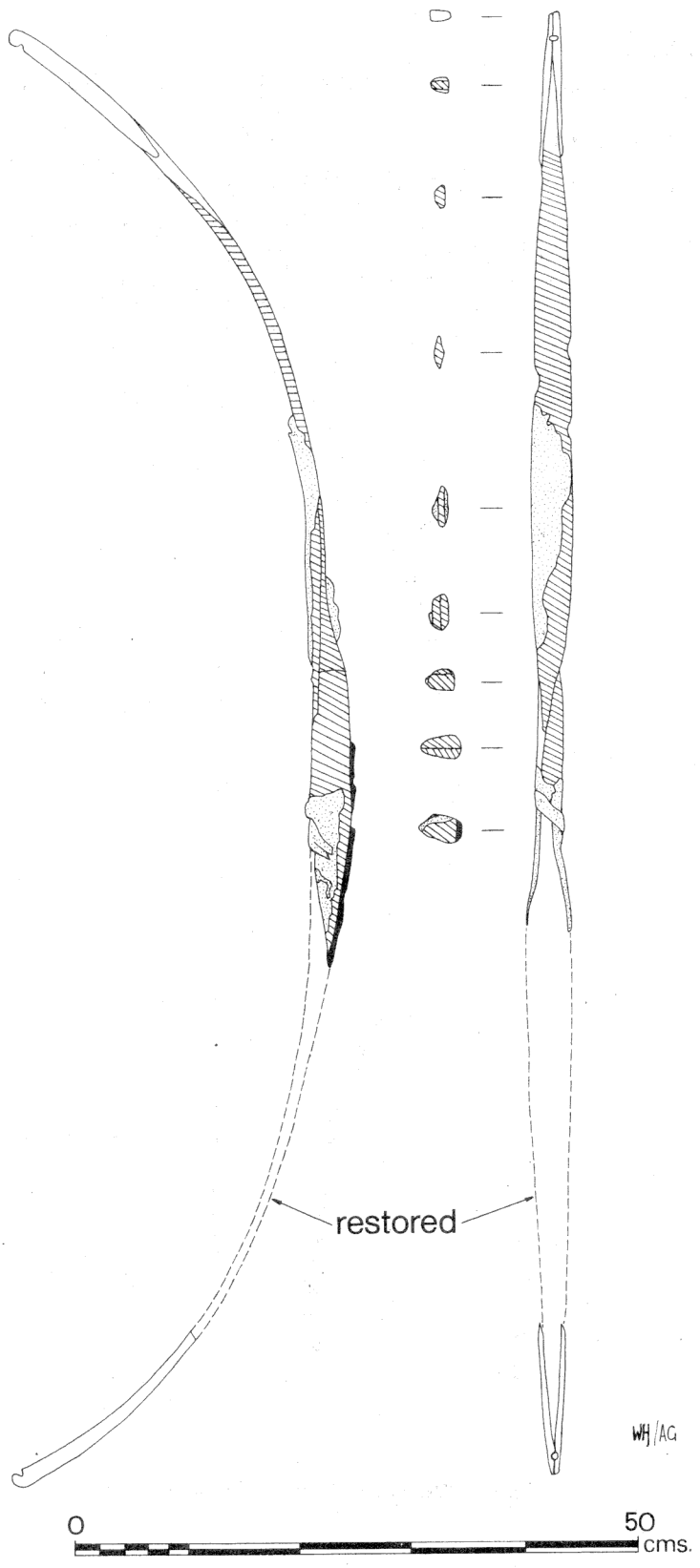


Fig.2

BELMESA EAR

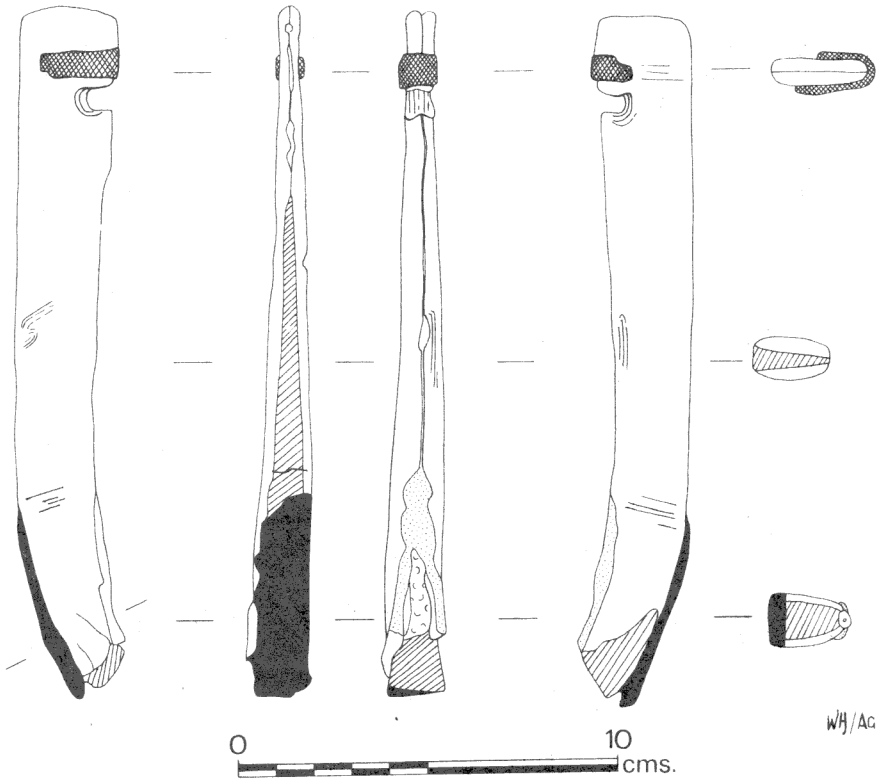


Fig.3

QUM DARYA BOW

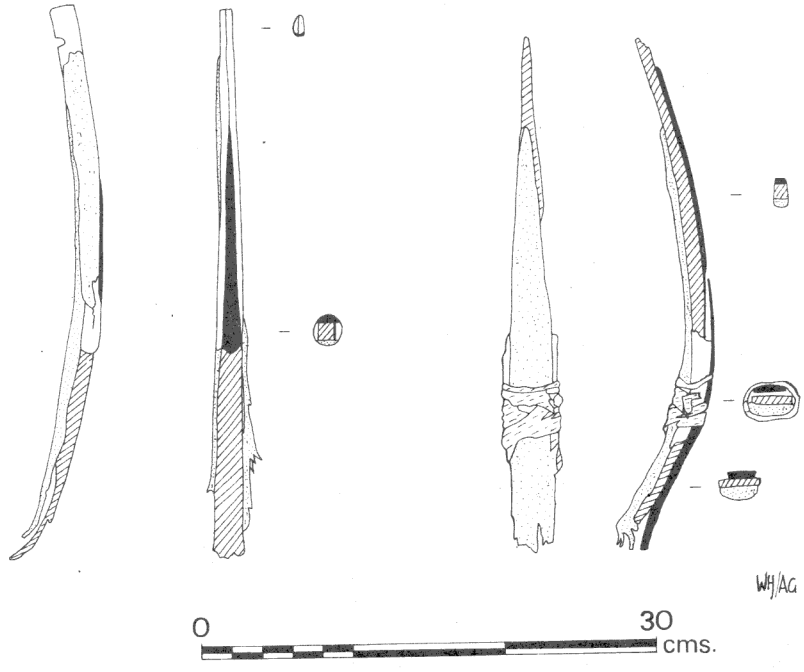


Fig.4

STAVE CONSTRUCTION STAGES

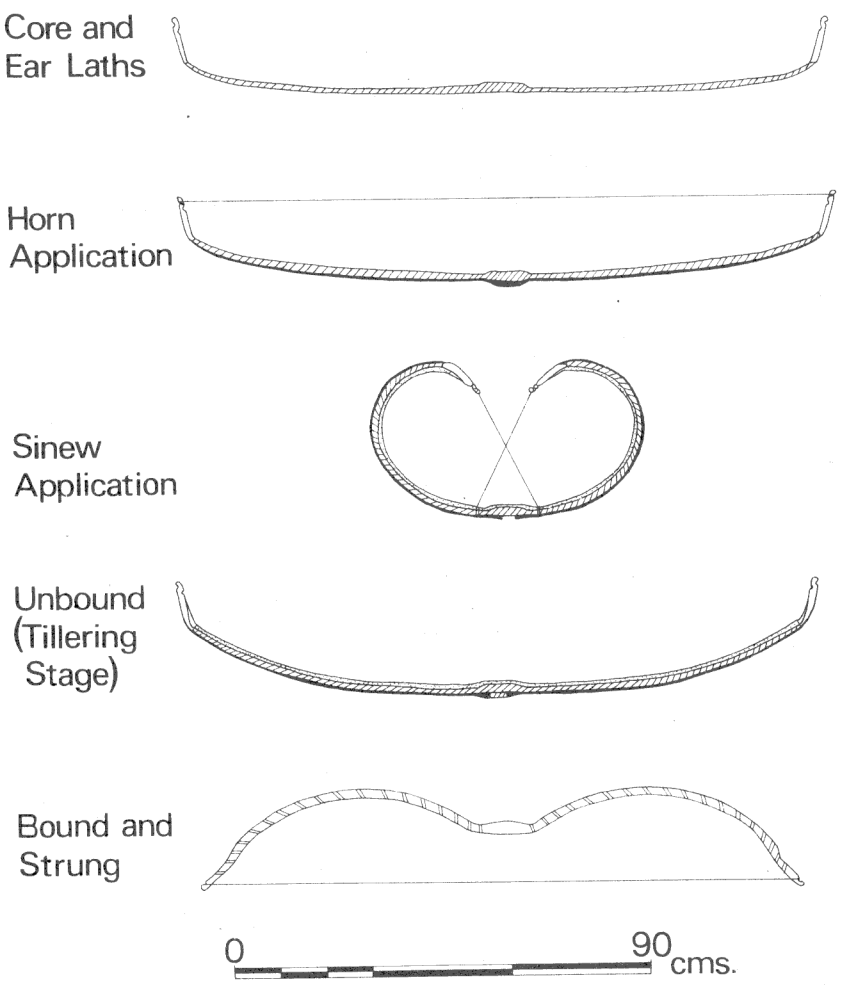
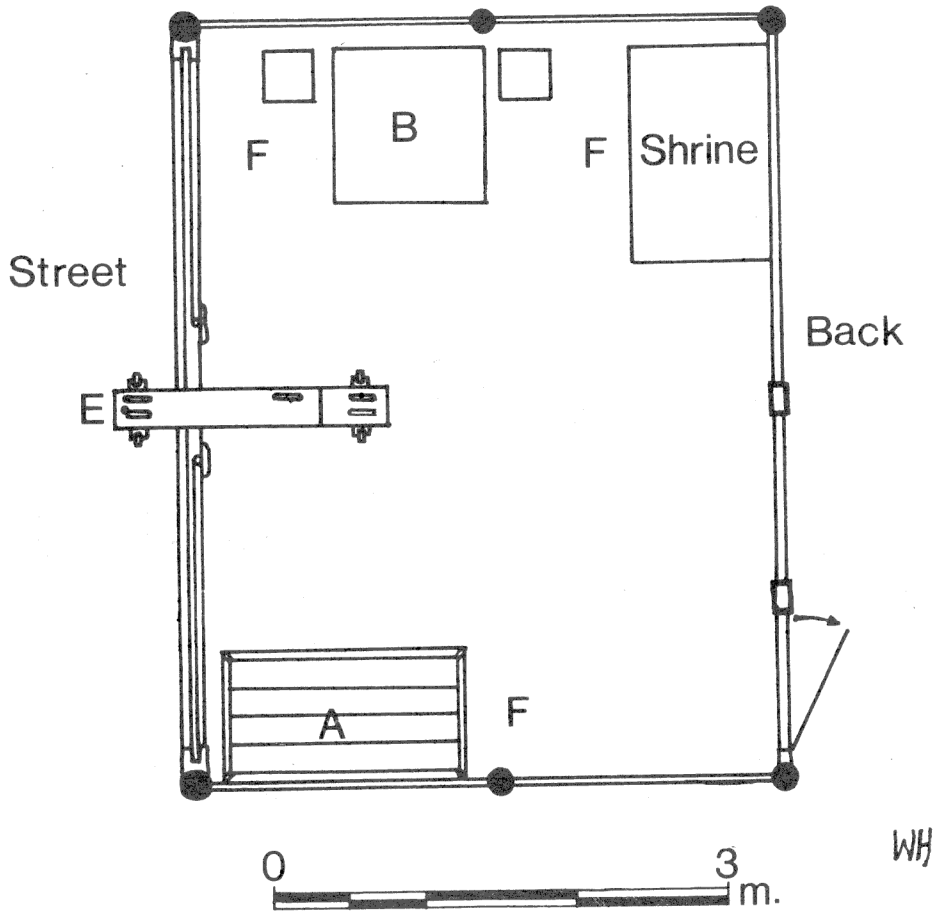


Fig.5

WH/AG

BOW WORKSHOP



WH

Fig.6

STAVE POSITIONS

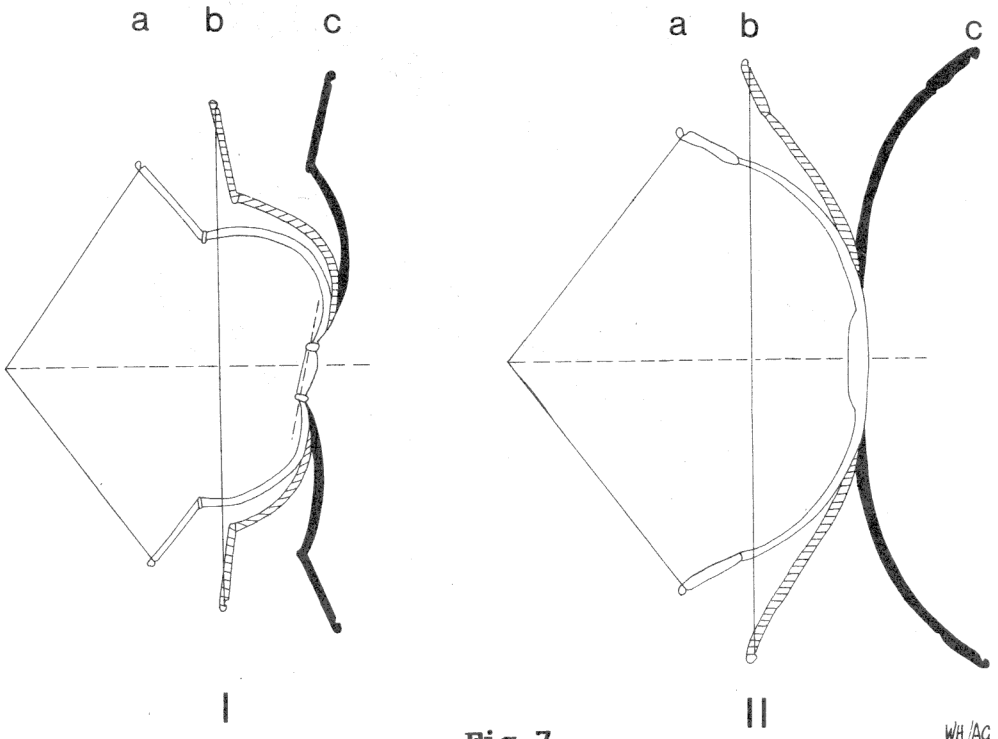


Fig.7

ARROW TERMINOLOGY

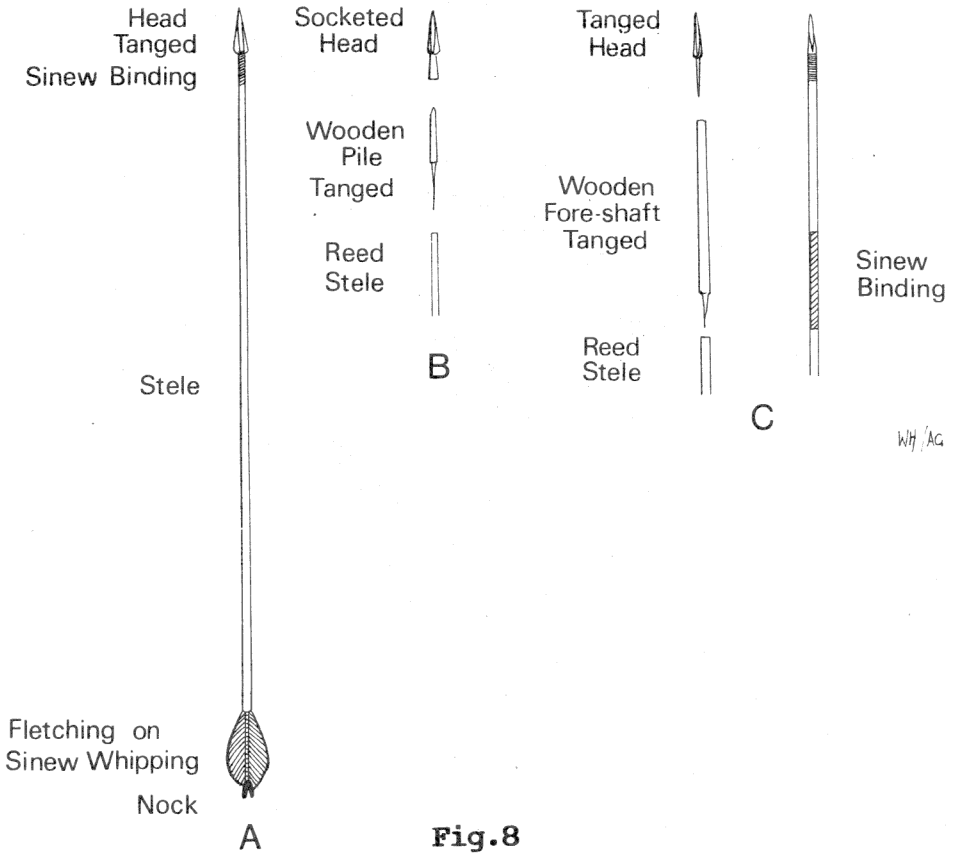


Fig.8

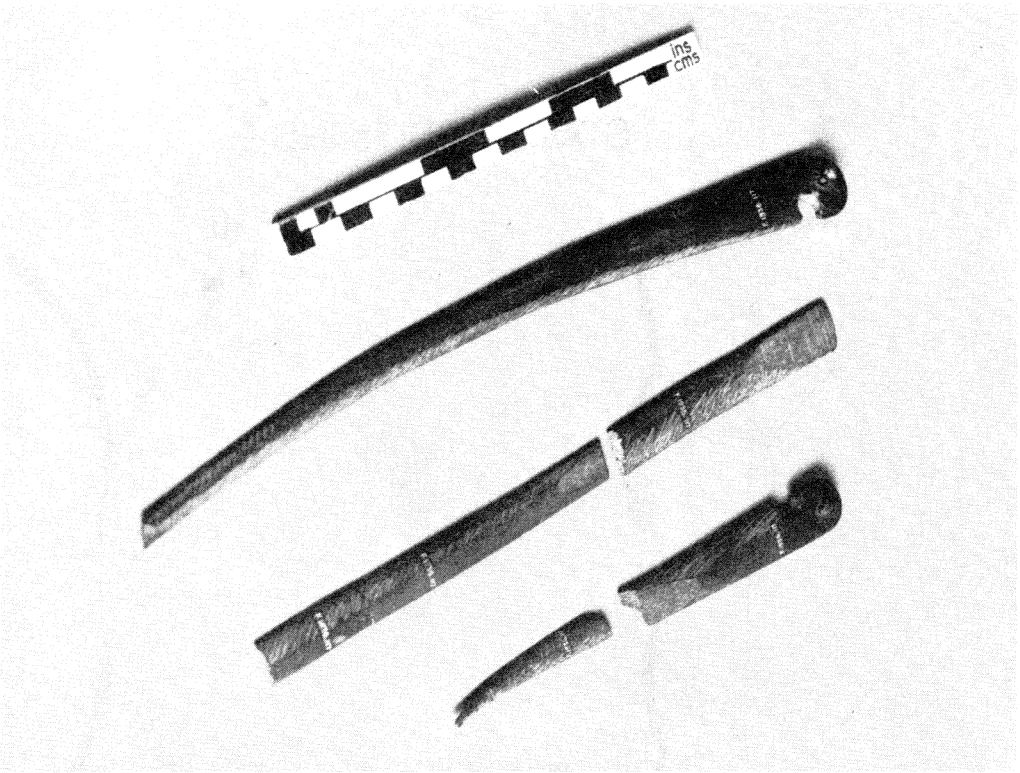


Fig.9

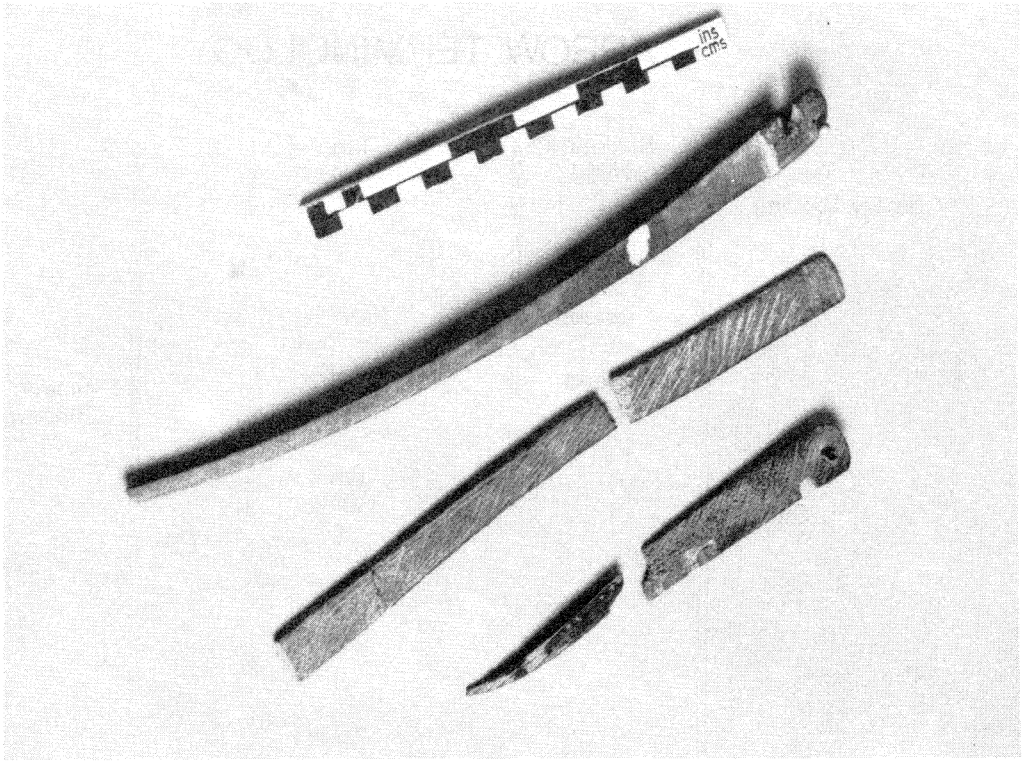


Fig.10

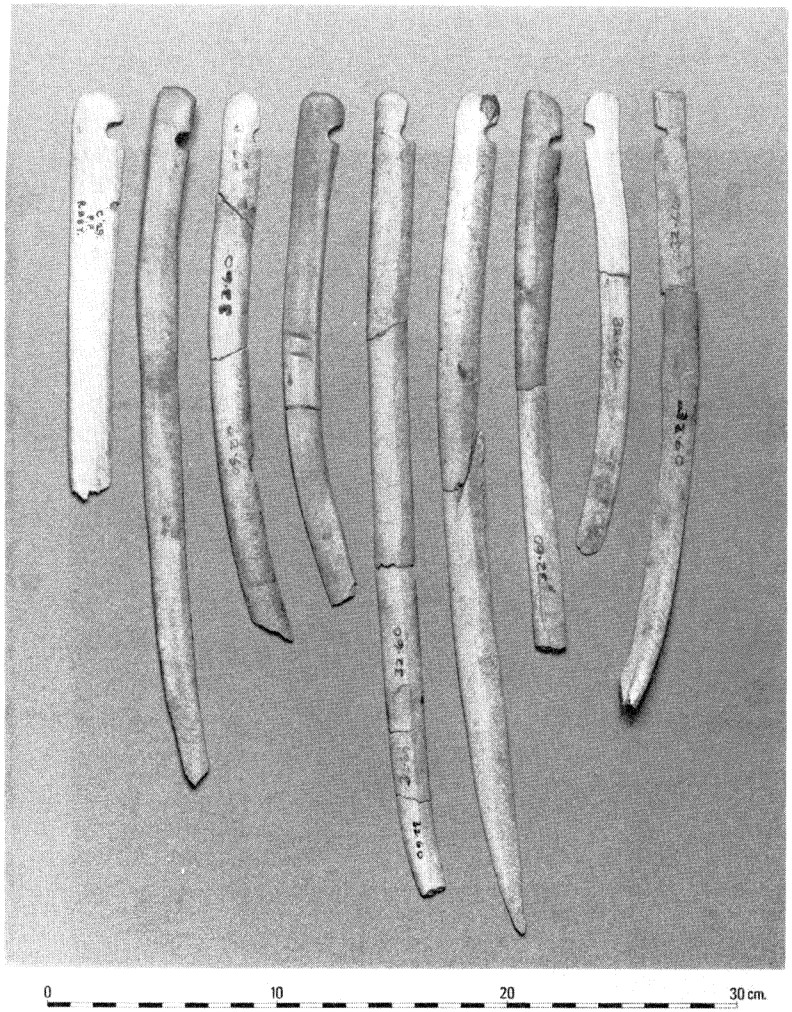
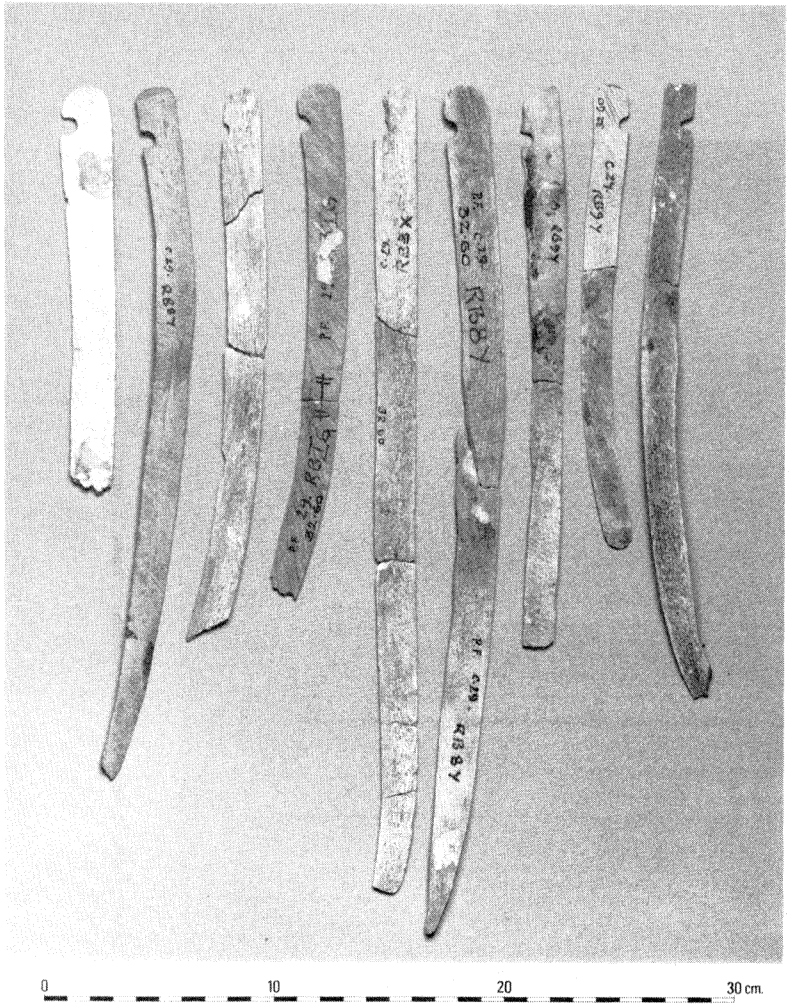


Fig.11



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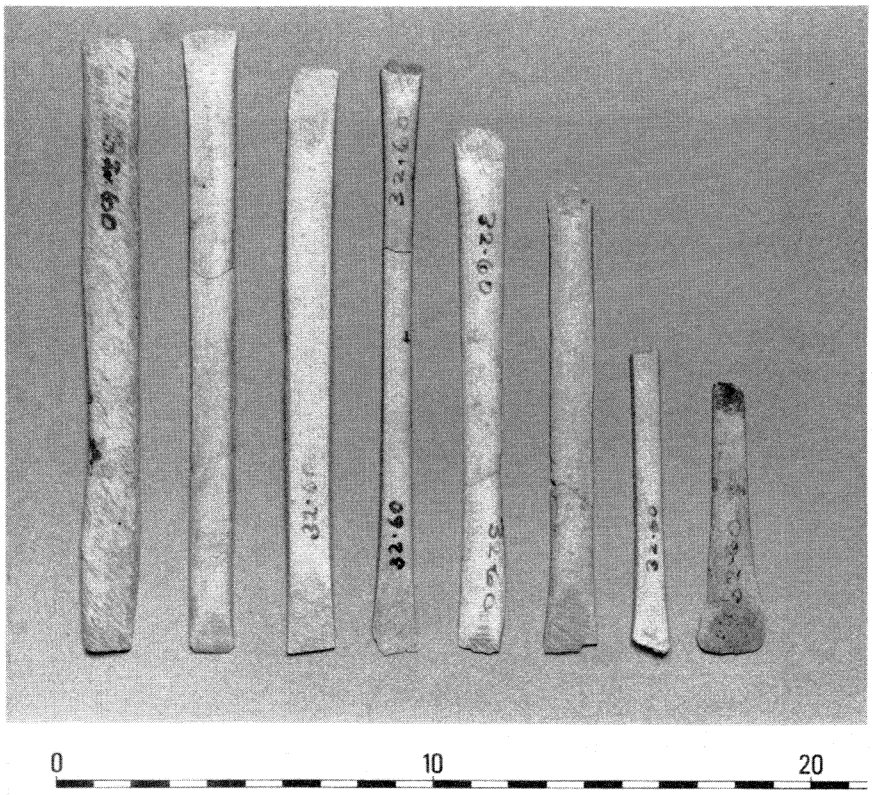

Fig.13

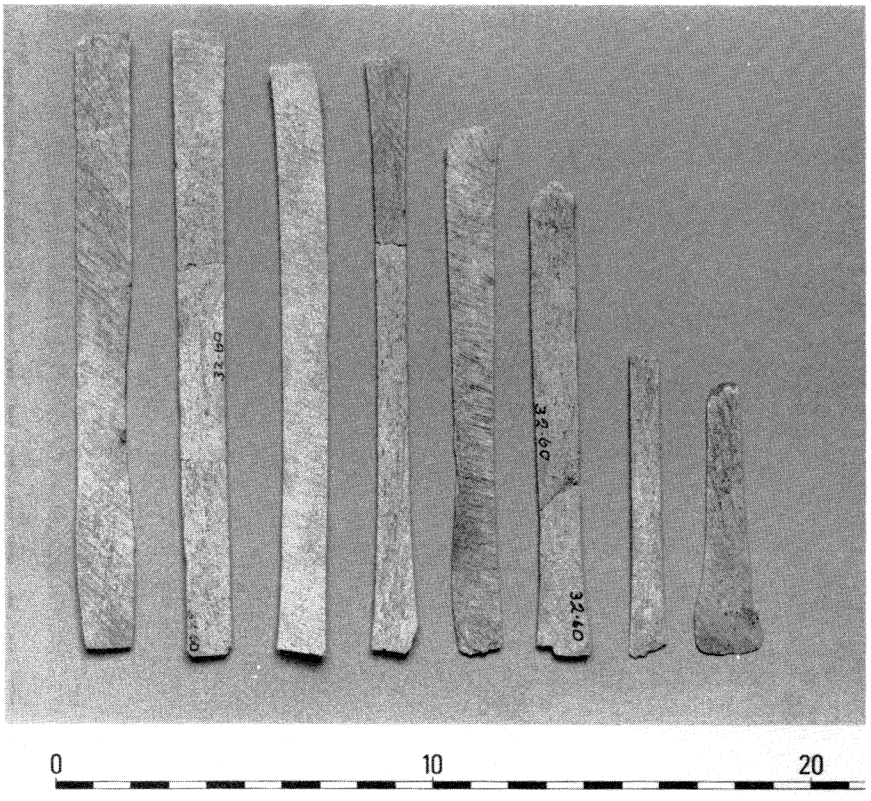

Fig.14


FRAGMENT OF COMPOSITE BOW
ROMAN PERIOD, BELMESA, EGYPT.
Presd. by Prof. W. M. Flinders Petrie, 1897.
INCHES

Fig.15

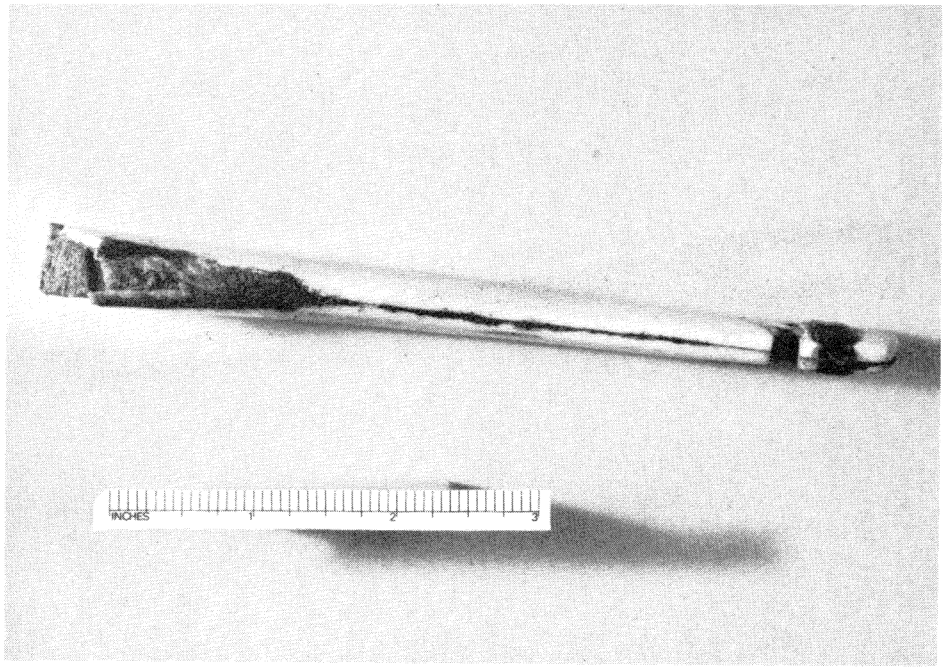
INCHES

Fig.16

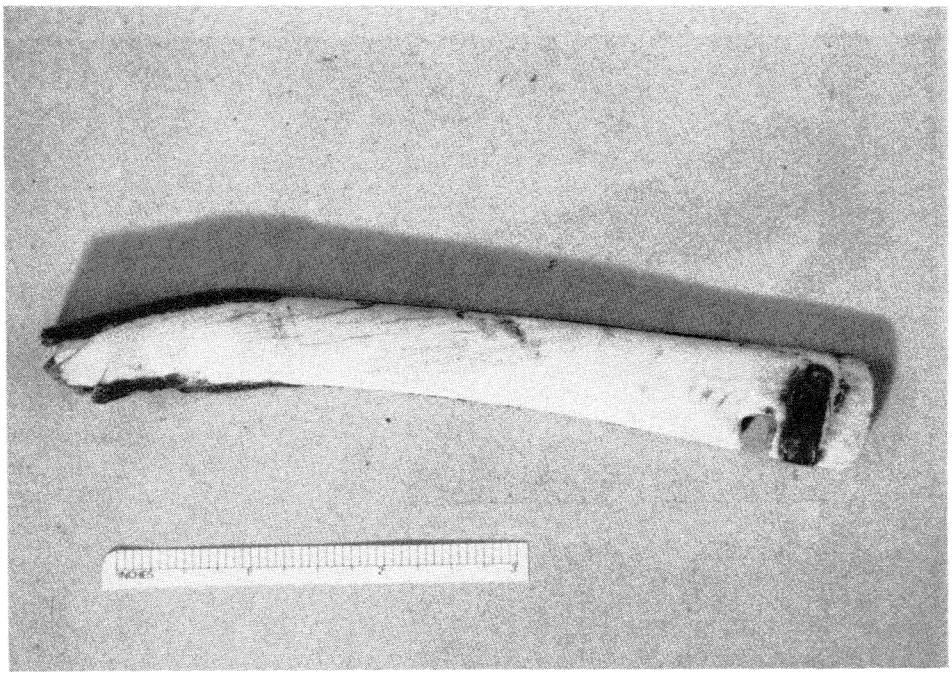

Fig.17

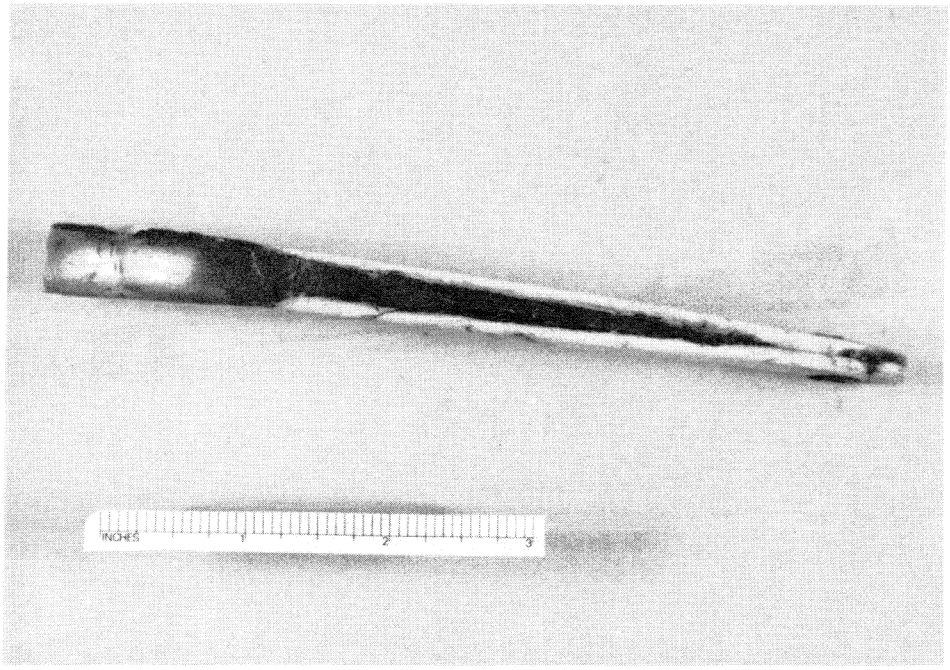

Fig.18

Fig.19

Fig.20

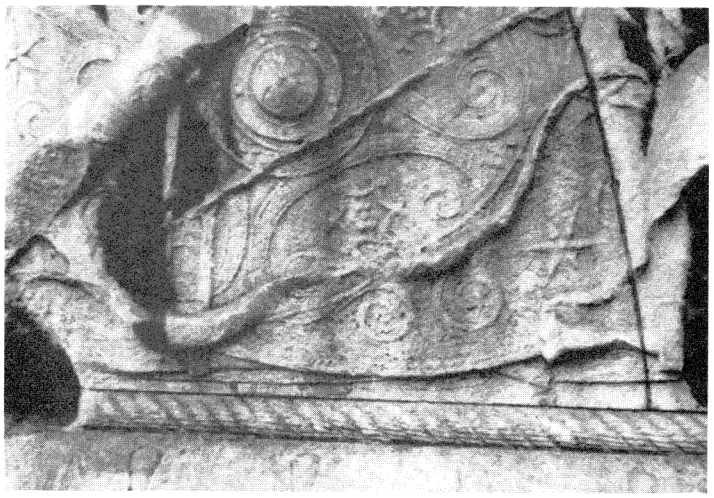

Fig.21

Fig.22

Fig.23

Fig.24

Fig.25

Fig.26

Fig.27

Fig.28

Fig.29

Fig.30

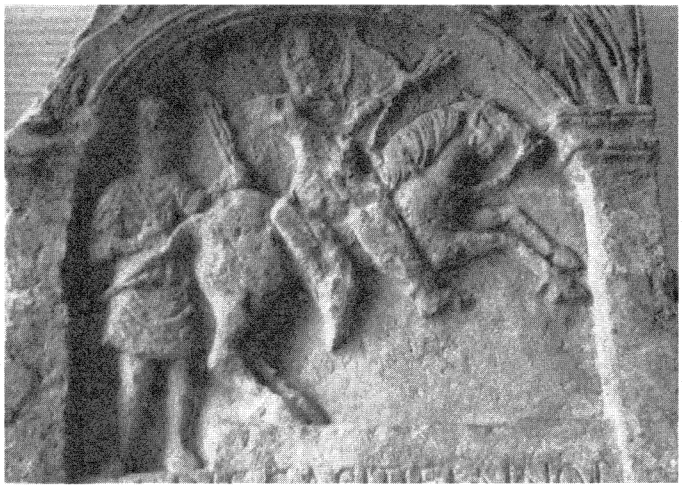

Fig.31

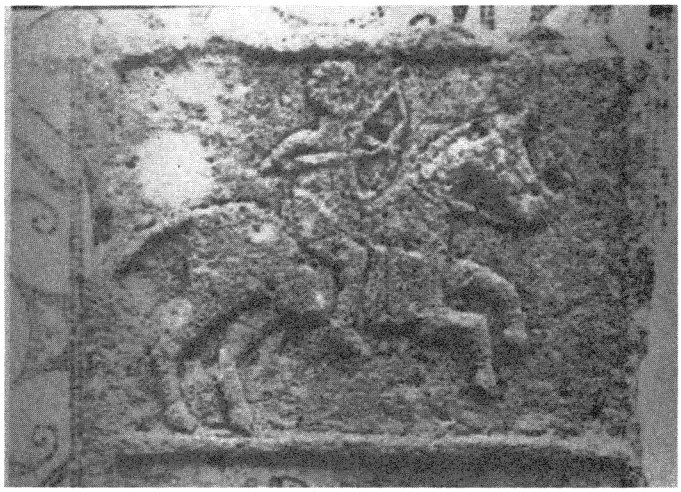

Fig.32

Fig.33

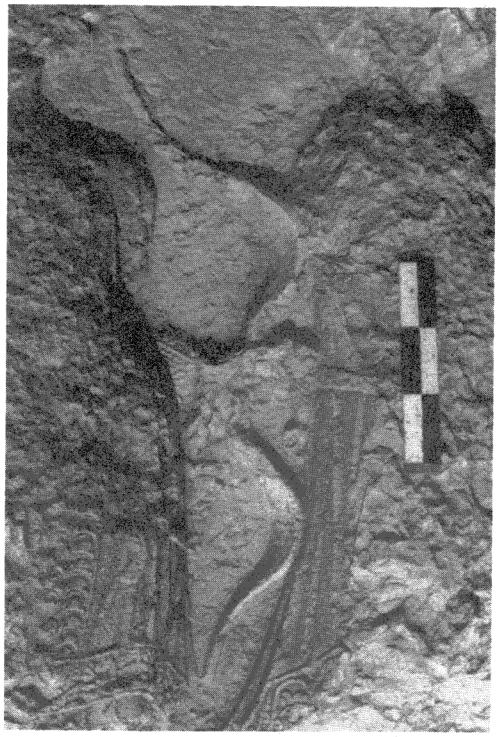

Fig.34

Fig.35

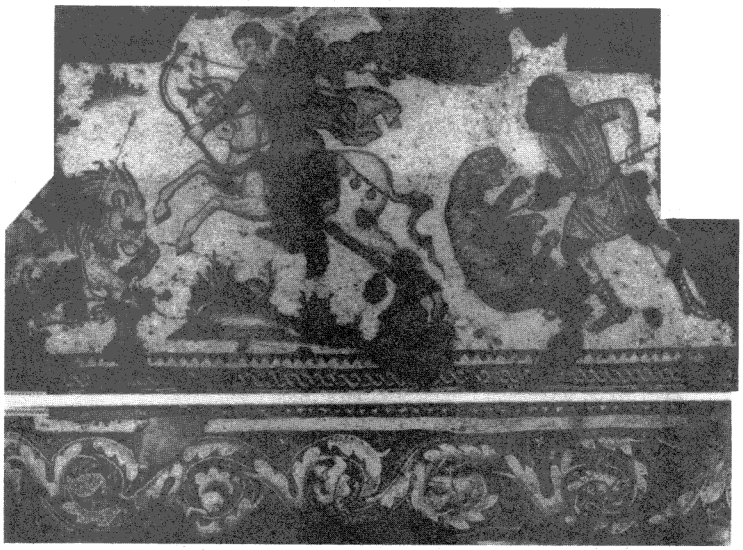

Fig.36

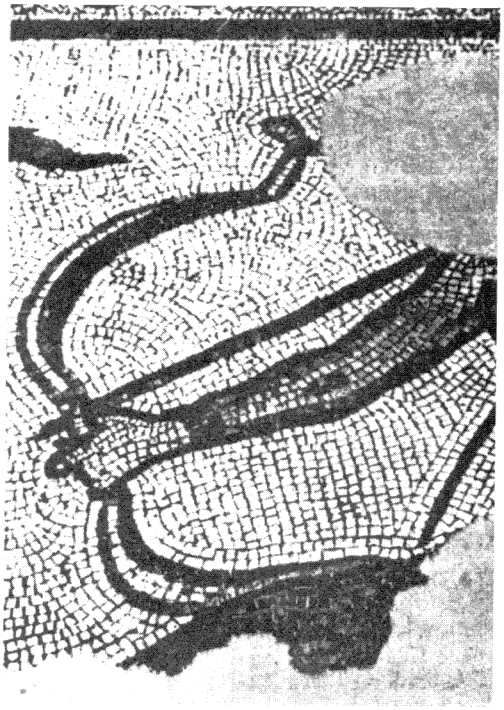

Fig.37

Fig.38

Fig.39

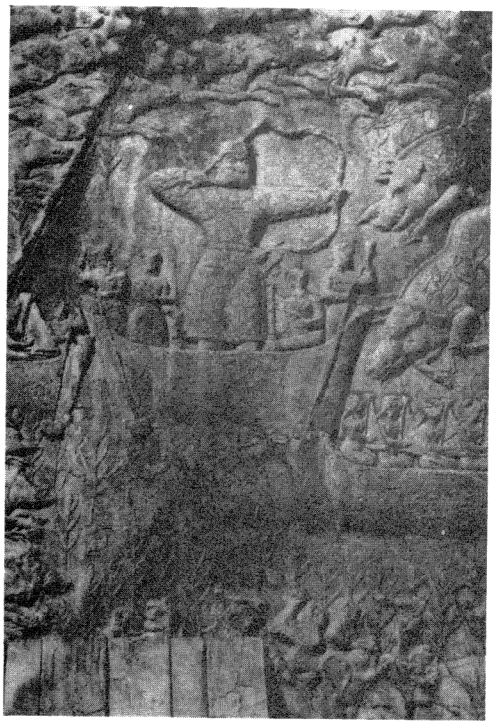

Fig.40

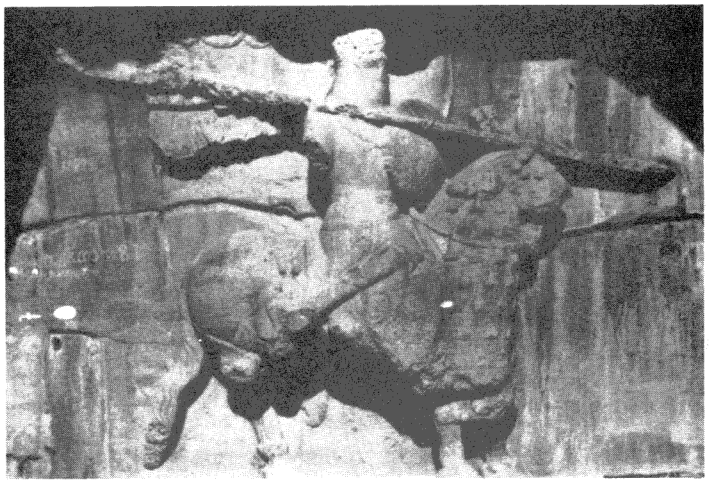

Fig.41

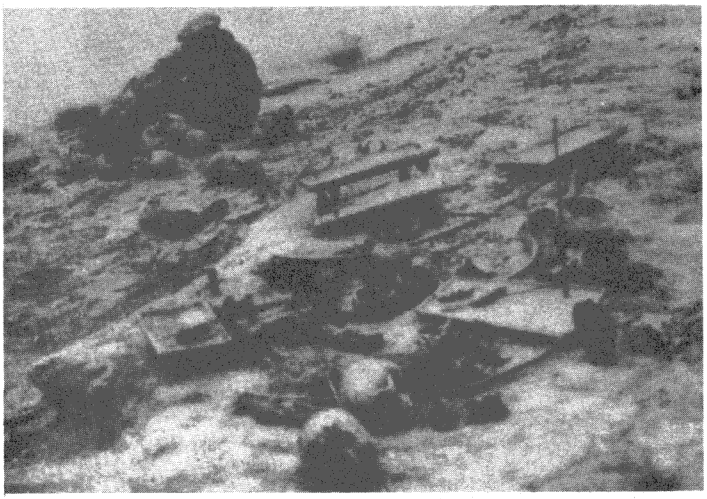

Fig.42

Fig.43

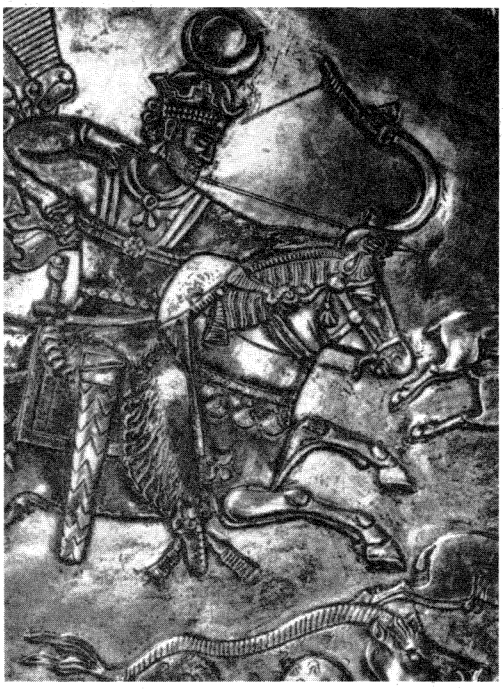

Fig.44

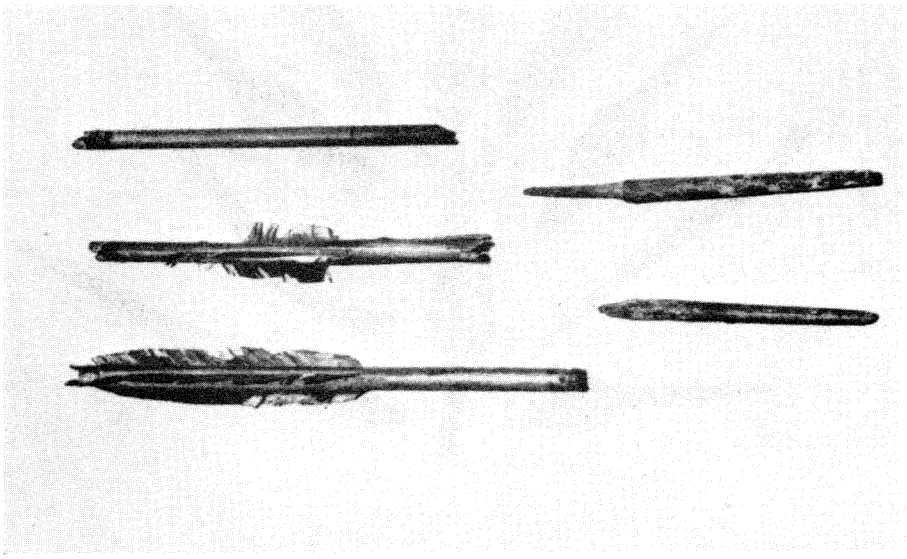

Fig.45

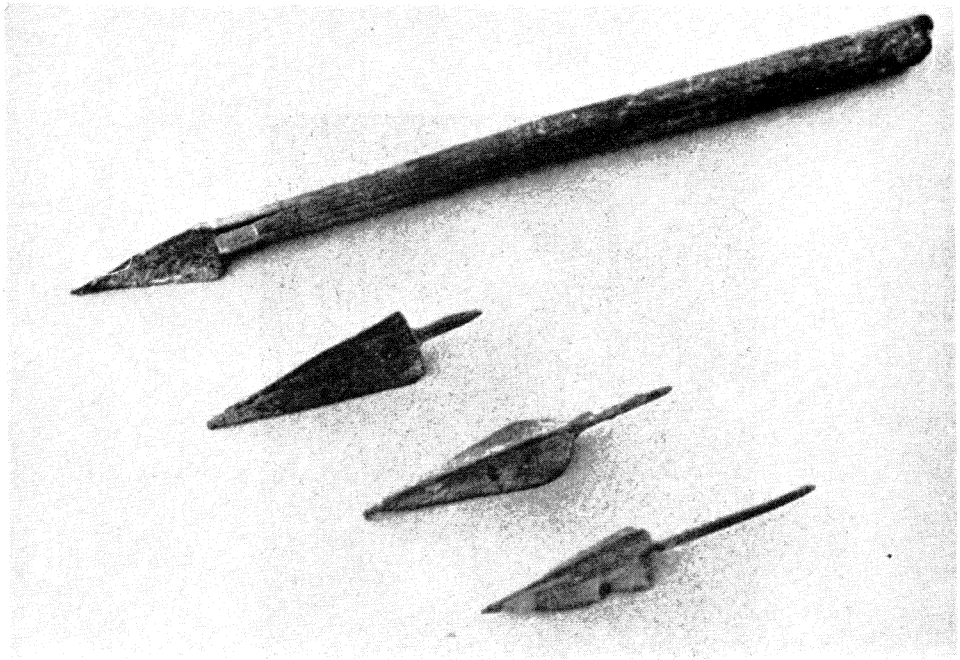

Fig.46

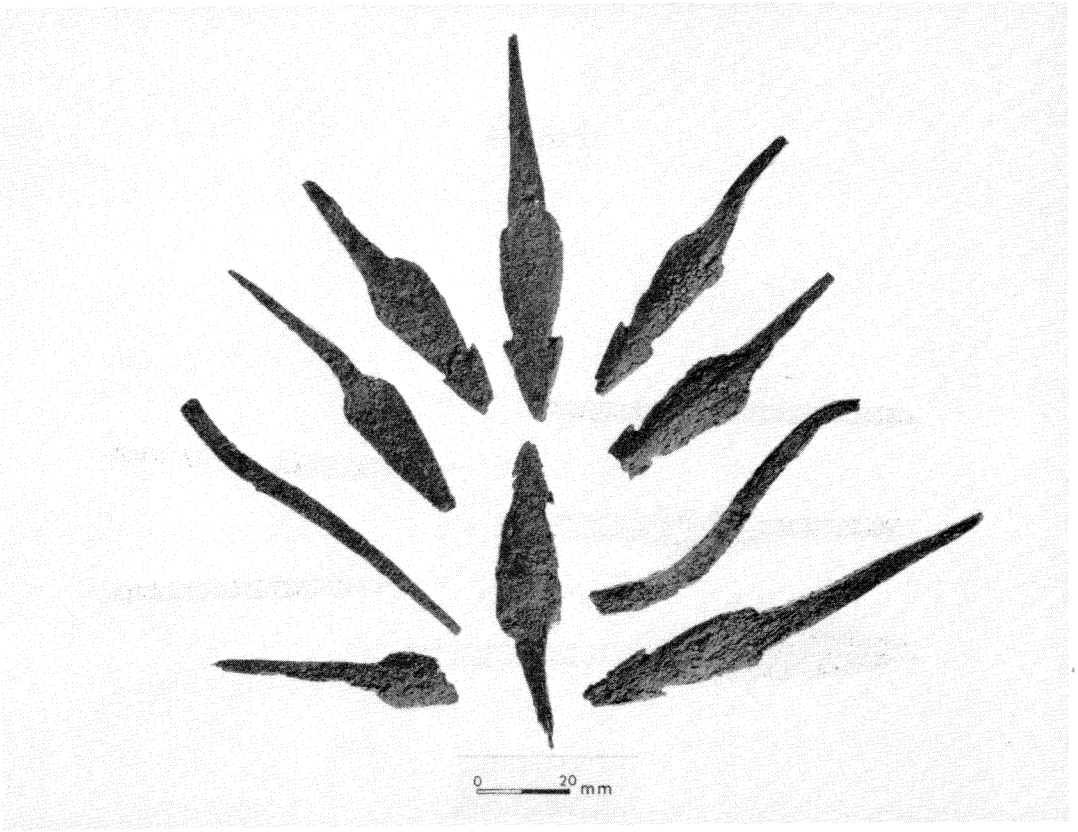

Fig.47

ABBREVIATIONS

A.A.	Archaeologia Aeliana
A.H.	Archaeologia Hungarica
A.J.A.	American Journal of Archaeology
A.R.B.	Guide to the Antiquities of Roman Britain, 3rd ed., British Museum, (London 1964)
Arch. Camb.	Archaeologia Cambrensis
A.S.H.	Acta Archaeologia Academiae Scientiarum Hungaricae
Brit.	Britannia
B.R.G.K.	Bericht der Römisch-Germanischen Kommission
C.I.L.	Corpus Inscriptionum Latinarum
C.S.I.R.	Corpus Signorum Imperii Romani
Ger.	Germania
G.R., III	Germania Romana: ein Bilder-Atlas, III, (Bamberg 1926)
I.E.J.	Israel Exploration Journal
I.L.S.	Inscriptiones Latinae Selectae
J.A.S.	Journal of Archaeological Science
J.R.A.I.	Journal of the Royal Anthropoligical Institute
J.R.S.	Journal of Roman Studies
J.S.A.A.	Journal of the Society of Archer-Antiquaries
M.Z.	Mainzer Zeitschrift
O.R.L.	Obergermanisch-raetische Limes
P.S.A.S.	Proceedings of the Society of Antiquaries of Scotland
R.E.	Paulys Real-Encyclopädie der Classischen Altertums
R.L.O.	Der römische Limes in Österreich

S.J. Saalburg Jahrbuch

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