THE LONGBOW

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WEAPON

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Series Editor Martin Pegler

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Dedication

For John Waller

Author's acknowledgements

My thanks to my good friends Dr Tobias Capwell and Gordon Summers, who read some portions of the draft text and gave invaluable feedback. I owe an age-old debt of gratitude to Robert Hardy, whose groundbreaking work on the subject in his 1972 BBC documentary 'The History of the Longbow' started me on what has become a lifelong interest. His subsequent writings on the subject have been an inspiration, as have the scholarly writings of so many others, whose researches I have drawn on for this book. I am grateful also to Dr Alan Williams for his guidance in setting up the deceleration tests in 2003. I am equally grateful to Dr Matthew Paine, who organized the blunt-trauma impact tests in 2011. I am indebted to Ian Coote, Joe Gibbs, Mark Stretton and Gary Symonds, members of the English War Bow Society, who have allowed me to photograph them shooting their great warbows, who have participated in archery experiments for some of my television projects and who have been very generous with their time in answering my questions. My gratitude also extends to Mick Manns, fletcher, and Hector Cole, arrowsmith, who have both shared their extensive knowledge with me. The bowyer Chris Boyton has been a constant source of information over many years. I thank him for that and for the two longbows that he made for me. They delight me every time I shoot them. Thank you also to the numerous people and institutions who have provided me with photographs: their names are credited alongside the images. Mostly, however, I wish to thank all those many friends with whom I have spent countless pleasurable hours 'bow-in-hand' and who share with me a passion for this ancient weapon – I have learned much from you all. However, the opinions expressed in this work are entirely my own and not necessarily the views of those who have been kind enough to give me their time and advice in its preparation.

Editor's note

When citing medieval prices and wages, references in this book are to the pre-decimal British currency of pounds, shillings and pence: 12 old pence (12d) made one shilling (1s) and 20 shillings made one pound (£1). In modern decimal currency 100 new pence make one pound. Measurements are given using the imperial scale, which has the following approximations on the metric scale:
1 mile = 1.6km
1lb = 0.45kg
1yd = 0.9m
1ft = 0.3m
1in = 25.4mm
1 gallon (UK) = 4.54 litres
100ft/sec = 30.48m/sec

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INTRODUCTION

In 13th-century England, the longbow began to emerge as a symbol of empowerment for the yeoman classes. Many accounts of the Robin Hood legend root him in this period. The idea that strength and skill can triumph over wealth and status is a powerful one; it is an idea that offers the hope that ordinary people can throw off the yoke of lordly oppressors. Holding more rigidly to standards of chivalric propriety and feudal hierarchy, the French nobility deplored the fact that men of inferior class, men with longbows, were able to fell expensive knights. However, to a certain breed of Englishman, the fact that this simple stick, the weapon of Everyman, was able to usurp the natural order of things made the allure of the longbow all the more compelling. The longbow has remained a very potent symbol of common justice, which is probably why it has continued to receive such romantic treatment. Longbows are also a great joy to shoot.

There are various definitions for the term longbow, including narrow criteria set out by the British Longbow Society (BLS) that would exclude longbows of a medieval type.[1] The first written reference I can find to the term 'longbow' is in a letter from Margaret Paston to her husband John, written in 1449 (Gairdner 1986: 101). At the time John Paston was embroiled in a private war with Robert Moleyns; in 1450 Moleyns sent 1,000 men to dislodge Paston from his castle at Gresham, Norfolk, and his followers subsequently attacked Margaret Paston. She had good reason to attend to the defence of her house. In her letter, Margaret urges John to get some 'crosse bowis' because the house is too low for men to shoot out with a 'long bowe'. Here 'longbow' is a term used to distinguish it from the crossbow – the longbow was both held 'longwise', not mounted

1 The BLS, formed in 1951, exists to preserve the recreational shooting tradition of Victorian- and Edwardian-style lightweight longbows which, unlike medieval bows, have a stiff centre section. It acknowledges that the medieval style of battlefield longbow was of differing specifications and does not claim that what it defines as a longbow is of a medieval type. Medieval longbows bent 'full compass', that is with a continuous arc through the centre section; they also had no binding for the handgrip, which is only a feature of later bows.

'crosswise', and it was also longer than the bow (prod) on a crossbow. Prior to this, longbows were referred to simply as 'bows'.

There is a direct correlation between the length of a simple wooden bow and the length of draw – longbows are also long. Unlike longbows, composite bows – which consist of laminations of various materials including wood, horn and sinew – are capable of taking extreme bend without breaking, and so a laminated bow or bow of composite materials can bend with a much greater arc in proportion to length than can a bow that is fashioned from a single stave of wood – known as a 'self' bow – which is the case with a longbow.

Longbows stood taller than the man who drew them because the height of the man was proportionate to the length of his arms and thus the length of his draw. A longer draw required a longer bow or the bow might break, and it was a characteristic of the medieval military longbow that the archer drew back to the ear or shoulder, a measure that sent his arrows thudding into the enemy with even greater impact. In 1590 Sir John Smythe, soldier, diplomat and author of military treatises, wrote, 'Our English bows, arrows and archers do exceed all other bows used by foreign nations, not only in thickness and strength, but also in the length and size of the arrows' (Smythe 1964: 69).

A late-15th century depiction of archers in action at the battle of Crécy, 1346. They wear an assortment of sallet-style helmets; note the combinations of brigandines, mail and plate. The arrows laying on the ground are possibly an attempt by the artist to represent arrows stuck in the ground and standing upright, but the challenges of perspective may have defeated him here. (Froissart's *Chronicles*, Bibliothèque Nationale de France, Ms. Fr. 2643, f. 165v, © Bibliothèque Nationale de France/Art Archive)

In recent years the term 'warbow' has been coined to differentiate the recreational longbow and the hunting longbow from their more powerful martial cousin. 'Warbow' is not a medieval term but it is nonetheless a very useful descriptor and I will use it intermittently in the ensuing text. However, the warbows to be discussed here are also longbows and it is that latter term, fondly familiar to me, that I will employ primarily in referring to this enigmatic weapon.

On land, the longbow had been used as a skirmish and battlefield weapon in the hands of the Anglo-Saxons and the Vikings. A line in the epic poem *Beowulf*, which may have been written as early as the 8th century and no later than the 11th, hints at the prevalence of battlefield archery during this early period. It speaks of the hero, Beowulf, 'who often endured the iron-tipped arrow-shower, when the dark cloud loosed by bow strings broke above the shield wall, quivering; when the eager shaft, with its feather garb, discharged its duty to the barb' (Anon 1973: 117–18). The longbow was also used by the Normans; the Norman lord Richard de Clare (1130–76), known as 'Strongbow', took several companies

of Welsh archers with him for the Norman invasion of Ireland in 1169. There was nothing to distinguish the longbows of these cultures from their later medieval incarnation other than perhaps increased draw-weight for the later medieval bows.

More significantly the longbow of these earlier periods was not used in great numbers. Well into the 13th century it was still being used for campaigns in difficult terrain, but seldom in pitched battle. However, at the end of that century there was a shift in tactics, and what changed was the scale of the longbow's use. Armies now counted many thousands of archers amongst their ranks and the longbow emerged as a prominent battlefield weapon. It reached its peak of both fame and function when it was employed in massed numbers by English armies on the open battlefield during the Wars of Scottish Independence (1296–1357), the Hundred Years' War (1337–1453) and the Wars of the Roses (1455–85). As a maritime weapon, the longbow would remain of paramount importance throughout the medieval era and until the end of the 16th century, especially for the English.

Although medieval English armies used archers to a greater extent than any other nation, they did not do so exclusively. The Welsh used archers very effectively in guerrilla warfare against Edward I (r. 1272–1307) and subsequently in the service of English kings in foreign wars. The Scots fielded archers, in fewer numbers but in similar manner to the English, on the battlefield. Scottish bowmen also served with distinction in French armies during the latter part of the Hundred Years' War. During the 15th century, English archers were in high demand to fight in the armies of Burgundy, a powerful duchy that was itself at war with France. In the following pages, however, I concentrate solely on the longbow's use by English armies and by English navies, for it is in their service that it made its most conspicuous impact. Moreover, a greater focus has been given to its use in the campaigns of Edward III (r. 1327–77). I consider this to be the longbow's apotheosis and a source of many good examples of its versatility.

Any assessment of the longbow's lethal potential must encompass an understanding of how armour developed to deal with the threat. In fact it is mostly through the progress of armour that we can best track the development of the weapon. In appearance longbows from different eras looked much the same, but it is probable that as armour improved, the draw-weight increased. As we shall see, there was certainly an evolution in arrowhead styles, which included not only armour-attacking forms but also case-hardened points. It may be argued, however, that the most significant developments in the longbow's trajectory to iconic weapon status were changes in the recruitment and tactical deployment of the archer himself.

Archers faced a mighty and impressive foe. The most glorious, most splendid and possibly the most powerful warrior ever to put his stamp on the battlefield was the fully armoured medieval knight. He engaged the enemy by smashing into him, and it was the archer's task to stop the knight in his tracks. The bowman did not always pull it off – but when he did, he became the stuff of legend.

DEVELOPMENT

The longbow's genesis and production

ORIGINS AND DISCOVERIES

As a hunting weapon the longbow can be traced to the Neolithic period, which begins around 10,000 BC. Extant examples include that of Ötzi, a Stone Age hunter, whose preserved body was discovered in the Italian Alps in 1991. His yew longbow, dated to around 3,300 BC, was made from the heartwood only. Glacial refrigeration kept Ötzi's bow 'on ice' for us, but numerous longbows have been conserved by other geological caretakers, peat bogs and marine silts, which preserve organic material by creating oxygen-free environments.

In 1863, 40 longbows were discovered in a bog at Nydam in Denmark. Dating to the 4th century, these magnificent bows – some made of yew, some of fir – were recovered from three ship burials. The Nydam bows are in a state of almost immaculate preservation and are on display at Denmark's Nationalmuseet (National Museum) in Copenhagen. Of particular interest on two of the bows is a spike at one end – one of metal, the other of bone – suggesting an anticipation of close combat, for which the bow can be hastily converted into a pike/spear. Although relatively little is known of its use during this period, the military longbow had made its debut.

To date, no longbows from the actual medieval period have been unearthed, but there is abundant evidence for their physical form in the cache of superb mid-16th-century specimens that emerged from the Solent mud – the warbows of Henry VIII's warship the *Mary Rose*. This momentous development in our understanding of the longbow came between 1979 and 1982 with the excavation and eventual raising of part of the hull of the *Mary Rose*, which sank in 1545; of the 172 bows salvaged, 137 are fully intact. They represent the closest material resource for understanding the medieval longbow that we have to date (Hildred 2011: *passim*).

These bows proved to be of similar cross-section and length to many of the longbows that were retrieved from the Nydam ships. Fundamentally they were identical, though the draw-weights of the *Mary Rose* bows were notably heavier. Of further note is that not all the *Mary Rose* bows were of the same cross-section; some were plano-convex (D-shaped) while others were oval.

Within this narrow range of variation, the design of the longbow itself – the wooden stick – did not change very much over the centuries, but the longbow did not exist in isolation. It was part of a developed weapons system that included the archer as operator, the bow as the launch platform, the arrow as the delivery platform and many target-specific forms of arrowhead as the actual weapon. It is in these other elements that change and development are to be found. One of the main catalysts for these changes was the continual improvement in armour's defensive capability from the mid-13th century onwards, since, on the battlefield at least, armour was the principal challenge that the longbow faced. Before examining the bow itself, it is important to understand this challenge and what the longbow had to overcome to be a viable force on the medieval battlefield.

COUNTERING THE LONGBOW: MEDIEVAL ARMOUR

Any consideration of the longbow's effectiveness in battle must deal with the subject of armour. While a thorough survey of this topic would consume several volumes, there are a number of general principles that it is useful to understand.

Given average battlefield conditions, armour was reasonable proof against the weapons of the day. Had it not been, fighting men would not have gone to the expense of acquiring and wearing it. Throughout the Middle Ages, most troop types wore some form of armour and this is unlikely to have been the case if armour did not deliver adequate protection. Even at the lower end of the price range, there was a significant cost to armour relative to the means of the wearer. As well as the expense of its acquisition, armour demanded time and money for its maintenance.

There was also the inconvenience of armour. All types of armour, including full-plate armours, allowed the required range of martial movement. Nevertheless, the soldier would have been able to move more freely and more comfortably without it. Armour has always been a manageable weight, seldom exceeding around 65lb – significantly less than the standard weights carried by modern infantrymen. A 2007 Naval Research Advisory Committee report entitled 'Lightening the Load' gives the following weights for a US Marine Corps rifleman: Existence Load (landing zone – secure area), 167lb; Approach Load (20-mile march within eight hours maintaining 90 per cent combat effectiveness), 123lb; Assault Load (into the fight), 97lb. It should also be noted that the modern soldier carries the majority of this load on his/ her back, whereas medieval armour distributed the load across the body.

Even so, there was a weight factor to armour, which affected comfort and fatigue and which would not have been endured without compensating advantage. In warm weather armour was unpleasantly hot and, in winter

conditions, the metal conducted the cold. Ventilation was also a significant issue. With armour for the head, there was a trade-off between full protection and full peripheral vision.

Set against this premise are the legions of tests, from the backyard to the laboratory, that have demonstrated time and again the ability of arrows shot from a longbow to penetrate all kinds of armour.[2] The results of the tests are indisputable: arrows shot from powerful longbows punch through virtually everything put in front of them, and they do so to depths that would deliver mortal wounds. Such tests confirm that the longbow, at the appropriate draw-weight and with the appropriate arrowhead, was a formidable weapon. However, there are a great many factors that determine an arrow's ability to penetrate armour, and the isolated conditions of the testing ground never fully replicate the complex and chaotic circumstances of the battlefield.

Types and forms of armour varied a great deal over the centuries of the longbow's use and what follows is only a brief summary of some of the main elements the longbow confronted.

Shields

The shield was the most significant item of defensive equipment against arrows. Shields were of composite structure and although some were made from adjoining panels, the core of most was formed from a single piece of wood – a German stained-glass window fragment of *c*. 1400 in the Glasgow Museum's Burrell Collection shows a shield-maker working a shield from a solid block of wood using an axe. In order to retain the curved shape, seasoned timbers were essential. European poplar and lime (also known as linden, or basswood in the USA) were the favoured woods, known both for being lightweight and easy to carve. Sycamore was another common choice; it was a little heavier, but harder.

To bolster the dense, energy-absorbing properties of the wood, shields were reinforced with multiple laminations of heavy-duty canvas, sometimes with an additional layer of parchment, which were bonded with casein glue to both surfaces of the core. Mosaic strata of horn or bone were familiar facets on jousting-shields, many of which survive. Such an additional layer on battle-shields, few of which remain to us, would have been highly effective. Most shields were finished additionally with a facing of leather, sometimes rawhide. On the reverse was a linen-covered pad, often of hair-felt, which not only buffered the shock of impact but also gave yet more depth to challenge arrow penetration.

I am not aware of any longbow testing against an authentically constructed shield but I would be fairly confident that, if properly made, the shield would be up to the task. A shield did not protect the whole body, but, held just a little way in front, it gave effective cover to a wider area than its own surface dimensions, particularly to the vital areas of chest and head. For massed troops, those behind the men of the leading rank were to a large

2 Many of the most compelling tests of this nature have been carried out by Mark Stretton and others of the English War Bow Society (EWBS); the results have been published in Soar 2006 (127–52), which contains two chapters written by Mark Stretton.

extent shielded by those in front, and so a shield held at an angle above the head would have offered a reasonable umbrella of protection. The English chronicler Geoffrey le Baker observed that the French knights at Poitiers advanced in close formation, 'protecting their bodies with joined shields, [and] turned their faces away from the missiles. So the archers emptied their quivers in vain …' (quoted in Strickland & Hardy 2005: 237).

Cuir-bouilli

As a material for armour, cuir-bouilli, a treated, hardened form of leather that was soft and pliable before drying, was well suited to forming into shaped pieces of armour, such as those for the limbs. These shaped pieces were often reinforced with metal splints. It was also available in large sheets, something that was not usually possible with iron and steel until the latter part of the 14th century, and this made it ideal for making large, globose breastplates from a single piece. In fact we get the term 'cuirass' from the fact that early breastplates were made from *cuir* (leather). There is discussion among historical leather-workers as to the exact nature of cuir-bouilli (Richardson & Beabey 1997: 94–101). Some favour boiling the leather in water, making it very hard, though perhaps a little brittle; others support the idea of impregnating it with hot beeswax. Either way, it was considered an extremely tough material and made for very useful armour.

Mail

Perhaps the most universal metal armour of the medieval period was mail, which combined good protection with excellent flexibility. It also had the potential for repair and modification, important factors for those of lesser means. Not all mail was created equal; variations included the thickness of the wire and the diameter of the links as well as the quality of the metal. Some mail featured all the links being closed with a rivet, while other examples were comprised of alternating rows of riveted and solid links. The regular assembly method attached each link to four others – two in the row above and two below. However, there is evidence for heavier, six-in-one weaves, with three in the row above and three below, which created a much denser defence.

Mail tends to be especially effective in resisting cutting blows from a sword or axe. It is less useful against the punch of a bodkin-style arrow, but in order to be penetrated, the arrow needs to strike mail at a good angle at close to 90 degrees to the target surface. Even when it fails to prevent penetration, the mail continues to have some effect on an incoming arrow by absorbing a great deal of the delivery energy.

Mail standard or pizane, *c.* 1350. These were high-standing collars, offering protection to the neck and throat. The collar part extended into a mantle, which defended to just below the shoulder. Note 4:1 assembly ratio for the mantle and a 6:1 ratio for the standing part of the collar. The yellow metal (copper alloy) is decorative. This is a good example of how the defensive properties of mail can be increased over vital areas by altering the construction. For those who could afford them or had the opportunity to loot them, mail collars like this, known either as standards or pizanes, were popular forms of armour for archers during the 14th century. They did not affect the bowman's ability to draw his bow but gave good protection against downward strikes from a cavalryman's sword. (British Museum PE 1856,0701.2244 © The Trustees of the British Museum)

Textile armour

The key to the effectiveness of medieval armour was the use of composite, layered materials; the outer skin of

leather or metal was only the front line of defence, while the textile armour worn beneath provided the real stopping power. The base layer of any medieval armour was the aketon or gambeson, a stuffed and quilted knee-length coat that not only offered formidable resistance to the shock of impact but whose dense layers also obstructed penetration.

A popular form of armour among archers in the 15th century was the jack, a shorter-length coat of defence. One of several construction forms consisted of 25 or more layers of linen, plus often an outer layer of deerskin, stitched in a quilted pattern that gathered the material. This 'gathering' condensed the surface area, bunching the fibres into a denser, more impenetrable mesh, which provided excellent protection in addition to the depth of multiple layers. Textile armour, such as the jack and the gambeson, was considered to be so effective that it was often worn on its own.

Writing in 1483, the Italian traveller Dominic Mancini observed: 'the more common soldiery have more comfortable tunics that reach down below the loins and are stuffed with tow or some other soft material. They say that the softer the tunics the better do they withstand the blows of arrows and swords' (quoted in Strickland & Hardy 2005: 383).

Plate

A major enhancement to both mail and textile armour was the coat-of-plates. This consisted of metal plates riveted to the inside of a leather or linen base, giving protection to the front, back and sides of the torso. Most well-armoured knights at Crécy would have worn coats-of-plates over mail shirts, in turn worn over gambesons or aketons. This was significant, multi-layered, composite protection.

Exterior view of replica coat-of-plates. Note that this construction method allows for considerable shaping of the plates and that the larger plates over the chest are prominently domed. (Photograph by kind permission of Stanislav Prošek, Mac-Armour, Czech Republic)

The principle of riveting or stitching plates to a textile base was also used to good effect with the brigandine and the jack-of-plates. Here smaller plates were used and overlapped for improved resistance. These armours became increasingly common in the 15th century, especially for archers, because they retained the flexibility of mail but had the added stopping power of plate, which was necessary in an age when the archer more commonly confronted enemy archers in the opposing army.

For knights, the limiting factor in getting better protection for the torso had been the inability to produce large plates of iron or steel from the bloomery hearth process, hence the need to make larger structures out of smaller plates, such as the coat-of-plates. However, in the late 14th century it became possible to produce large plates of ferrous metal reliably and repeatedly (Williams 2003: 55). This technological advancement made one-piece breast- and back-plates a reality and heralded a fundamental shift in armour design.

Interior view of replica coat-of-plates. Note that the finished armour would be worn over a combination of mail and textile armour. (Photograph by kind permission of Stanislav Prošek, Mac-Armour, Czech Republic)

Before the advent of solid-plate body armour, all forms of armour were flexible to some extent – they gave on impact. This meant that the

North-west European brigandine, *c.* 1540–50, Royal Armouries, Leeds. This 16th-century example of a brigandine differs very little from medieval types. Note how the small overlapping plates not only articulate well but also allow for a tailored, form-fitting configuration that enhanced the wearer's range of comfortable movement, especially around the shoulders and armpits. In addition to the defensive capabilities of the plates, the mass of securing rivets and the layers of fabric also combined to augment the quality of protection. Originally the term 'brigand' referred to any foot-soldier and the armour derived its name from its ubiquitous use by such troops. (© The Board of Trustees of the Armouries)

energy of a blow could significantly affect the body's soft tissues, internal organs and even skeleton, as the armour flexed against the striking force, even though it might have prevented penetration. Large, shaped plates enabled rigidity. Now the body could be fully encased in a hard shell. There was still a need for some padding inside to absorb the shockwave of an impact, but much less than was required previously.

Further improvements came with the ability to harden the plates. Almost all medieval armour before the late 14th century was made of wrought iron, which could not be hardened and tempered because it contained only negligible traces of carbon. By the early 15th century, however, steel was becoming easier to produce in large amounts. An alloy of iron and a more significant amount of carbon (around 0.5–0.8 per cent), steel could be heat-treated in various ways to improve its protective qualities substantially – it could be hardened (Williams 2003: 938–39). Access to strong, tough, heat-treatable steel eventually allowed armourers to create fully arrow-proof harnesses for those who could afford them.

In the Statutes of the Armourers of Paris in 1451, the marks of Italian armourers are deciphered as meaning either *à toute épreuve* ('full-proof') or *à demi-épreuve* ('semi-proof'). The suggestion is that the semi-proof armours were tested with lever crossbows and that the full-proof ones had withstood being shot at with the more powerful windlass crossbow (Williams 2003: 924). Such a system would have given knights confidence in their equipment, though any perceived guarantee would be of small comfort if the claim proved to be false.

As well as its varying degrees of hardness and toughness, the effectiveness of plate armour was determined by its thickness and its shape. Plate armour could be thinner, and therefore also lighter, than might be expected, not only because of the strength of the metal itself, but also because of the structural integrity imparted by a strong form – a curved, dished plate being much more resistant to deformation than a flat sheet. The thickness of armour plates also varied according to the vulnerability of the different parts of the body; plates tended to be thinner on the arms and legs, and thicker on critical areas such as the chest and head, where a serious wound was much more likely to prove fatal. Limbs were therefore potentially more susceptible to arrow injury – but then they were also smaller, narrower targets and more likely to be in significant motion during combat.

Perhaps the most important element of plate armour's defensive capability was its ability to cause deflection. Unless an arrow strikes at an angle close to the perpendicular it is most likely to be deflected and, even if it bites, the impact will be greatly lessened according to the angle.

Great helm, *c.* 1350. Although early forms of the visored helm had been developed by the time of the battle of Crécy (1346), it was more common at this period for both English and French knights to wear great helms like this example. Great helms were usually worn over an open-faced bascinet, giving a double layer of metal protection to the skull. Ventilation was an issue and in the stifling heat of battle, some knights might take their chances against arrows, trusting to their shields, and wear only their open-faced bascinet. Arrow wounds to the face are commonly reported in the chronicles. An aventail of mail attached to bascinets would protect the throat, neck and shoulders, whether or not it was worn alone or beneath a great helm. The mail tippets seen on this great helm would have added a double layer of mail protection to a vulnerable area. (Germanisches Nationalmuseum, Nuremberg/Bridgeman Art Library)

Horse-armour

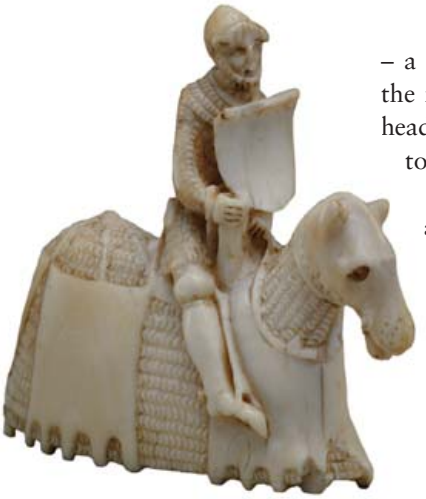
Horses, though extremely vulnerable on the battlefield, were not entirely undefended – they too had armour. By the end of the 15th century, plate armour began to be available for some horses, but until then medieval horse-armour consisted of padded textile, leather and mail (Breiding 2000: *passim*). Today these perishable and recyclable materials survive only as fragments. Clear images of this type of horse-armour are rare because an outer textile covering – the cloth caparison – mostly obscured it. However, it did exist. As early as the 13th century, during the wars of Edward I, there are records of squires with armoured horses being paid 1s per day, while those with unprotected horses were paid only 8d per day (Williams 2003: 42).

Philip VI of France had two horses killed under him at Crécy (Ayton & Preston 2005: 150). Circumstantially we can deduce that Philip's mounts were taken out by English archery. All armour could fail and horse-armour was no exception, even though a king's horse might be expected to have been fully armoured. Certainly it was technically possible to build full armour for horses, and it would be a mistake to assume that all medieval cavalry were easy targets. The animal's size meant that it was a costly business to armour it, especially if remounts were to be similarly equipped, and there was probably some variation in the amount and quality of horse-armour worn. Nevertheless, most knightly horses were fully enclosed with a protective 'bard'.

A chess piece, contemporary with the first part of the Hundred Years' War and now in the Metropolitan Museum of Art in New York, shows a full mail bard for the horse (see overleaf). The large panels hanging over the mail are not iron or steel – at this period it was not yet possible to produce single plates of this size. More probably they represent 'cuir-bouilli', a common material for armour. As with the rider's armour, there would have been padded textile armour beneath the mail. There appears to be some form of domed bolster of extra-thick padding on the horse's back behind the saddle

The Wallace Collection, London/Bridgeman Art Library

This type of visored bascinet, with steep deflecting surfaces, emerged around 1370 and is typical of those worn at Agincourt (1415). Dramatic developments of form can be readily discerned from the great helm. This design offered the optimal protection to a man walking towards an onslaught of arrows. The deep snout not only encouraged arrows to be turned aside but also allowed the sights to be placed significantly further forward from the eyes than had been possible previously, so that even long, narrow bodkins seeking to snake through the narrow slits would become wedged before piercing their target. It is hard to imagine a more unnerving experience than seeing this at first hand. The position of the sights reduces the wearer's field of peripheral vision, and it is for this reason that there are secondary sights beneath the snout. These allow the wearer to look down to see the terrain below, whether he is mounted or on foot.



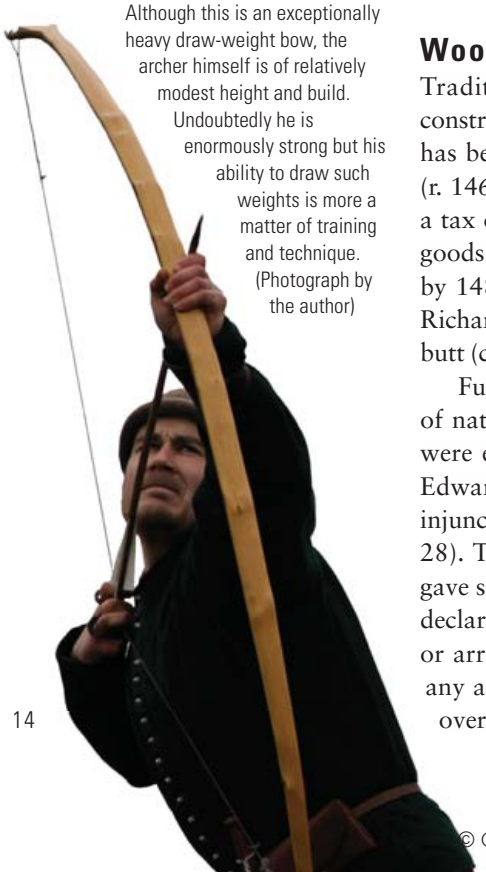
Ivory chess piece, believed to be English, from between 1350 and 1375. (The Metropolitan Museum of Art, New York, Pfeiffer Fund, 1968, 68.95, © The Metropolitan Museum of Art/Art Resource/Scala, Florence)

– a large area vulnerable to falling arrows, though equally exposed to the fall of a sword in close combat. The shaffron covering the horse's head, including its ears, has a moulded shape, suggesting that this is intended to represent cuir-bouilli.

The permutations of different types of armour, its varying quality and the extent to which it was provided for man or horse are many, but tests that purport to assess the capabilities of the longbow are equally tests that evaluate the effectiveness of armour, and the question should equally be 'did we get the armour right?' as much as it is 'did we get the archery right?' I will come to such tests in due course, but first to the heart of the matter – the bow.

BUILDING THE BOW

Whether a bow would bend or break was down to delicate judgements of the bowyer's eye and his ability to decipher the instructions from the fine print of the wood's grain. For this he needed good light and in 1371 Edward III ordered that 'no bowyer of London shall work by night from henceforth, on pain of paying … for each offence half a mark'; the same order also prohibits fletchers from working after dark (Memorials). Such a law tells us that the supply of sub-standard bows was a significant problem for an army that ordered them in great quantities. In 1399, an individual named Tom Coton was appointed the Maker of the King's Bows, and was charged with inspecting the quality of bows supplied to the English national arsenal at the Tower of London (Megson 1993: 30).



Joe Gibbs of the EWBS shooting a 170lb warbow made from Italian yew by bowyer Ian Coote. The staggering power of this immense bow is evident in the flex of its great limbs. Although this is an exceptionally heavy draw-weight bow, the archer himself is of relatively modest height and build. Undoubtedly he is enormously strong but his ability to draw such weights is more a matter of training and technique. (Photograph by the author)

Wood for bows

Traditionally, yew has been considered the wood of choice for the construction of longbows and yew from southern Europe, especially Italy, has been regarded as the best of all. In 1471, as the Yorkist Edward IV (r. 1461–70, 1471–83) resumed the English throne, customs tariffs levied a tax of four yew staves for every tun (cask with 252-gallon capacity) of goods imported into England from Italian merchants (Megson 1993: 54); by 1483, the year of Edward's death and the accession of his brother as Richard III (r. 1483–85), the duty had changed to ten bowstaves for every butt (cask with 126-gallon capacity) of Malmsey wine (Megson 1993: 85).

Furthermore, finished bows of any timber were regarded as an asset of national importance; accordingly, as well as import incentives there were export embargoes. In 1371, towards the end of the long reign of Edward III, 300 bows were confiscated at Southampton with a royal injunction that 'they shall not be taken out of the realm' (Megson 1993: 28). The following year an order to customs officers at Dover, which gave safe passage to a returning group of papal envoys and their retinues, declared, 'They or any of their company shall not take with them bows or arrows save two or three bows and as many sheaves of arrows, nor any armour, gold or silver in the lump, in plate or in any coined money over and above their reasonable expenses …' (CCR Ed III 1363).

A common alternative to yew was wych elm. The clergyman and chronicler Giraldus Cambrensis (Gerald of Wales) reported that the bows of the archers he encountered on his journey through Wales in 1188 were fashioned from elm (Cambrensis 1894: 371). Lord Admiral Thomas Howard, in accounting for deficiencies in some of the bow stocks supplied to the *Mary Rose* in 1513, complained that those that 'could not abide the bending' were of wych elm (quoted in Soar 2006: 12). The Anthony Roll inventory of the ship in 1546 records 250 'bows of eugh'; it makes no mention of other woods (quoted in Hildred 2011: 581). Taken together with the Admiral's statement, this might lead to the supposition that any wood other than yew was not fit for service. Earlier inventories of the Tudor fleet, however, record the regular use of bows of other woods, including elm (Hildred 2011: 580).

That yew was superlative for the task and was highly esteemed at the time is beyond question, but the Admiral's condemnation meant only that a particular consignment of wych elm bows, perhaps from the same supplier, were shoddy goods. I have spoken to a number of present-day archers who shoot with bows made from wych elm and they praise it universally as an excellent bow-wood. This is just as well because, for many medieval archers, their lives depended on it. Medieval longbows were fashioned from a diverse assortment of timbers.

Section of seasoned Italian yew, showing the natural bond between the creamy sapwood and the dark heartwood. Note that the grain is fairly straight, close and regular in size, which makes it ideal for building a heavy draw-weight bow. The yew tree – *taxus baccata* – grows throughout Europe, with some of the best growing conditions situated in the Italian Alps, although Spanish and Portuguese yew were equally prized. Trees in dense plantation, competing for sunlight, grew tall and straight. Moreover, on mountainsides or sandy soils with comparatively poor nutrition, trees grew slowly. Slow growth in even climate conditions resulted in a high-density, fine-grained wood that had the ability to store energy without failing. Modern bowyers talk about the sapwood of Italian yew as having a 'plastic' feel when being worked. Certainly it is more resistant to lifting than English or Welsh yew. This enables it to 'contain' the bow at draw, giving enhanced security against breakage and so making it the desired material for the heavier bows. (Photograph courtesy of Magén Klomp)

Draw-weights

From the moment the first *Mary Rose* bows were released from the care of the Solent mud, debates have raged about the draw-weights of medieval longbows. These mighty staves suggested draw-weights far greater than had previously been imagined, although circumference is not an infallible indicator of draw-weight – I have seen 100lb bows that have a more slender girth than some 80lb bows. Much depends on the individual stave of timber. Nevertheless, the *Mary Rose* bows were monsters and here they were in magnificent abundance.

Most modern recreational archers shoot bows in a 30lb to 40lb range and those who hunt with the bow find 70lb adequate for killing large animals such as deer. A 90lb bow used to be considered something

These six longbows have been constructed by bowyer Joe Gibbs from a range of woods in use during the medieval period. From left to right, with the draw-weight noted, these are: English yew (118lb @ 32in); plum (100lb @ 32in); ash (130lb @ 32in); hazel (160lb @ 32in); wych elm (160lb @ 32in); and holly (scorched from heat treatment; 130lb @ 32in). (Photograph by the author)

Ian Coote of the EWBS demonstrating the long draw of the medieval archer. The sole surviving complete medieval arrow found to date, the Westminster arrow, has a total length of 30½in. However, a tall man, such as the archer in this photograph, would require an arrow of around 32in. Medieval archers drew their bows back much further than modern archers do – 'Draw, archers, draw your arrows to the head!' (Shakespeare, *Richard III*, Act V Sc 3) – it was vigorous work and it required bows that would take this level of bend. (Photograph by the author)

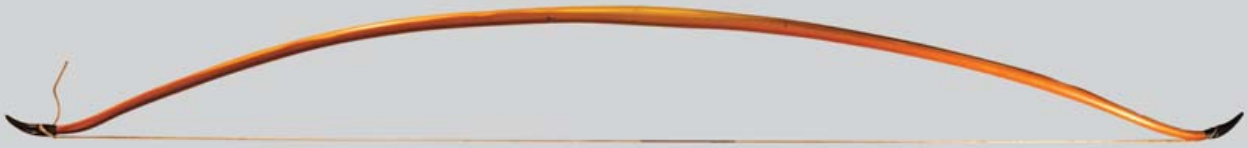
that only rare individuals were able to manage. Now the needle has shifted and 90lb is at the lower end of the dial for today's warbow archers. There are a growing number who shoot bows over 100lb with apparent ease and a select few are shooting above 140lb, with some managing an astonishing 170lb. By the time the printer's ink is dry on this page, there is likely to be a new record. Shooting exceptionally heavy bows is clearly possible and there is no doubt that the heavier the bow, the harder the hit and that there is good military advantage in that. Nevertheless, I consider it unlikely that any but a rare few would find the heaviest bows practical for battle.

In 1355, the year before the battle of Poitiers, archers from Cheshire were paid 6d per day and those from other areas 3d per day (Strickland & Hardy 2005: 204). It is probable that this pay differential distinguished the regular and elite archers, and we might expect the higher-paid archers to shoot stronger bows. However, in battle they too would need to be able to shoot them for a sustained period and with great urgency. When an enemy is bearing down on you, it is not only about what weight you can pull; it is also about the number of repetitions you can manage.

Circumstantially, based on the fact that the capability of armour to defend against arrows improved so much between the mid-14th and the mid-15th century, we can reason that the average draw-weight of bows increased gradually throughout this period in an attempt to edge ahead in the arms race. Everyone will have his or her own opinion and, for what it is worth, mine is that battlefield bows had draw-weights of between 90lb and 120lb around the beginning of the Hundred Years' War and that these increased in the ensuing century to between 100lb and 140lb, with the majority of archers shooting bows at the lower end of these scales.

The fact that people today can shoot bows of 170lb does not necessarily signal that this was a manageable weight in battle, but it does lend credence to the notion that archers of this ability would be capable of sustained, rapid shooting with 120lb or even 140lb bows. They would be the elite, however, and by far the greater majority would be shooting bows nearer the 100lb mark. I do not doubt that super-heavy bows existed for a super-elite of archers and that they could be of use in sieges or at sea, but I question the suitability of anything over 140lb for land battle.

Even drawing a 100lb bow remains a considerable feat, and for the men who bent these bows in battle, the work rate was phenomenal. Lactic acid builds up quickly at these weights, and in a desperate fight archers would have to push through immense walls of pain in order to keep their shafts flying.



The recurved longbow

A distinctive variation of the regular medieval longbow can be seen in many manuscript images. It was recurved at the ends. There is controversy in determining its geographical distribution and the extent of its use during the medieval period. Without the material evidence of actual bows, it is hard to be certain. Some maintain that it was exclusive to the archers in the service of Burgundy; this is based on the fact that recurved longbows are more commonly seen in Burgundian art. English archers were, of course, a mainstay of Burgundian armies during the 15th century, and so even if Burgundy were the source of this style, it may well have been adopted by some English bowmen also.

There is further debate about the method of manufacture. One theory proposes simply that staves were selected which already embodied a recurved profile. Another is that the limbs were bent into shape on a former and heat-treated to set them. (I own such a heat-treated bow. After three years the curves straightened out but they were reset and it has now lasted another six years. I still shoot it quite often. It is my favourite longbow, with a beautifully smooth action.)

ABOVE Modern replica of a medieval recurved longbow, made by Chris Boyton. The advantage of such a design is that the recurved shape makes the limbs work faster, the tips snapping forward like striking snakes, which in turn moves the string faster. This results in an arrow speed that would otherwise have required a bow of far greater draw-weight to initiate. Quite simply, it is a more efficient spring. (Photograph by the author)

The performance benefit of a recurved bow is that it has the ability for better cast – that is, it will propel the arrow further than a straight-limbed bow of equivalent draw-weight. The renowned bowyer Richard Galloway, a proponent of the ubiquity of medieval recurved longbows, calculated that recurving a bow added 20 per cent advantage to the cast (Soar 2010: 38).

It seems probable that there were various regional styles to the profile and cross-section of longbows, and that the option and benefits of recurved limbs were widely known by all. Nevertheless, there is considerably more work involved in fashioning a recurved longbow. They were therefore more expensive and took longer to make, so at times of high national demand it seems more likely that it was straight-limbed bows that were produced and stacked in their thousands in the nation's arsenals.

BUILDING THE LONGBOW ARROW

Arrow supply and demand

'And then the battle raged at its fiercest, and our archers notched their sharp-pointed arrows and loosed them into the enemy's flanks, keeping up the fight without pause. *And when their arrows were all used up*, seizing axes, stakes and sword …'. So wrote the anonymous chronicler of *The Deeds of Henry V*, reporting how the English archers ran out of arrows at the battle of Agincourt in 1415 (quoted in Curry 2009: 36 – my emphasis). It may be true that arrow resupply to detachments on the flanks was more difficult than it would be to archers in the front of the main army, and uncorroborated observations by individual chroniclers have to be read with a measure of caution. Nevertheless, our anonymous chronicler highlights a critical issue for effective military archery – arrow supply!

In 1360, 500,000 arrows were delivered to the national arsenal at the Tower of London, making an impressive addition to the existing stocks; this followed a consignment of 850,000 arrows sent the previous year (Hardy 1992: 84). In 1417, just two years after Agincourt, an order went out for six feathers from every goose; a year later the counties had to supply 1,190,000 goose-feathers to the Tower (Hardy 1992: 83). The Tower of London wasn't the only receiving depot; 11,000 arrows were

dispatched to Bristol prior to the Crécy campaign in 1346 (Hardy 1992: 83), and we may imagine various other regional repositories garnering similar numbers. Other sporadic statistics hint at the scale of supply, which, naturally enough, escalates considerably both just before and just after a campaign.

Apart from the limitations of what the nation's fletchers could supply, there were considerations of logistics, ships and wagons in getting ammunition to the battlefield. We know from the 1513 campaign conducted by Henry VIII (r. 1509–47) that 240,000 arrows required 26 wagons (Hardy 1992: 86). Edward III took around 7,500 archers[3] with him on his Crécy campaign in 1346. For an archer army of this size it is likely that he required between one and two million arrows, which makes for quite a wagon train.

The cost of arrows

Medieval longbow arrows were, arguably, the most expensive form of small-arms ammunition ever devised. Arrows were counted in sheaves, with 24 to a sheaf. At various times statutes required an archer to provide a sheaf of arrows, along with his own bow, as part of his equipment when he was arrayed. In 1356 a sheaf of arrows sold for 16d; arrowheads cost 2s 6d per hundred, and may have represented an additional cost (Strickland & Hardy 2005: 21). Most regular archers were paid 3d per day (Strickland & Hardy 2005: 204), though men of elite corps and mounted archers were paid more. In other words, at this time a sheaf of arrows might cost a man the equivalent of over five days' wages, so not only did his sheaf contribute to the overall army ordnance, it also meant that the archer understood, in a very personal way, the value of each shaft he shot. It was, furthermore, an inducement for him to retrieve what shafts he could for mending at the end of a battle.

Wood for arrows

Roger Ascham, Latin and archery tutor to Edward VI (r. 1547–53) and Elizabeth I (r. 1558–1603), wrote *Toxophilus*, the first book in English on archery, in 1545. It remains a standard work on how to shoot and is full of practical knowledge. In it he exhorts the use of ash for arrow-shafts, saying it is 'swiftest and again heavy to give a great stroke, which asp[en] will not do' (Ascham 1968: 166). He clearly understood the principle that the impact force of an arrow strike was determined by both the weight of the projectile and its speed. He lamented that the lighter, inferior aspen – known more commonly today as poplar – was in contemporary use. Samples from the 2,600 arrows recovered from the *Mary Rose* show that 77 per cent were fashioned from aspen/poplar (Hildred 2011: 674), although nine other woods have been identified.

3 Estimates vary. Clifford Rogers (Rogers 2000: 423) calculates 7,000 foot-archers plus an unspecified percentage of his estimate of 3,500 mounted archers and hobilars. Andrew Ayton (Ayton & Preston 2005: 189) offers a more conservative 5,000 foot-archers plus an unspecified percentage of 3,500 mounted archers and hobilars. I have steered between these two.

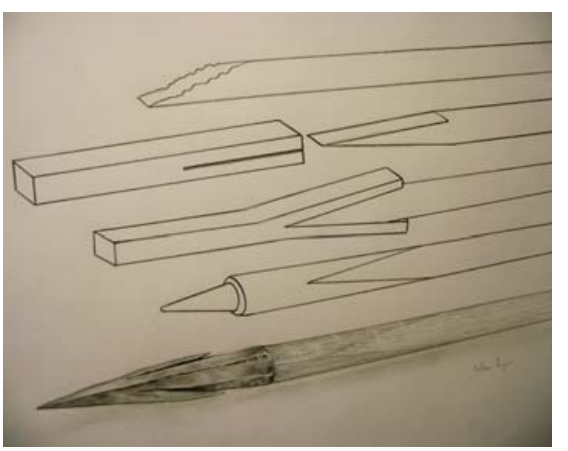
Aspen also appears to have been the wood of choice in the previous century. In 1416, Henry V (r. 1413–22) ruled that aspen could only be used for arrows (PRME: 24: III), prohibiting by the same order its use for pattens (wooden overshoes, with a deep carved sole similar to a clog; they were in widespread popular use during the medieval period). It was a ruling that confirmed his reliance on aspen shafts for his famed archer army. In fact, the preamble to this legislation states:

> 'The fletchers of the city of London and elsewhere in the realm have always been accustomed to use, and still do use, a wood called aspen, and no other wood, for making arrows of all kinds'; it goes on to declare, 'it is probable that within a short time the same wood called aspen will be completely exhausted by the said patten-makers, to the great and perpetual detriment of archery' (PRME: 24: III).

Errant patten-makers were to be fined the princely sum of 100s. This spotlight on potential shortages of arrow-making materials gives support to the idea that damaged arrows may have been harvested from the battlefield and taken for repair.

Recovering and repairing arrows

What percentage of shot arrows survived a battle, to be gathered by the victor, is hard to estimate. Shot arrows that landed on the ground, either directly or by ricochet, were vulnerable to the crowding stamp of both feet and hooves, while those embedded in a dead comrade or opponent might easily break during attempts to extract them. Depending on where an arrow broke, it was possible to repair it, and Ascham mentions 'piecing of a shaft with brazil or holly or other heavy woods' (Ascham 1968: 168). It was an elaborate process (today called 'footing') that involved splicing with fishtail joints, and so it was unlikely to have been accomplished in a campaign camp. With his mention of more exotic woods (brazil wood came from India), Ascham is referring to a bespoke, superior-grade arrow, but it would be equally possible to piece an arrow with the same species of wood as the main shaft. We might imagine that there was some profit in gathering arrows after a battle, including those that had broken near the head. However, they would all probably need expert attention in a fletcher's workshop before they could be recycled for use.



Stages of 'piecing' an arrow. First the broken end of the arrow is cut with precision into a wedge. A piece of new timber is sawn to receive the wedge and the two parts are spliced and glued together. The repair is then shaved to conform to the shape and size of the rest of the shaft. Before a head can be fitted, the foreshaft must be pared to receive it. (Drawing by Matthew Ryan)

By the time of the Wars of the Roses in late 15th-century England, during which both sides used massed archers, there may have been the possibility of gathering up enemy arrows before they were trampled, but in battles such as Crécy, Poitiers and Agincourt, no such opportunity presented itself. Arrow supply remained a critical factor for an army that was reliant upon massed archers.